THE IMPACTS OF COMPUTER/COMMUNICATIONS ON EMPLOYMENT IN CANADA: AN OVERVIEW OF CURRENT OECD DEBATES

Z.P. ZEMAN, PROJECT LEADER

Report

Contract No. 12SV 36100-9-0017, Department of Communications

INSTITUTE FOR RESEARCH ON PUBLIC POLICY
Montreal
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"IGNORE THE CHIP LONG ENOUGH AND YOUR JOB WILL GO AWAY"

"ONE CHIP CAN REPLACE 800 WHITE COLLARS"

POSTERS PRODUCED FOR ASTM, THE U.K.
WHITE COLLAR UNION

"Ilium, New York, is divided into three parts. In the Northwest are the managers and engineers and a few professional people; in the Northeast are machines; and in the South, across the Iroquois River, is the area known locally as Homestead, where almost all the people live."

Kurt Vonnegut

Player Piano, 1952

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PREFACE

The present volume forms the first module of the larger IRPP project, "Study on the Impacts of Computer/Communications on Employment in Canada." It has been jointly sponsored by the Telecommunications Economics, Department of Communications and the Futures Studies Program at IRPP.

Conceived as a literature review, the work began with a thorough computer search of bibliographic material. Over four million titles and abstracts in close to one hundred data bases available on Dialog (Lockheed), Infomart (SDC), New York Times, and QL Systems data bases offered the starting point from which nearly four hundred relevant documents were retrieved. The resulting indexed bibliography forms a separate appendix to this report. This bibliography forms an independently-selected alternative to the bibliography produced in 1978 by Professor S. Peitchinis, Department of Economics, University of Calgary in The Effects of Technological Changes on Educational and Skill Requirements of Industries," Report, ITC, Ottawa, 1978.

Out of the tremendous amount of literature written on the topic, we identified over forty documents as seminal. As many of these documents have influenced the thinking of others, they are sometimes repeated in an abbreviated, sometimes in an extended, version elsewhere.

This report is one of a number of probes that investigate some probable impacts of technological and economic change on Canada, the project led by Z.P. Zeman. It forms part of the Futures Studies Program directed by D. Hoffman.

There are many friends and colleagues in several OECD countries and in Canada to whom we feel obliged. Their names are listed in Part 6 of the report. The authors benefited enormously from a mid-term panel-seminar review of the topic. The lists of seminar participants can be found in Part 6 as well.

Unfortunately, the Citation Index could not be used to determine which documents are more important than others, because most of the documents reviewed here are about three to six months old. Not enough time has elapsed to permit their entry into the Citation Index.

Therefore, discussions with the leading authors and a series of indepth interviews with key informants had to be relied upon. The authors nevertheless feel reasonably confident that the reports selected for review are the more important.

Work represents today only one of the human experiences that have been profoundly influenced by computers. But our mandate has caused us to focus here on only those aspects of human life where we may expect the most dramatic life-style impacts: on employment loss or employment creation.

1. INTRODUCTION

Will Canada have 2.5 million people unemployed by 1990? The answer is "yes" if the authors of a major study which we have reviewed here are right.

Clive Jenkins and Barry Sherman in their new book, The Collapse of Work, published in the spring of 1979, starkly predict that in the U.K. five million people will be out of work by 1990 as a result of a new wave of technological change, mostly due to the current microelectronics revolution.

If we normalize for the size of the populations of our two countries, and if Canada were to follow the path which Jenkins and Sherman predict for Britain, this country might well end up with 2.5 million unemployed by 1990.

Whether such an outcome is really likely is extremely difficult to determine, and we have heard dire predictions before. Back in 1962, Don Michael in his little book, Cybernation - The Silent Conquest, saw and foresaw serious employment consequences of the prevailing automation. Michael asserted that between 1956 and 1962 more than 1.5 million people had been displaced in the manufacturing sector of the United States and that the service sector would not provide any permanent solution to employment because there would soon be job losses in that sector as well.

He went further and identified the kinds of jobs that would disappear. He pointed out that it would not only be blue collar workers but also white collar workers whose jobs would be jeopardized. Professionals and managers would be impacted very heavily as well.

Michael did not, however, provide any time frame for his prediction. He spoke of all these impacts as if they were coming tomorrow. With the benefit of hindsight, when we know much more about the diffusion rates of new technologies, we understand that what he telescoped into one time frame actually would be more likely developed over much longer periods of time than he suspected.

It is not surprising therefore that his and similar voices of doom were overwhelmed in the later sixties, at least in the United States, by what may be called "business as usual school." The National Commission on Technology, Automation and Economic Progress published in Washington in 1966 its authoritative report: The Outlook for Technological Change and Unemployment. This report played a decisive role in the debate on automation. The authority of the report may be attributed to the fact that for the first time a heavily quantified statistical material was introduced into the public debate with a devastating effect on its opponents.

Above all, the Commission's work was very political. The Commission was composed of the representatives of the Big Business, such as Watson of IBM, and of the Big Labour, such as Walter Reuther of AFL-CIO, together with academics such as Daniel Bell, Wassily Leontieff and Robert Solow. Moreover, the research for The Outlook for Technological Change and Unemployment was done between 1963 and 1965, a high point of optimism in the United States. The report, ordered by the President, was supposed to clear "that little cloud on otherwise sunny skies."

One of the report's conclusions was that automation is not dramatically different from any other technological change that has been with us since the beginning of industrial society. The Commission also concluded that the growth of demand would provide the answer to unemployment. If fiscal and monetary policies were correctly managed, demand would grow. Aggressive fiscal and monetary policy would stimulate growth.

The rest of the proposals were New Society recommendations to alleviate the hardships which are bound to be brought about by any structural change - to maintain incomes of those groups that are to suffer from necessary structural readjustments of the economy.

Despite all its inadequacies, the report has been widely accepted as the definitive statement of the problem of technological unemployment.* It knocked off all the prophets of doom like Michael and diminished any sense of urgency to deal with the issue further. Curiously, the ghost of the report is still with us: it appears to have effectively killed any discussion about technological unemployment in the United States and for that matter in Canada. So prevailing has been its influence that no reason has been seen to become disturbed about new technological developments. The technologists'

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* See appendix to Chapter One.

cries of "wolf" were totally discredited. The calmer voices of mainstream professional economists have prevailed.

Today, we know a little more about the diffusion rates of new technologies. We do know that takeover times are measured in decades, not in years. Consequently, we have become more patient in waiting for the social impacts of technology. We therefore understand much better why the alarmists of the '50's were wrong about the impacts of computer technology.

However, it can be argued that the present wave of technology <u>is</u> different. While even mainframe computer technology diffused relatively slowly, the miniaturized computer--the chip--is diffusing seven to ten times <u>faster</u> than any other previous technology. Consequently, within the last two or three years we have observed, especially in European countries, but lately also to a lesser extent in the U.S. and Canada, a revival of the employment debate. The people who propose that technological unemployment is a serious emerging problem say that the predictions of the 1950s will come to us in the 1980s and that they will come to us with a vengeance because we have not prepared for the upcoming wave of new automation.

To better understand the possible upcoming changes, we have felt it useful to review the major voices in the current debate in several OECD countries to establish what others think about the issue. What are the basic positions? What are the core assumptions underlying these positions? What are their internal inconsistencies? Some answers emerge from our literature review.

Appendix 1

SOME HIGHLIGHTS FROM THE HISTORY OF ECONOMIC THOUGHT ABOUT TECHNOLOGICAL CHANGE

CLASSICS

Smith (1776):	- Monopoly retards technological change - Technological change is recognized as an important source of increase of productivity
Malthus (1798):	- Failure to recognize the potential of technological change in agriculture

MARXISTS

Engels (1844):	- Faith in technological change
Marx & Engels (1848):	- Constant revolutionizing of production
Marx (1867):	- Monopoly retards technological change

NEOCLASSICS (1870-1930)

Walras:	- Technological change is not central
Pareto:	- Technological change is continuous
Jevons:	- Monopoly retards technological change

KEYNESIANS

Keynes (1930):	- Technological change neglected - Technological change = residual third factor of economic growth

MODERN

Schumpeter (1928):	- Technological change is central - Competitiveness due to technological superiority - Technological change is not necessarily continuous
Galbraith (1967):	- Automatization of technological change - Technological change prospers under oligopoly
Leontieff (1923):	- Technological coefficients
Solow (1949):	- Technological factor of production

Denison (1967):	- Disaggregated technical change into various components

EMPIRICAL RESEARCH

Jewkess (1958):	- Economists should pay more attention to technological change
Mansfield (1968):	- Relation between R&D intensity and output established
Charpie (1967):	- Relation between non R&D factors and output
Mansfield (1971) Stead (1974) : Sherwin/Bensen (1966)	- Importance of R&D laboratories exaggerated
Jewkess (1969):	- Importance of pluralism in sources of new technology
Machlin (1973):	- Interindustry differences in research intensity
Katz (1971):	- Importance of adaptive R&D (subsidiaries of foreign MNCs)
(1970):	- Shift from interest in invention to the broader context of technological change
Langrish (1972) Gibbens/Johnston (1974) Pavitt/Walter (1974) Langrish (1974)	- Relation between science and technological change: different for different industries

2. OVERVIEW OF THE CURRENT DEBATE ON COMPUTERS/ COMMUNICATIONS AND UNEMPLOYMENT IN OECD COUNTRIES

At the same time as we have been conducting this study, parallel overviews of the debate within OECD countries have been carried out by others. Although there have been exchanges of information with the principal researchers engaged in this activity -- Professor J.-L. Missika, Université de Paris - Dauphine, France; Professor E. Braun, University of Aston in Birmingham, U.K.; Mr. A. Malecki, Metra, London, U.K.; and Dr. H. Markmann, WSI, Dusseldorf, West Germany -- their reports have not been available to us.

Our report therefore proceeds on a country-by-country basis, identifying the extent of interest in the subject and noting the major studies where they exist.

2.1 Western Europe

The debates in western Europe are wide ranging. There is a sense of urgency, of alarm. The European Commission now has several commissions studying aspects of computerization of society.

2.1.1 France

In France, the seminal Nora-Minc Report has highlighted the connection between informatics and employment. The report produced a forecast that

30 per cent of employees in banks and insurance will be redundant within 10 years. This figure certainly stirred lively debate, led to searches for new solutions in employment and has helped trade union claims for shorter (35 hours) working week. The report has galvanized public opinion not only in France but elsewhere in Europe.

The Nora-Minc Report has also generated a wave of counter-reports. We have included as relevant to this review the Bounine-Lussato booklet, as well as the Carré-La Moigne open letter.

Carré-La Moigne's analysis points out that if we accept assumptions of the Nora-Minc Report that some 30 per cent of people employed in the tertiary sector will lose their jobs, it then follows by simple calculation that either Nora-Minc figures cannot be trusted, or that France will be faced with four more million people out of work by 1985.

Carré-La Moigne assume that by 1985, the total workforce in France will be near the 24 million mark and that 50 per cent, that is, 12 million will be employed in the tertiary sector. Thirty per cent of labour force of 12 million means indeed four more million people out of work! La Moigne points out that the present number of unemployed in France is at the 1.4 million mark. Even the most pessimistic projection of the Institut National de la Statisque et des Etudes Economiques (INSEE), one that includes the impact of the second automation wave, does not project more than 2.7 million unemployed for France by 1985. That is far from the total of 5.4 million of unemployed that could be derived from Nora-Minc predictions. Carré-La Moigne stress the risks involved in sensationalizing debates by extreme projections.

Important contributions to the French debate on the employment aspects of "informatique" were marked by two recent events: L'Informatique et L'Emploi (Computers and Employment) meeting in April 1979, organized by the Fondation Frederick K. Bull, and the great public debate Semaine Informatique et Société, held in September under the aegis of the French Ministry of Industry.

The forthcoming informatization of society, which includes employment impacts of computers/communications technology, is seen by many in France not only as the new industrial revolution but also as a major mutation of our civilization. Informatisation et Société catapulted the issue of informatization of society into the forefront of the public policy domain. This massive symposium, with over 7,000 participants, has attracted the attention of the highest officials of France, such as France's President, Valery Giscard d'Estaing, and the Prime Minister, Raymond Barre, as well as the general public.

One of the contributors to the conference, Michael Cooley, a trade unionist from the U.K., pointed out that "although the basis of unemployment is cyclical, a main feature is that its base is continuing to rise." He expressed concern that we may be moving into what was termed a form of New Feudalism - a dual economy, where on one side a small elite is working and on the other, a large mass of people are displaced.

However, during the deliberations of one of the conference's Commissions (C5) two case studies of banking, insurance and accounting industries (M. Dubrulle, P. Rauchon and C. Salzman) were reported. These, contrary to their expectation of discovering reduced employment, have found that between the mid-sixties and mid-seventies the employment levels in fact grew, even though more slowly (at about a 50 per cent rate) than the volume of services, admittedly with some evidence recently of a further slowdown.

Preliminary results of a major study on the effects of computerization on employment in France by 1985* were also reported, showing that while several tens of thousand jobs will be created in services, more than 200,000 jobs will be eliminated. Employment levels will be stabilized, while one million new entrants are expected on the labour market.

The conference's Commission (C5) on Informatization and the Level of Employment, concluded that it is difficult to forecast precisely the effects of informatization on employment outside of the computer/telecommunication industry. The problematique is simply too complex.

However, it was recognized that if potential negative impacts are to be coped with, great co-operation among different social partners is called for.

Thus, in France, a more balanced picture is emerging in recent months.

2.1.2 The United Kingdom

The technological employment issue debate is extremely intensive in the U.K., having drawn a flood of articles, reports and books. We have felt obliged to include here at least the Jenkins-Sherman book, an Association

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* Pastre, O. et al. Automation, Travail et Emploi: Etude empirique des principaux automatiques avances et éléments d'approche macro-economique. IRIS, Paris, 1979.

of Scientific, Technical and Management Staffs (ASTM) discussion paper, Barron-Curnow's and Osborne's books, as well as Freeman's, Stonier's, Hayman's and Hines' papers. Barron-Curnow's book provides the best comprehensive and carefully documented analysis of the issue from a single point of view.

The reviewed work suggests that while there are considerable benefits in the form of cost savings to be reaped from the use of microelectronics, a substantial part of these savings would be savings of labour. A major reduction in the need for unskilled, semi-skilled and female labour is expected.

While the University of Warwick's 1978 study predicts 10 per cent of unemployment by 1982, Barron-Curnow predict 16 per cent unemployment by 1990 and Jenkins and Sherman forecast 25 per cent unemployment rate by 1990. Stonier (1979) predicts that, within 30 years, no more than 10 per cent of the population will be employed in the present sense of the word.

It is therefore not surprising, in light of such startling forecasts that negative employment consequences of the new technology dominate the heated debates. It is only in the most recent trade union document - Lea, 1979 - that one finds some toning down of the trade union fears.

While in Canada, very few people so far have been concerned about, let alone actively worked on, issues of technological unemployment, quite a different picture emerges from the U.K.: there the Central Policy Review Staff oversees and co-ordinates all research work in this area; the Manpower Study Group within the Department of Employment conducts studies of this issue as does the Advisors Council for Applied Research and Development (ACARD). The Department of Industry is organizing a widespread campaign of awareness of microelectronics technology. In addition, the Department of Education and Science is responsible for starting massive retraining with the Manpower Commission.

2.1.3 Federal Republic of Germany

It has been variously estimated that about 5 million workplaces in trade, industry and public administration - some quarter of the total workforce - will be altered significantly as a result of technological change within the next 5 to 10 years. The conventional view holds that the social consequences of this development can be only partially foreseen. Nevertheless, the federal Minister for Research and Technology has responded to these uncertainties by starting a dialogue on technology policy, the so-called "Technologie-politischer Dialog."

The dialogue is being carried on at two levels: at the first level, the decision makers - trade unionists, industrialists, academics and politicians - have started to discuss the speed, scope, framework, probable social impacts as well as possibilities of controlling this technological change. On the other level, the wider public debate is being conducted with the help of the media.

A number of reports dealing with new technological unemployment have been produced recently:

- Prognos Study (Ahfeldt) 1978
- Battelle Study (Baden-Wurtenberg) 1978
- Management Institut Hohenstein Study
- ISI Study (Bavaria) 1978

- Topfer Study on Watch Industry 1978
- IAB Investigation 5-44 (1971-1976)

Highlights of these six studies have been included in our main selection.

In the Federal Republic of Germany, at least twelve different projects on microelectronics/communications and their employment consequences are now in progress, ranging from the impact of word processors to effects on the machine tool industry.*

In addition to these twelve reports in progress, the Economic and Social Science Research Institute of German Trade Unions (Wirtschafts und Sozialwissenschaftlichen Institut des Deutschen Gewerkschaftbundes) in Dusseldorf is undertaking a major project on this topic for the Trilateral Commission (Project Director, Dr. Heinz Markmann). We have included in our review an article by one of the Institute's leading researchers, Dr. Ulrich Briefs.

An unpublished, but widely cited, report "Buero 1990" produced in 1976 by Siemens, A.G., is still influential with its key prediction that 40 per cent of office work could be eliminated in this wave of technological change. It is not included in our annotated set, because it is not in the public domain.

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* See appendix to Chapter Two.

2.1.4 Italy

If there is a public debate on technological unemployment in Italy, it has escaped our attention. We have included only B. Lamborghini's paper in our selection. It is a rare species. Written from within industry, it nevertheless demonstrates significant concern for the issue.

2.1.5 The Netherlands

An important study of new technological unemployment was started for the Ministry of Social Affairs by a London-based consulting company, METRA (A. Malecki). At the time of writing it was just getting under way.

2.1.6 Sweden

Attempts to quantify the employment effects of computerization were undertaken in the 1970s. Since the report of a special Reference Group for the Commission on the Computer Industry in 1974, continuous investigation has been conducted by the National Industrial Board. In parallel, the Central Bureau of Statistics has attempted to calculate the effects of computerization on the labour market. While job losses in the office sector were forecast, in fact, since the calculations were made, the total number of persons employed in the office sector has continued to increase.

In spring 1979, the Commission on Computerization and Employment started its work, under the mandate of the Minister of Labour. Their report is now expected by the end of 1979 or early 1980.

2.1.7 Norway

Norway, until 1978, enjoyed practically full employment. Therefore research focussed on problems of working conditions rather than total level of employment. However, by 1979, Norway had launched a massive study on employment in the 1980s.

The Commission on Information Technology and Employment, within the Department of Labour, is expected to produce their first report (in Norwegian only) by January 1980.

A general agreement between the Norwegian Federation of Trade Unions (LO) and the Norwegian Employees Confederation (NAF) concerning gradual introduction of automation technology is in place.

2.2 Japan

While one can detect a sense of near panic in Western Europe, a quite contrasting view emerges from a review of the materials from Japan: here there seems to be no fear of technological unemployment.

The reasons for the relative lack of fear of technological unemployment can be summed up as follows:

1. The Japanese started to study this topic intensively in the late 1960s.
2. They mastered the new microelectronics technology to the extent that they have become its net exporters, in fact exporting unemployment.

3. Trade union voices on the national level in Japan are relatively weak and even if the issue is perceived by them as imminent, it would be unlikely that it would gain prominence.

4. To a considerable extent, the life-time employment system for the elite workforce helps significantly to alleviate fears of new technological unemployment. On the contrary, it allows the workers to embrace automation.

In our review of the major studies, we have therefore included only the JACUDI report, written basically by Yoneji Masuda, aided by numerous other experts.

2.3 The U.S.A.

As has already been suggested, very little policy discussion on the issue of electronic unemployment is heard in the U.S.A. One explanation is that Americans are still under the considerable spell of The Outlook for Technological Change and Unemployment. Another might be the fact that, in a so highly heterogeneous economy, there is simply no one who can see the total employment picture. A further obvious reason is the fact that the U.S. is very strong in microelectronics and therefore, like the Japanese, are still benefiting in employment creation more than they are displacing or actually losing in employment. Last, but not least, is the prevalence of the complacent view that once the new technology arrives, it will create new industries.

In our view, Professor Leontieff's articles and Professor Machlup's report are probably the studies with the best theoretical foundations. Professor Machlup's (co-authored with Dr. Bitros) is a comprehensive report which contains, among other things, the best available survey of the past theoretical literature.

Within the National Science Foundation, at least two relevant projects are under way. Within the Socio-economic Effects of Science and Technology Program (R. Piekarz, Group Leader), L. Jacobson of the Institute for Naval Analysis, Alexandra, Virginia, is analyzing "Labour Adjustments to Technological Change: Multi-Industry Study" with an econometric model. It should also be noted that Professor W. Cook, Institute for Industrial Relations, University of California, Berkeley, is studying the "implications of technological change within the computer industry" for another NSF program (A. Fechter).

Significantly, there is practically no work done on microelectronics and employment in the Office of Technology Assessment. The closest thing that comes to it is the project of O. Pengov, in which Fred Wood is conducting a study on electronic mail. However the project has been suffering lately from budgetary cuts. (The Conference Board has also more or less abstained from the issue.)

However, within the Department of Commerce, the Industrial Innovation Domestic Policy Review Program, directed by Dr. Jordan Baruch, has come close to investigating the employment implications of the new technology. In addition, the Bureau of Labour Statistics has produced a number of high quality employment outlooks for various individual industries. We have included (in one entry) all four of J.J. Macut's reports, as well as a summary paper by J.A. Mark.

Elsewhere, Professor Lund at MIT is working on a project on automation. Two documents are reviewed in our selection. A Delphi exercise on the impacts of robotization on the workforce in the car manufacturing industry, produced by the University of Michigan in 1978, although not included in our review, provides some interesting figures for those interested in sectorial analysis of car manufacturing. Similarly, Professor Gilchrist's work on Point-of-Sale (POS) terminals will be of considerable use to those interested in particular problems in the distribution area.

From the West Coast of the United States, there is a strong voice of alarm coming from the Stanford Research Institute. We review Willis Harman's report and article here and take note of the work of another SRI researcher, Dr. Rosen, who forecasts that by the year 2000 there will be no more than 5 to 10 per cent of the U.S. population working in the manufacturing sector.

Although still very much a minority view, there is growing evidence of similar concerns.

Dr. Martin in the U.S. Office of Education is one of the latest voices to warn of the possible negative consequences of the new technology. Then, of course, there are statements from labour: the UAW, the postal unions and the Communications Workers of America - none of them so far strong enough to make electronic unemployment a national public policy issue.

However, M.O. Dymmel's paper, speaking on behalf of CWA, could provide the flavour of official trade union statements in the future.

Further, the two bills in front of the U.S. Congress - those on job relocation and on protection of jobs - together with the upcoming joint meeting of British Trade Unions (TUC) and the U.S. Trade Unions (AFL-CIO) in Washington, D.C., suggest that the issue of technological unemployment might gain more prominence in Washington.

2.4 Canada

Thus far in Canada the level of public debate on technological unemployment is quite insignificant. In large measure this may be because of the spill-over of the dominant U.S. view on the subject. In fact, a domestic study done in 1968-1970 by Professor Noah Meltz, prior to the introduction of the Unemployment Insurance Act, came to roughly the same conclusions as the 1966 report on technological unemployment in the U.S. In any case, the issue has not evoked great attention outside a few institutions. On the other hand, if our information is correct about the foreseeable emergence of the "computerized unemployment" issue in Washington, one may expect - in now fairly predictable fashion - the emergence of the same issue in Ottawa, as well as in Toronto and Quebec City.

We assume that the Canadian literature originating within government is known to our readers. We have therefore opted for not including it in our review.

Important work has been done within the Canadian government by M. Prentis, J. Halina, M. Andrieu, M. Estabrooks, S. Serafini, P. Robinson and H. Brune, all experts in the Department of Communications.

Some attention has been paid to the issue from outside government. Professor E. Beach of McGill has provided some early interesting theoretical work on this topic and Professor K. Valaskakis and P. Sindell of the GAMMA group have proposed a program for the study of employment issues arising from the information revolution within the framework of their project on the Information Society. The as-yet-unpublished work of Professor G. Warskett of Carleton University also deserves special mention.

Within the Economic Council, Dr. D. DeMelto's group is closest to the technological employment issue. Elsewhere, the work done by Scrimgeour and his colleagues in the Industry, Trade and Commerce on computer-assisted design/computer-assisted manufacturing in several areas overlaps with the topic at hand. In the Science Council, Dr. A. Cordell, responsible for the project paralleling GAMMA's project on the Information Society, also has interesting plans for seminars on the employment and automation.

The strongest expression of concern has been heard from the trade unions. The most interested parties on this issue are the Canadian Union of Postal Workers, Canadian Federation of Communications Workers and the United Automobile Workers.

Returning to the major works in the general debate, in our detailed review, we have selected only the most comprehensive Canadian study published to date - a study of Dr. S. Peitchinis of the University of Calgary done for the Department of Industry, Trade and Commerce (ITC).

2.5. <u>International Organizations</u>

National studies are not the only elements to be considered in our review of the literature. In fact, several important studies have emerged from international organizations.

The Washington-based World Watch Institute, Trilateral Commission, UNITAR, OECD and the International Labour Organization are the strongest voices interested in the international employment impacts of the electronics/computer/communications technology.

We have included in our review the work of Rada, Lemoine, Lamberton, Jenness and ILO documents on telecommunications as the best representatives of these efforts.

Appendix to Chapter Two

A LIST OF SOME CURRENT STUDIES

1. Study sponsor: RKW

   Project A 135: Labour Economic and Social Impacts of New Technologies in Text Processing

   Study Investigators:
   IFO - Institute for Economic Research, Munich
   IFS - Institute for Social Science Research, Marburg
   IAD - Institute for Labour Science, Darmstadt

2. Study sponsor: RKW

   Project A 126: Employment and Social Implications of Rationalizing in Selected Plants

   Project Investigators: Institute of Sociology, Berlin

3. Study sponsor: RKW

   Project A 133: Introduction of Microprocessors and Microcomputers: Economic and Social Impacts in Machine Tool Engineering

   Project Investigator: ISI Karlsruhe

4. Study sponsor: Bavarian Ministry of Labour

   "Employment Impacts of Structural and Technological Changes in Selected Industries of Nuremberg/Furth/Erlangen Area"

   Study Investigators: Dorsch-Consult Munich

5.	Study sponsor:	Federal Ministry of Economics
		"Technological Progress - Impacts on Economics and Labour Market"
	Study Investigators:	ISI, Karlsruhe Infratest, Munich IFO, Munich
6.	Study sponsor:	Federal Ministry for Research and Technology
		"Technological Progress - Impacts on Economy and Labour Market"
	Study Investigators:	Prognos, Basel Mackintosh Consultants
7.	Study sponsor:	Ministry of Social Affairs, Hessen
		"Social Consequences of the Growing Implementation of Microelectronics in Certain Branches"
	Study Investigators:	ISI Karlsruhe
8.	Collaborative study:	"Sectorial and Occupation Specific Impact of Information Technology"
	Collaboration:	ASA, Koln BMA, Bonn DIW, Berlin GMD, Birlinghoven IAB, Nuremberg
9.	Study sponsor:	RKW
		"Economic and Social Impacts of Automatic Text Processing"
	Study Investigators:	ISI Karlsruhe

10. Study sponsor: BMFT

"Flexible Finishing Systems and their Impacts on Employment Positions"

Study Investigators: IAB
ISI, Karlsruhe
IWF, Berlin

11. Study sponsor: Austrian Federal Ministry for Science and Research

"Application Areas and Impact Assessment of Microelectronics in Austria"

Study Investigator: Institute for Socio Economic Development,
Austrian Academy of Science,
Vienna

12. Study sponsor: BMBW

"Impacts of Microelectronics on Manpower Training and Licensing Policy"

Study Investigator: Battelle Institute
Frankfurt

FOOTNOTE

1. Within the context of this review, the issues of technological unemployment in the Comecon countries have been excluded. In general, these countries have been so far fully committed to full employment with exports of migrant labour of some countries (Yugoslavia, Poland). Concern about the erosion of government policies by technology could be heard.

The re-emerging cautious reform of Hungarian economy, brainchild of Dr. Huszar, counts with admitting for the first time an ideologically explosive phenomenon of unemployment.

3. SELECTED KEY DOCUMENTS

3.1 Introduction

With all the sources and issues outlined above in mind, we finally selected some 42 which we consider fundamental. There are some important documents that have simply not reached us in time for inclusion. Others, though important, have not been analyzed among the "major works" because we have assumed that they are well known to Canadians. These have been included, nevertheless, in the Selected Bibliography. In addition to the 42 key documents, we have also found a place for excerpts from some minor works that we have judged to be of considerable interest.

The ordering of the entries in the list that follows is quite deliberate: items one through forty-one have been arranged from what we consider to be the most "pessimistic" to the most optimistic. Entry 42, the report by Dr. Juan Rada, has a special significance - we consider it to be the most comprehensive survey of the state of the art to date.

3.2 MAJOR WORKS

1. JENKINS, C. and SHERMAN, B. (ASTM). The Collapse of Work, 1979.

2. SHERMAN, B. et al. (ASTM). Technological Change, Employment and the Need for Collective Bargaining, 1979.

3. LEA, D.E. et al. (TUC). Employment and Technology, 1979.

4. STONIER, T. (U.K.) "Technological Change and the Future," 1979.

5. FRIEDRICHS, G. (West Germany). "Microelectronics - A New Dimension of Technological Change and Automation," 1979.

6. HARMAN, Willis W. (SRI). Chronic Unemployment and Underemployment, 1978.

7. HARMAN, Willis W. (SRI). "Chronic Unemployment: An Emerging Problem in Postindustrial Society," 1978.

8. LEONTIEFF, W. (USA). "Is Technological Unemployment Inevitable?", 1979.

9. LEONTIEFF, W. (USA). "Employment Policies in the Age of Automation," 1978.

10. OSBORNE, A. (U.K.) Running Wild - The Next Industrial Revolution, forthcoming.

11. HINES, C. (ERL). "The Chips are Down," 1978.

12. BARRON, Iann (INMOS) and CURNOW, Ray C. (SPRU). The Future with Microelectronics: Forecasting the Effects of Information Technology, 1979.

13. NORA, Simon and MINC, Alain. (France). L'Informatisation de la Société, 1978.

14. BOUNINE, J. and LUSSATO, B. (France). Télématique...ou Privatique? Questions à Simon Nora et Alain Minc, 1979.

15. CARRE, D. and La MOIGNE, J.L. (France). "Pour un Contre-Rapport Nora," 1978.

16. MAGNUSSON, B. (Sweden). Electronic Data Processing and Manpower, 1977.

17. ERLANDER, B. (Sweden). Effects of Computerization on Employment and Working Environment, 1979.

18. FREEMAN, C. (SPRU). Technical Change and Unemployment, 1977.

19. FREEMAN, C. (SPRU). "The Kondratiev Long Waves, Technical Change and Unemployment," 1977.

20. LAMBORGHINI, B. (Italy). "The Diffusion of Microelectronics in Industrial Companies," 1979.

21. LAMBERTON, D. McL. (OECD). "Social Costs of Change, Employment, Professional Skills and Curricula," 1978.

22. MACHLUP, F. et al. (NSF). Effects of Innovations on Demand for and Earnings of Productive Factors, 1974.

23. PEITCHINIS, Stephen G. (Canada). The Effect of Technological Changes on Educational and Skill Requirements of Industry, 1978.

24. PEITCHINIS, Stephen G. (Canada). "Technological Changes and the Sectoral Distribution of Employment," 1979.

25. LEMOINE, P. (OECD). "Informatisation and Economic Development," 1979.

26. LUND, R.T. et al. (MIT). Industrial Automation - Its Nature, Effects and Management: Critical Issues Report, 1978.

27. LUND, R.T. (MIT). Microprocessor Applications: Cases and Observations, 1979.

28. HAYMAN, C. (CPRS). "Social and Employment Implications of Micro-electronics," 1978.

29. TOPFER, P. (Germany). Impacts of Technology: Developments in the Workplace in German Watch Industry, 1978.

30. MANAGEMENT INSTITUT HOHENSTEIN. (Germany). Inquiry into the Third Technological Revolution.

31. AHFELDT, H. (Switzerland). Economic and Labour Market Development in Federal Republic of Germany and Baden-Wurttemberg, 1978.

32. ISI. (Germany). Impacts of Microelectronics on Bavarian Economy, 1978.

33. BATTELLE. (Germany). Technological Development and its Impacts on Work Place in Machine Manufacturing and Precision Engineering, 1978.

34. DOSTAL, W. and ULRICH, E. et al. (IAB). Impacts of Technological Change on Labour, 1977.

35. DYMMEL, M.D. (USA). "Technology in Telecommunications: Its Effects on Labour and Skills," 1979.

36. ILO. (Geneva). Effects of Technological Changes on Conditions of Work and Employment in Postal and Telecommunications Services, 1977.

37. JENNESS, R.A. (OECD). Manpower and Employment: Problems and Prospects, 1978.

38. MASUDA, Y. et al. (JACUDI). Social and Economic Effects of Information-Oriented Investment, 1974.

39. MACUT, J.J. et al. (USA). Technological Change and Manpower Trends in Major American Industries, 1974.

40. MARK, J.A. (USA). "Impact of Technological Change on Labor," 1979.

41. WASSERMAN, J. et al. (ADL). Strategic Impacts of Intelligent Electronics in U.S. and Western Europe 1977-1987, 1979.

42. RADA, Dr. Juan F. (FLASCO). Microelectronics: A Tentative Appraisal of the Impact of Information Technology, 1979.

3.3 MINOR WORKS

1. BRIEFS, U. (FRG/WSI). "The Effects of Computerization on Human Work," 1979.

2. ELLING, Karl A. (USA). "Co-determination by decree is not a panacea," 1976.

3. YOUNG, Howard. (USA/UAW). Jobs, Technology, and Hours of Labour: The Future of Work in the U.S., 1978.

4. ROSS, David P. (OECD). "Unemployment in the Industrialized World," 1978.

5. BENN, A. (U.K.). "Eight in Ten Secretaries Will Lose Jobs," 1979.

6. McINTOSH, T. (U.K.). "Union Agreement Could Herald Electronic Office," 1979.

7. NILES, Jack M. (USA/USC/NSF). "Opportunities and threats from the personal computer," 1979.

8. ENGBERG, Ole. (Denmark). "Who Will Lead the Way to the 'Information Society'?", 1978.

9. POST NEWS. (U.K.). Electronics in Supermarkets, 1979.

10. ROSEN, A. (USA/SRI). "Percentage of the Labour Force in Manufacturing in the Year 2000," 1979.

The detailed, individual items and selected bibliographies are to be found in Chapters Five and Seven.

4. OUR CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

The purpose of this study was to provide a review of the most significant literature dealing with the impact of computer/communications technology on employment. This we have done in great detail in Chapters Two and Five.

However, we are not content to leave the matter there. Fresh from our bath in the minutia of conflicting viewpoints, we are inclined to offer some tentative observations on the nature of the debate and to draw -- from our clear impression of its inadequacy to date -- conclusions about the direction of appropriate further research.

4.1 The Nature of the Debate

The present debate on this extremely complex issue is not in fact a structured dialogue. Instead, the situation could be viewed more faithfully as an unstructured series of parallel, or even better, tangential monologues. The voices in the discussion differ widely in their theoretical presuppositions, working with different levels of abstraction. The individual documents also differ widely in scope and in the method used. In contrast to the great sophistication and variety of theoretical propositions concerning technological unemployment, the available empirical evidence is too weak to help the critical analyst to orient himself.

The reviewer of the current literature cannot but be struck by the relatively poor factual base on which the present debates are conducted. The controversy appears clearly to be ideological in nature. It is therefore important always to keep in mind the Weltanschaung (worldview) of the individual author. Furthermore, it is always necessary to keep in mind the affiliations of the people who speak. We have therefore identified, as far as possible, the affiliation of the author. Clearly, the labour-related spokesmen demonstrate a tendency to stress the negatives, while the management-related researchers and authors attempt to minimize them and to stress the positive contributions of the new technology.

To repeat, the nature of the debate is above all political and should be judged as such.

4.2 Imprecise Basic Framework of Analysis

Most of the reviewed works are generally cast in a simplified framework.

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where ⟶ is meant to be either "effects" or "consequences" or "impacts."

In fact the interaction of these two elements is anything but the relation suggested by the words used. The true interaction reminds one more of a ballet, where both elements are in constant movement. These interactions create a fascinating sequence of "kaleidoscopic" successions of ever new configurations. That is why it is so difficult, if not impossible, to produce any authoritative and respectable forecast on the resultant level of technological unemployment.

4.3 Polarization

Crudely speaking, there have been two poles to this rather confused and ill-structured debate. These poles are usually characterized as "massive unemployment," and "business as usual." Most of those involved in the unemployment debates are hybrid participants, or would at least disclaim the more extreme viewpoints.

The major contributors are clearly identified with one or another pole in the debate. But an objective observer can quite legitimately recognize, at least partially, the validity of both positions.

To dichotomize is by no means to indulge in a purely hair-splitting academic controversy. It raises major issues of contemporary policy towards technological unemployment. Consequently, it is not surprising that some participants in the debate have had decision making responsibilities. Nor would it surprise a sociologist of technology to find that studies sponsored by agencies responsible for industry (ITC or CB) have come up with findings which by and large might justify "business as usual" interpretation, whilst studies sponsored by labour have come up with rather a different emphasis.

This does not necessarily justify a cynical view of a debate, although it provides additional evidence of the extent to which the interest groups may influence the choice of subject matter and emphasis of interpretation. The complexity of the issues and paucity of the information base mean that it is quite legitimate to entertain the possibility of several interpretations until further evidence shows more conclusively which of them (if any) is correct.

4.4 Unrealism of the Ultrapessimistic Forecasts

The authors of extremely pessimistic forecasts usually have fallen into one or several of the following traps:

1. An excessive extrapolation
   - from a case in a single or several companies, a vast extrapolation is made for a whole sector, if not economy.

2. Ignoring interactions among sectors of economy
   - these usually will have an attenuating effect on any dramatic local change.

3. Ignoring social resistance to technological change
   Technological change is always introduced in a particular setting - economic, as well as social or political. It is unrealistic to expect that when, for instance, office workers are faced with mass layoffs, they would remain

still and not start organizing themselves to protect their endangered jobs. In fact, in the U.K. and Norway, technological agreements to this end are already in place.

Managers, especially the middle-management, are also likely to resist the change as automation transforms the organization structure and "deskills" managers' jobs.

Public opinion, reflected in the media, may be another factor that would tend to slow down the diffusion rate of the new technology. A recent opinion survey* revealed that 71 per cent of people believe that computers create unemployment, while only 24 per cent believe that they create employment. This is nearly exactly the opposite of what the people in the industry believe.

Another bottleneck often mentioned is the lack of specialist workers (rare skills) that would eventually put a brake on rapid introduction of the new technology. Many industries simply do not have enough people at the present time or in the near future to implement all the possible microelectronics applications.

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* Brune, H.H. (1978) "The Social Implications of Information Processing." Paper, CIPS/ACM meeting, Ottawa, December 12, 1978.

Whether capital shortages would ultimately present yet another bottleneck, is also the matter for debate. The people who do not see it as an obstacle point out the low capital requirements of microelectronics. On the other hand, even a simple calculation can demonstrate that a tremendous amount of capital would be needed to replace say 20 per cent of the workforce by technology. In times when capital productivity drops and manufacturing must compete with energy capital requirements, it seems quite unlikely that the amounts needed would in fact be available.

4. <u>Ignoring the differences between the most and the least progressive companies</u>

Triggering technology is not introduced simultaneously in all companies the moment technology is available. The differences between individual companies are enormous. Significant lags between the leader and the followers can result.

4.5 Quantification

Individual authors in the current debates most often resort to qualitative statements about employment consequences of the new wave of information technology. In several cases comprehensive attempts to quantify were made but all appear to provide an element of "hardness" to what is otherwise still a very subjective base.

1. Peitchinis (1978), attempts to assess the importance of impacts of new technology in various sectors of the economy (industrial classification) by expressing first their relative importance as a fraction of their contribution to the formation of the Gross National Product (GNP).

   On an arbitrarily selected scale of ten, a small group of three experts selected subjectively the degree of impact on the sector. The impact then is simply a product of the share of GNP and of this degree of impact.

2. Jenkins-Sherman (1979) provide the guesstimates of numbers of people losing jobs in individual sectors. The risk of job loss is classified as high/more risk, minimum and zero. No quantitative value of the risk is given. There exists no standard methodology for producing the final figures. The methodology is not revealed in the text. As admitted by one of the authors, it is based on estimates derived from proprietory surveys of the ASTM and other unions. Apparently the situation of a number of key companies was analysed and a generalization for the whole industry was made.

3. Barron and Curnow (1979) looked first at the industrial sectors, and then, dissatisfied with the existing industrial sector classifications that tend to mask the pervasiveness of some technologies, turned to the potentially more useful occupational concept.

   The potential job-loss is expressed as a product of a population in a particular category and a subjectively-derived degree of estimated risk. The risk is specified as high, medium, low or zero. In the pessimistic scenario, the job loss factors associated with the above degrees of risk are 50, 25, 10 and 0 per cent respectively. In the optimistic scenarios the job loss factors are specified as 25, 10, 1, 0 per cent respectively.

To sum up, the attempts to analyse the issue quantitatively have so far been less than satisfactory. No account is taken, for instance, of the development of entirely new industries. This significant omission contributes to the leaning towards more pessimistic scenarios. Furthermore, the authors inevitably suffer from an inability to forecast in all sectors with the same degree of understanding. More seriously, in all three quantitative attempts which we have reviewed, the authors analysed sectors or occupational groups in isolation. The intersectorial linkages were completely ignored.

The crucial consequence of this omission is that, again, pessimistic figures are arrived at, probably more pessimistic than would be warranted from a more realistic, systemic view. If considered, interactions within the economy as a whole would tend to mitigate the job loss impacts.

Finally, the feedbacks present in the economy will tend to produce surprises - or in other words, exhibit "counter intuitive behaviour." The quantitative results themselves must be accepted with extreme caution. Their uncritical acceptance can even be dangerous. The illusion of expertise is created in an area where none exists.

4.6 The Crucial Importance of the Core Assumptions

While quantitative calculations are, again in our view, secondary, it is much more important to look at the core assumptions underlying the individual items reviewed. To paraphrase Ascher (1978),* the core assumption represents the author's basic outlook on the context within which the specific issue of phenomenon of "computerized unemployment" is perceived. These assumptions have been chosen more or less independently of the subsequent treatment of the problem. When the core assumptions are valid, the rest is either secondary or obvious. When the core assumptions fail to capture the reality of the context, other elements of an elaborate and painstaking analysis such as degree of detail, degree of sophistication in quantitation, and so on, generally make little difference. Even worse, often the authors draw their evidence from studies where the core assumptions are completely submerged or unstated. The reliance on core assumptions, for example, coming from <u>previous</u> forecasts of employment is likely to be even less accurate and relevant - the so-called "assumption drag" is yet another source of potential error.

4.7 Some Conceptual and Analytical Difficulties

4.7.1 The concept of "technological unemployment"

In the past, most economists armed with analysis based on general-equilibrium

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* Ascher, W. (1978) <u>Forecasting: An Appraisal for Policy-Makers and Planners</u>. Baltimore: Johns Hopkins Press.

theory have denied that technological change can create permanent unemployment, while a minority, starting perhaps with the late John Stuart Mill, have dissented from such a view. At present, the situation has reversed: the most widely held view accepts the possibility of technological unemployment. However, a strong minority, represented by economists such as Hayek or Machlup, continue to deny the validity of the concept of technological unemployment itself. The limited theoretical underpinnings of the debate in general is remarkable. From one side, the theoretical concern has centred mainly on references to the existence of Kondratiev cycles, without much further explanation of the notion. On the other side, no good discussion of the inadequacies of the general equilibrium model has been found among the papers presently under review.

4.7.2 The nature of the triggering technology

The positions associated with less pessimistic forecasts tend to see the new wave of technological change connected with microelectronics as just another case of technological change: traditionally, we have been able to cope with it; we shall cope again. However, the pessimists argue that microelectronics is not a new technology like the others. It is pointed out that the rate of diffusion of microelectronics has the shortest known takeover time. While for traditional technologies these have typically been measured in decades, for microelectronics the takeover time is measured in years -- a degree of magnitude of difference. What is more, microelectronics nearly exclusively substitutes technology with very little complementarity of role. It is further pointed out that microelectronics is a technology that permeates practically all sectors of the economy. Nearly anywhere where information has so far been processed, either manually or mechanically, the chip could enter. The chip is also a new, major reorganizer of the work situation, permitting decentralization where once the logic of concentrated computer power suggested centralization. Moreover, it is a truly transforming technology, being so close in its "intelligence" to what we consider to be essentially human.

Those who foresee major employment implications claim, furthermore, that the chips will so profoundly alter our society that it is appropriate to speak not only of finding ourselves in the trough of the fourth Kondratiev long wave, but of the existence of the third industrial revolution.

Needless to say, evidence for either proposition has so far been scarce.

4.7.3 Factoring out technological unemployment

It appears extremely difficult, but not entirely impossible, to factor out that part of the unemployment rate which can properly be ascribed to technological unemployment. The new wave of technological change is arriving at a time of general slowdown or even decline in the OECD economies, where capital productivity is falling. We are witnessing simultaneously a large international transfer of technology from OECD countries to the new industrialized countries, which has had the effect of internationalizing the microelectronics industry. How much of the change in employment (rate of growth of unemployment) can be attributed to this phenomenon?

Policy-induced unemployment -- that attributable to the existence of unemployment insurance and minimum wage legislation for example -- represents another factor to be taken into account. And how much shall be allowed for so-called frictional unemployment? Furthermore, on the supply side, the increased participation of women and exceptional bulges in the new entries to the labour force created by the baby boom wave are other factors that must be discounted before one can arrive at the "dirty residual" -- that part of the unemployment rate that can, with some degree of certainty, be ascribed to the effects of technological change.

4.7.4 The problem of fictitious jobs

In many projections which we have reviewed, potential job savings said to result from the introduction of the new microelectronics-based technology, are compared with what are really fictitious jobs. Authors of such forecasts, of course, assume the *ceteris paribus* condition, not taking into account the fact that rising costs, relative slowness in the actual introduction, and the low reliability of non-automated systems, would negatively influence the demand for certain services. Such services would then simply not be offered, and some of the jobs that are presumed to be lost by automation would, in fact, never have been created.

4.7.5 Dynamics of the labour market

The labour market is constantly in extremely dynamic flux. It is claimed that within a decade (1960-1970) in the U.S.A., 8,000 types of jobs were eliminated while 6,000 types of jobs were created. The Canadian data are said to be too unreliable to make certain inferrences, but the general situation is surely similar.

4.8 The Emerging Picture: Limited Consensus on the Major Impacts

On the key question of the net job balance effect for the whole economy resulting from the new technologies, there exists no consensus in the literature.

One argument often used by the technological optimists is that if some jobs are not sacrificed to automation, the whole sector risks becoming internationally uncompetitive, with resulting job loss to a much larger number of people. Most would probably feel intuitively that there is something to the argument, but the inability to derive estimates for the totally hypothetical situation make it seem less relevant to those who fix their analysis on sectoral effects.

The argument does open up an important issue to which too few people have paid attention: who should bear the brunt of technological change? An individual, company, sector or society as a whole? Public policy debate here is overdue.

Most of the reports are in agreement that in the secondary sector we might well witness job displacement mostly from Computer-Assisted Manufacturing/Computer-Assisted Design (CAM/CAD) with robotics and numerical control machines playing the key role.

In the service sector, word processors would invade the offices. The biggest impacts may be expected in financial institutions, insurance companies and distribution. Government would probably be less impacted, as it is better shielded from brutal market forces than is the private sector. Significant job killing -- attributable to the new technologies -- is also expected for the education and health areas.

Such a general consensus helps to put the views of authors, such as C. Hayman's, in sharper relief. She believes that jobs destroyed in agriculture and manufacturing will be soaked up in services. However, in Canada, over 90 per cent of new jobs have been created in services since 1948 and it would seem that the absorptive capacity of the tertiary sector is reaching its upper limits. The braking of growth of the public sector and the decline of employment opportunities in the education sector, point in this direction.

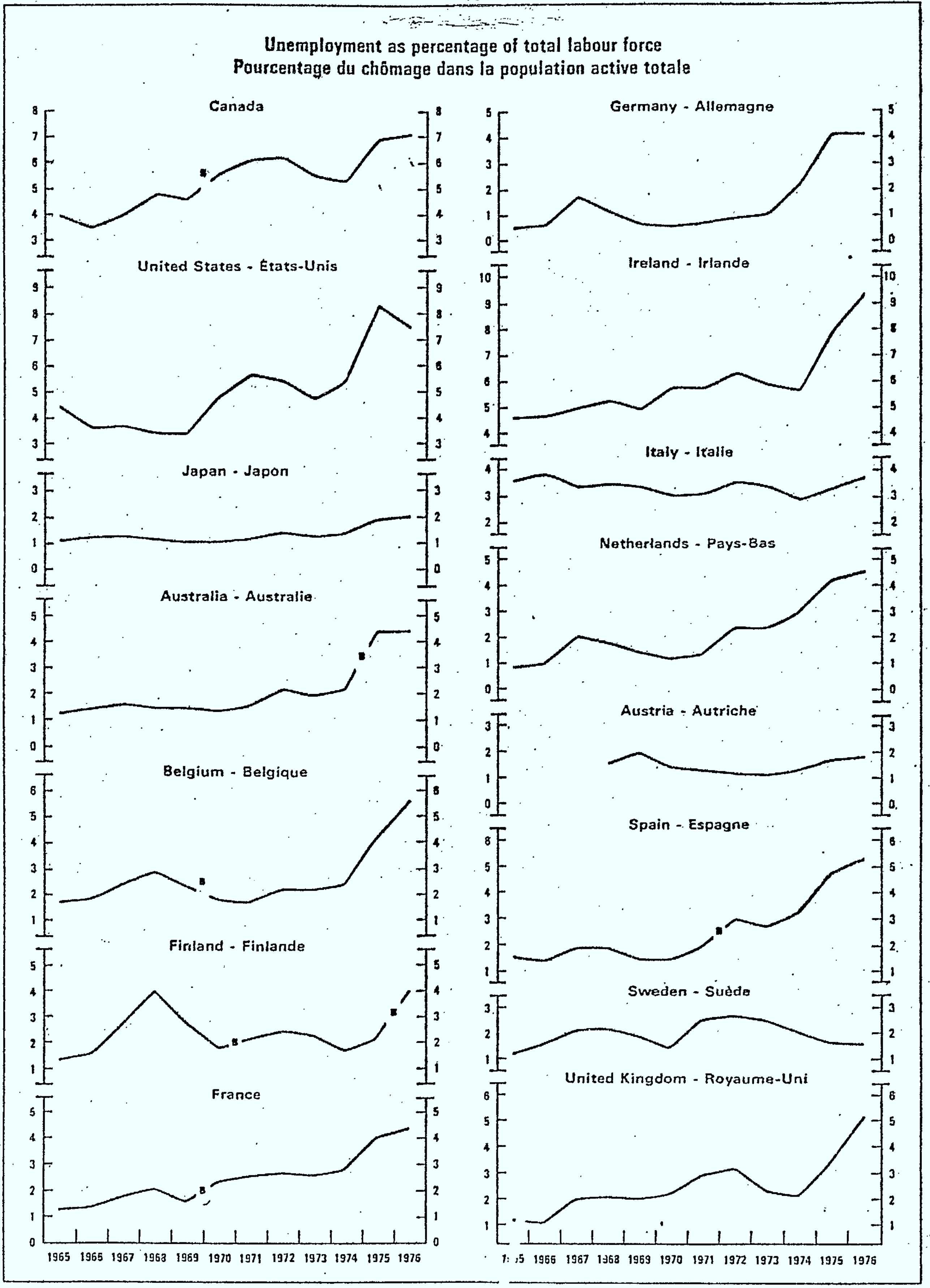
The literature which we have reviewed points out that the consequences of informatization on employment differ. On the one hand there is the case of the computer scientist who has obtained high prestige in society, being one of the most sought-after professionals on the job market. On the other, the typist is let go because her employment has been made redundant by the new word processor that the computer scientist has helped to develop.

There does seem to be some agreement, as well, on job destruction in specific segments of the labour market: these are thought to be more severe for older workers who have less flexibility in retraining, re-education and relocation and for the lower-level, skilled labour force. Among managers, the middle management is expected to be hardest hit. But overall, it is the women, who form the bulk of information manipulators in the service sector, who are expected to bear the brunt of the impact.

Technology optimists usually argue that jobs destroyed in one area would be compensated in the other. The effect of introducing microelectronics is, above all, to make dumb machines "smart." So far we have not seen many entirely new goods based on microelectronics -- electronic games, electronic notebooks, translators and home computers for example -- that have actually been creating a great many new jobs. What is more, these and other future products will probably be rather less job intensive. However, microelectronics-based automation in services has, so far, generated new jobs. Brand new services, such as inter-branch banking, can be offered with new computer/communications technology. In this respect, new services have required new people.

The dynamics of the two processes of job destruction and job creation are, unfortunately, extremely complex. It is not inherently obvious that the ratio of jobs created and destroyed will or should be 1:1. The pessimists, such as Professor Stonier, see one job created for five to ten destroyed, but even this perspective fails to take the international transfer of technology into consideration: jobs created in one country could be created at the expense of jobs destroyed in another.

It is our conviction that, with the present state of knowledge and with so many factors at play, no one really knows what the net employment outcome of this new wave of technological change will be. While it is probably right to be pessimistic about future trends -- the unemployment rate in most OECD countries has doubled over the last decade (see graph) -- rising unemployment will not necessarily be an inevitable consequence of this wave of technological change. Yet, for the reasons indicated earlier, we cannot be sure



Unemployment as percentage of total labour force
Pourcentage du chômage dans la population active totale
Canada
United States - États-Unis
Japan - Japon
Australia - Australie
Belgium - Belgique
Finland - Finlande
France
Germany - Allemagne
Ireland - Irlande
Italy - Italie
Netherlands - Pays-Bas
Austria - Autriche
Spain - Espagne
Sweden - Suède
United Kingdom - Royaume-Uni
1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976

of its consequences. We are, therefore, well advised to start our further task of separating the facts from the myths by admitting our ignorance.

4.9 To Debate or Not to Debate The Question?

If we maintain the rate of increase in output faster than the rate of increase of the population, we will generate all the demand needed both for leisure and work. Thus, if technological change, whatever it is, results in a rate of increase in output greater than the rate by which population increases and government steps in to redistribute the result (however it decides to redistribute it), the problem that then emerges would be the social problem of only some people wanting to work, rather than any other.

Although this is a total generalization of the issue, we nevertheless believe it is a valid generalization. Social problems have arisen when the rate of increase in output has lagged behind the rate of increase in the population (or the rate of increase in the labour force) and governments could not distribute a lagging increment. If this is so, the question then becomes: can we focus some of the issue surrounding the effect of technological change on output?

Should we or should we not follow the German, British and French example and start a public policy debate on the employment impacts of this new microelectronics-based computer/telecommunications technology? Proponents of having such a debate point out that a timely public discussion could help to deflect the trends that, if unchecked, seem to point towards rather pessimistic scenarios for our country. The opponents for the debate, on the other hand, argue that the employment impacts of the microelectronics revolution have so far not been detrimental and to debate the issue could become only another symbol of what is wrong with Canada -- le mal Canadien -- and that rather than engage in self-flagellation, we should channel our energies more creatively elsewhere into, for example, designs of industrial strategies for Canada.

The present review of the debates elsewhere and our knowledge of the Canadian situation do not indicate unequivocally that Canada faces a real problem. However, it can be said that the evidence is not conclusive one way or the other: both sides in the debate need to hedge their bets. Further monitoring of the issue on a continuous basis is essential.

4.10 The Need for Further Research

In carrying out our own research, we were very much aware of the dangers of simplistic use of aggregated statistics which may obscure as much as they reveal. We have attempted to gain some more detailed knowledge of the technological and economic changes which have occurred and which have influenced developments in particular sectors, whether or not they were provoked by the aggregate statistics -- spot checks, so to speak. Contrary to our expectations, the few concrete situations examined differed radically from what the reviewed reports, based in turn on aggregate statistics, would have led us to believe.

The general thrust of further research should, therefore, be directed towards gathering more factual information relevant to the current debates, with a preference for case studies both at the sectoral and company level.

Intensive, concrete investigations of actual technical and structural changes in the economy have thus to complement aggregated statistical approaches to analysis. Simultaneously, further macro-level research might be pursued as follows:

1) We ~~might well start by admitting our~~ ignorance of this extremely complex and dynamic phenomenon.

2) We could then accept, with Professor Leonteiff, that there is no inherent reason why humans cannot be replaced by technology and that, fundamentally, the employment of human labour can go down.

3) We must then systematically construct several scenarios of microelectronics-employment - ideally four - each based on explicit assumptions about the diffusion rate of microelectronics, about international technology transfer, capital requirements and social adaptation rate, and other sensitive variables. These scenarios would range from very optimistic, through mildly optimistic and mildly pessimistic to very pessimistic.

4) The scenarios should consider the Canadian economy in a model in which all sectors of the economy are seen together. In this way, the indirect impacts would be portrayed.

While it may be impossible to provide forecasts of job losses for an horizon of even five to ten years, a robust, small (computer-based) simulation model is called for for other purposes. Such a model would allow the investigation of crucial "what if" questions. Quantitative analysis on a "toy" model of the economy would first point out all the inconsistencies or cases of what Hermann Kahn calls "hot snow loads" -- the simultaneous use of extreme conditions that cannot happen simultaneously. The model would also determine how sensitive projections are to assumptions of rates of technological diffusion, levels of international trade, and levels and rates of international transfers of technology.

The model would thus serve as a powerful heuristic device to enable analysis of a band of alternative scenarios with a higher degree of confidence than with the present -- in our view -- inadequate quantification. But even there, its quantitative results should be used only qualitatively, and for conditional answers.

Finally, the federal government should begin to monitor more closely the triggering technological change as well as job impacts, especially in the areas where consensus has emerged. To this end, an interdepartmental task force that would include representatives from departments close to the technological change, should team up with departments that have traditionally focussed on the labour market.

We trust that this review will serve as a useful jumping off point, one very close to the cutting edge of current knowledge of the issue, for the more intensive study which we believe the significance of the matter clearly justifies.

ELECTRONICS/TELECOMMUNICATIONS
TECHNOLOGIES AND EMPLOYMENT:
AN OVERVIEW OF CURRENT DEBATES

ZAVIS P. ZEMAN
RUSSELL WILKINS

5. EXCERPTS FROM OVERVIEWED LITERATURE

A. MAJOR WORKS

JENKINS, C. and SHERMAN, B.

The Collapse of Work

London, Eyre Methuen, 1979

NOTE: Clive Jenkins has been General Secretary of the Association of Scientific, Technical and Management Staffs (ASTM), a trade union in the U.K.

Barrie Sherman is currently a Director of Research at the ASTM.

Resumé

The book is intended to fill the gap of a lack of in-depth discussion of structural or technological unemployment.

The authors define work as a "non-pleasurable activity which attracts a monetary compensation." Work - the castor oil of masses on industrialized society - is threatened at the time when expectations have been raised.

The threat comes from the new industrial revolution caused by the most influential technology of the 20th century: microelectronics. This technology is producing the most rapid industrial change in history. As it does not create new goods or services, but increases productivity, it follows that employment will fall and only few jobs can be created.

The authors predict that by 1990 the U.K. will have 5 million unemployed, instead of the present 1.5 million.

A new attitude to work is a must, as the industrial societies will not be capable to provide work for all on a continuous basis. The "Collapse of Work" should be changed into "Ascent to Leisure." No more than five years are available for such an attitude change.

These are the main lines of the book.

Excerpts: Nature of Microelectronics Impacts

The book points out that the present technological change comes to us as a wave that can only be described as the fourth of the Kondratieff's cycles (lasting 50-70 years), if not the third industrial revolution. The core of this technological change is a miniaturized computer - the chip.

What makes the impact of microelectronics worse is that it comes at the time of "depression" when the post-1945 growth (based on seven sectors) is coming to a standstill.

Although the technology has not yet fully emerged - being around for only a little over five years - its impacts are already felt.

Employment Impacts So Far

Oft-quoted example of the Swiss Watch industry is repeated here. Between 25 and 40 per cent of the work force lost jobs here.

Another example given in the book is the system X - Electronic Switching System in the Public Telephone Network. A similar system has allegedly already freed some 50 per cent of direct workers. (This refers to the ATT case.) It should reduce the direct labour force by 75 to 90 per cent.

In the automobile industry, the robots will have a great employment impact locally, but only limited effects generally because of the small number of workers involved directly in manufacturing process. Nevertheless, the U.S. car manufacturers plan to drop 128,000 auto-workers by 1985 - 20 per cent of the direct labour force.

No manufacturing sector will be immune to the microelectronics wave.

It is, however, the service sector where the largest impacts will occur - banks, insurance companies, newspapers and the office, in general.

A German Siemens report predicts that 40 per cent of all office jobs are threatened by 1990.

It is estimated that some 250,000 word processors are operating in the USA. If 2 to 3 operators replace 10 typists, then 750,000 to 1.5 million typing jobs would have to disappear.

Design and research work is also being automatized through CAD (Computer Aided Design).

The job creation is at least problematic. It is often suggested that the new jobs will be created in microelectronics, computers and communication equipment manufacturing. However, the electronics companies are not increasing their labour forces dramatically. For instance, Philips of Eindhoven will not increase at all the number of its employees. On the contrary, it will have to reduce its staff by some 60 per cent. Similarly, IBM is increasing production significantly without any increase in the number of its workers.

Inadequacy of Analyses

The authors correctly point out the lacunae between economic and technical analyses.

Keynesian economics is reproached for its belief that the labour released by this new automation will be reabsorbed, blasting its unrealistic assumptions of close economy, infinite geographical and skill flexibility, no discontinuity in technological change, and a naive view that the present ownership structure would allow the implementation of such a policy.

The authors propose some changes in the economic analysis, such as to subdivide economic growth into three categories - according to whether it is job creating, neutral or job destructing.

Furthermore, they criticize the statistical services of the U.K. for not providing a reliable picture of unemployment phenomena; the worst obstacle is the old-fashioned occupation classification.

Reviewing various categories of unemployment, such as "frictional," "structural," "natural" or "technological" they point out (correctly, again) that it is rather difficult to pinpoint where a particular case really belongs, case in point being shipwrights of North-East England.

Macro Employment Forecasts

Two organizations - The Institute for Manpower Studies at the University of Sussex and the Cambridge Economic Policy Group - have done employment forecasts for the U.K. for the 1990 time horizon. The Sussex study has forecasted for 1990:

2.5 million unemployed, assuming 3 per cent growth

4.8 million unemployed, assuming 2.5 per cent growth

6.8 million unemployed, assuming 20 per cent growth

The CEPG estimate forecasts for 1990:

4.5 million unemployed, assuming the progressively reduced growth from 3 per cent to zero.

Both groups reject the notion of technological unemployment, speaking rather about the lack of expansion.

What Jobs Will Be Eliminated?

The unskilled, semi-skilled and skilled manual jobs, as well as clerical, administrative and managerial jobs, are at risk. Clearly not all the jobs but some of all of these types are threatened.

Although the jobs are at risk, not all of them will be lost. Machines need operators, and some jobs will be created in production of machines.

Generally, the information workers' (50 per cent in USA?) jobs will be at risk.

Public service employees will generally fare better than their opposite numbers in the private sector for at least two reasons: high level of unionization, and a habit of measurement of managers by the number of subordinates.

Quantitative Analysis

Two reports that attempted to quantify technological impact on employment, according to the authors are:

1) NORA-MINC Report in France - implicitly envisages in 20 years unemployment in the range of 12-14 per cent.

2) SPRU Report in the U.K. - potential job loss over the next 15 years; for the U.S.A., 7.2 per cent (roughly 7.2 million); for the U.K., 16.0 per cent (roughly 4.0 million).

The authors propose that the U.K. has only the following choices:

> "Remain as we are, reject the new technologies and we face employment of up to 5.5 million by the end of the century. Embrace the new technologies, accept the challenge and we end up with unemployment of about 5 million."

While the authors warn that the figures representing job losses should not be taken as estimates but only as guidelines, they do provide the following job quantified outlook for the U.K. based on job content analyses (numbers are in thousands of workers).

Industry	1978	1983	1993	2003
Agriculture, Forestry and Fishing	357.3	340	300	300
Mining and Quarrying	341.7	310	280	250
Food, Drink and Tobacco	688.7	630	500	450
Coal and Petroleum Products	36.9	35	30	25
Chemical and Allied	428.6	430	390	360
Metal Manufacture	469.7	450	350	250
Mechanical Engineering	928.1	920	800	620
Instrument Engineering	148.3	130	100	80
Electrical Engineering	741.4	700	520	410
Shipbuilding and Marine	174.7	170	120	80
Vehicles	786.6	750	500	400
Metal Goods	535.5	540	500	430
Textiles	468.3	430	300	120
Leather and Fur	40.4	40	38	35

Industry	1978	1983	1993	2003
Clothing and Footwear	365.3	350	260	220
Bricks, Pottery, Glass and Cement	261.3	260	240	190
Timber and Furniture	258.7	255	250	220
Paper, Printing and Publishing	536.2	500	350	250
Other Manufacturing	325.5	310	300	400
Construction	1215.5	1200	1000	1000
Gas, Electricity and Water	339.1	340	350	350
Transport and Communications	1413.8	1300	1000	1000
Distributive Trades	2657.1	2550	2000	1600
Insurance, Banking and Finance	1136.6	1050	780	650
Professional and Scientific	3589.3	3650	3500	3650
Public Administration	1872.1	1600	1700	1800
Miscellaneous Services	2249	2100	2100	2000

To sum up. While the 1978 labour force was 22,365,700, the authors expect by

1983 - 21,340,000 - a reduction of 1 million

1993 - 18,556,000 - a reduction of 3.8 million

2003 - 17,140,000 - a reduction of 5.2 million

While the authors admit that the figures presented can be argued with, they conclude that the figures are consistent with both previous reports.

NOTE: The book will irritate the reader as it is diffuse, opinionated and full of imprecise quotes. But their message that the public debate on the economic and social consequences of the new technology is overdue, remains sound.

SHERMAN, B. <u>et al</u>.

"Technological Change, Employment and the Need for Collective Bargaining"

An ASTMS Discussion Paper
ASTM, London, U.K., 1979

NOTE: ASTM is the Association of Scientific, Technical and Managerial Staffs.

The paper is not a policy document, but an aid for discussion.

<u>Excerpts</u>:

<u>Introduction</u>

Whilst a limited technical change can be isolated in any advance employment effects, this* cannot; there is nowhere to hide. The problems which will arise are dynamic ones, not static, for with the best will in the world, jobs across the economy will not be created as quickly as they are lost. This paper does not argue that high permanent unemployment is inevitable, what it does argue however is that high unemployment will be with us for some considerable period, even if the correct remedial actions are taken.

There is no question that we must adopt micro-electronics, both developing it and applying it. However as present policies stand this will be done at the expense of existing and future employees both in terms of their ability to get paid work and the quality of the work available.

Most of the benefits will accrue at the national level, higher G.D.P., a stronger balance of payments, higher productivity, etc., but the costs will

* Microelectronics revolution.

come at the workplace. It is this imbalance which will have to be attacked by redistributing both the resulting income and wealth.

The Impact of Microelectronics on Manufacturing

Changes in Product Design

Microprocessors and other integrated circuits can replace many mechanical and electromechanical components, and reduce the amount of wiring previously needed to inter-connect these components. For example, one silicon chip in an electronic sewing machine replaced 350 standard parts. Products can be redesigned so that less labour is required to produce them. It now only takes 11 hours, for example, to assemble an electronic telex machine instead of the 75 hours needed to assemble a mechanical telex machine.

It is this substitution of electronic integrated circuits for electromechanical components which has led Philips, the world's largest electrical manufacturing company, employing some 425,000 people world-wide, mainly on light assembly work, to estimate that even allowing for a 3% p.a. real increase in turnover for the next 10 years, it will still be 56% overmanned. The implication is that Philips could shed over half of its world-wide force during the next decade.

The Dutch trade union, NVV, recently gained access to a report produced by Philips personnel and industrial relations department, which outlined the company's plans to cut its workforce in the Netherlands by 20,000 to 65,000 over the next ten years, a 23½% reduction. Philips has already reduced its Dutch workforce over the last few years by natural wastage, replacing only half of those who have retired or left the company.

However, it is not simply that less labour will be required to actually make and assemble products. Because less components and equipment will be required, there will be a corresponding drop in the labour required for the processes which are ancillary to the actual assembly, such as stock control and warehousing invoicing, materials handling, billing, and transporting. Similarly, many supervisory and managerial jobs will disappear simply because a truncated production process means less administrative work.

Three examples of the effect of the change to electronic components:

Cash Registers

In their 1975 Annual Report, National Cash Register said:

"The electronic products we are manufacturing today...have a labour content of about 25% of their predecessors. Today the manufacturing operation primarily involves the assembly of purchased components. Accordingly, our total employment in manufacturing plants is down to 18,000 today, compared with 37,000 in 1970."

The successful company needs less labour, but the unsuccessful company goes out of business and jobs are lost there as well. In relation to cash registers, the switchover to electronic machines began first in the USA in the early 1970s. NCR, which has half the US market, has not produced mechanical cash registers in the US since 1975. In 1976 NCR subsidiaries in Switzerland and Germany were closed down. In the UK, NCR's main operations were at Dundee where they once employed 6,000 people in eight factories.

By mid-1975 there were only 3,000 people and four factories, and by 1978 only two factories were left employing 1,000 people.

The NCR example illustrates some general features of the effects of changing to electronics. Old machinery and stocks must be written off and less labour is required. The labour force which remains requires extensive retraining, and new machinery and stocks must be bought.

Once the switch-over to electronics has begun, every company in the field is forced to develop electronic capabilities or risk going out of business. Already many companies have had to withdraw from the cash register market after making substantial losses, the most notable example being the business division of Singer which, despite holding 60% of the US market for point-of-sale systems, ran up losses of $19 million in a single year, and was subsequently sold off.

Telecommunications

The effects of switching to electronic components will drastically affect the telecommunications manufacturing industry.

System X "if properly implemented" would eliminate the jobs of 90% of the workers currently employed on the production of TXE4, the semi-electronic system, during the 1980s. The following table compares the number of workers required for the production of other systems for every 100 workers employed on Strowger and Cross-Bar Production.

	No. Workers Required
1975 Strowger & Cross-Bar	100
1977 TXE4	40
1985 System X	4

Western Electric, the manufacturing arm of American Telephone and Telegraph, who supply the majority of telephone systems in North America, has reduced its direct labour force from 39,200 in 1970 to 19,000 in 1976. It expects this to be down to 17,400 by 1980.

Televisions

Japanese colour TV manufacturing...reduced the number of components in each set and introduced advanced automation techniques. As a result, product quality improved, the number of employees was dramatically reduced, and production volume soared.

Number of Employees in Colour TV Factories

Company	1972	1976
Hitachi	9,051	4,299
Matsushita (National Panasonic)	9,875	3,900
Sony	4,498	2,778
Other four large firms	24,462	14,700

Production volume raised by 25% from 8.4m sets in 1972 to 10.5m in 1976.

Number of Components in a 20-inch Colour TV

Components	1970	1977
Integrated Circuits	2	4
Transistors	65	34
Diodes	65	38
Other (index)	100	50-70
Electric power consumption	155w	85w

Changes in Production Methods

Microelectronics will change production methods by bringing more versatility to robots and other automatic devices, and by allowing fully automated manufacturing systems to be developed.

Robots and Automation

The American vehicle manufacturing industry intends to invest so heavily in labour-saving equipment over the next few years that 128,000 auto workers at General Motors, Ford, Chryslers and American Motors will lose their jobs, because of the resulting productivity increases by 1985. This is over 18% of the total production workers in the American industry.

The most significant impact of microelectronics on automation will occur in those areas previously relatively immune to automated techniques. Because microprocessors can be reprogrammed, automated assembly techniques can be introduced into areas of lower volume production than, say, vehicles. Microprocessors give increased flexibility to robots, and have also substantially lowered the costs of automation.

Automation has been largely confined to production runs of 250,000 or more because of the costs involved.

Microprocessors and more sophisticated robots such as the IBM assembler are changing this. It is now possible to introduce automation to that part of the manufacturing spectrum which produces anything from 5,000-250,000 units per annum.

Computer aided factories for batch production are being developed in Japan and Bulgaria. A completely new type of machine is envisaged which would be a universal machine working unattended. A group of such machines could be linked together to form an unmanned manufacturing system.

The Impact on Office Work and the Service Sector

Office Work and the Service Sector

Not all service industries will be equally affected by the new micro-electronics-based technology. This technology is ideally suited to applications involving information handling activities - i.e., the production, manipulation, storage and transmission of information. The service industries which will be most affected are those whose activities are mainly of an information handling nature. These are the Postal Services and Telecommunications, Insurance, Banking and Finance, Accounting and Legal Services, and Research and Development Services and Public Administration. Together these service industries account for over 16% of all employment.

Other service industries which will be affected are distribution (both wholesale and retail) and educational services, which make up another 19% of total employment.

Those occupational areas which will be most affected by information technology (office work generally and certain service industries) therefore account for about 45% of all employment. Within this total office work itself accounts for about 35% of all employment.

Word Processing: The Beginning of Office Automation

The current number of word processors installed in Europe is estimated at around 100,000 units compared with perhaps 350,000-400,000 units in the USA, where the word processor population is expected to double by 1981.

Examples of labour saving effected through the introduction of word processors include Bradford Metropolitan Council (a 50% reduction in the number of typists in the area where the word processors were used), British Standards Institute (a 33% reduction), and Provident Financial Group (a 37% reduction in full-time typists and a 77% reduction in part-timers).

Electronic Mail: The Essential Step

A UK example of a company developing its own internal services is provided by the insurance company, Friends Provident.

The Services Manager of Friends Provident expect staff savings of 40% to pay for the cost of installing the system.

The Automated Office

Although the first step in the introduction of office automation will be the substitution of existing office processes, entirely new processes will be capable of development. We already have text editing and word processing systems in operation, but the potential of the new technology goes far beyond this.

Automation in the Distribution Industries

Point-of-sale (POS) terminals are becoming increasingly common in large stores and supermarkets. They are sophisticated electronic cash registers linked to a computer facility. Apart from performing all the usual functions of a cash register, they are also capable of automatic stock control.

These forms of automation have increased the speed of operation of cash desk operations and reduced substantially the need for staff to record stocks, fill shelves or change prices.

Automation in Finance Industries

Automation has already developed to a considerable extent in the banking and insurance sectors.

Apart from the general developments in office automation, the banks will also be affected by...the use of Electronic Funds Transfer (EFT).

The advantages of EFT from the bank's point of view is that they could employ less people at each branch office, and allow cashiers more time for complex transactions, although most cashiers could be dispensed with.

From the retailer's point of view, EFT would also mean fewer staff involved in handling money transactions and accounting procedures, as well as offering greater security in transactions. The impact of EFT could even reduce the need for security guards currently employed in escorting money between locations.

The Impact on Employment

Problems of Assessment

There are many problems in assessing the impact of technological change on employment patterns.

Despite these problems, we do know enough about the nature of the technology, its likely applications and the driving forces behind its use to make a broad assessment of its likely impact.

We recognise that new technology is itself profoundly influenced by demand as well as by other economic and social factors. Moreover, we also recognise that the application of new technologies proceed at variable speeds under different social circumstances and are modified in unforeseeable ways by political, economic and cultural factors.

Occupations at Risk (% of all occupations):

At Risk - Total = 62.1　　　　Not at Risk - Total = 38.6

The Demand for Labour

If we wish to obtain an estimate of the overall impact on employment levels, we must make certain assumptions. The consequences of these assumptions are that in 1985 3,831,000 people will be unemployed, an unemployment rate of 15%. By 1991 5,235,000 will be unemployed, and the unemployment rate will be 20%.

Clearly, the results depend on the assumptions.

This will not be a problem for the UK alone. The French Government have published a major study (Nora-Minc) of the impact of information technology on the French economy. France will have to abandon the old ideal of full employment in order to make her industries modern and efficient.

The picture for office employment is very gloomy. The report estimates that the banks could reduce their staff by 30% by implementing modern computing techniques over the next 10 years. The insurance industry, too, could make similar cuts. In the general office environment, the report estimates that many of the 800,000 secretaries in France could see their jobs taken away by automatic typewriters and word processing systems.

In Germany, a report by the electronics company, Siemens, says that by 1990 around 40% of present office work can be carried out by computerised equipment, centred around automatic writing machines linked to a data transmission system. German trade unions have calculated that this means a threat to the jobs of two million of Germany's five million secretaries and typists.

In the UK a major study (Barron-Curnow) of the impact of information technology says that the labour displacement could be as high as 16%, resulting in an unemployment rate of 10%-15%. The jobs particularly at risk, according to the study, are proof-readers, library assistants, mail carriers, telegraph operators, draughtsmen, programmers, accountants, financial administrators, secretaries, billing clerks, key punchers, cashiers, filing clerks, meter readers, shipping clerks, TV repairmen, plateprinters, telephone repairmen, light electricians, machinists, mechanics, inspectors, assemblers, operatives, material handlers, warehousemen, sales clerks and stock clerks.

New Products

Another argument against the view that the new technology will lead to large-scale unemployment is that it will allow us to produce many new products which in turn will mean many more new jobs.

There is, as yet, little indication of what these new products might be, or in what ways they will create employment.

New products often <u>replace</u> old products. This is not to deny that there are no new products which could be developed.

Many of these genuinely new products will be much less labour intensive than the old product manufacturing process.

The Service Industries

Another argument which has been advanced is that the service industries will continue to expand and thereby mop up the labour displaced in manufacturing industries. This argument ignores the fact...that 74% of the increase in service sector employment between 1971 and 1976 was in part-time employment. The argument (also) ignores the fact that the service sector will bear the brunt of the impact of new technology.

Public administration...(is an) area where employment has also been growing over the last ten years.

The problem here is that the level of employment in these areas will depend on the level of public spending.

Responses to the New Technology

Employment Protection

The introduction in any establishment of new technology which has an impact on the nature and specified number of jobs should only be carried out if agreement is reached with the trade unions. The obligation to reach such an agreement should be enforced by law.

It is now time to strengthen this (The Employment Protection Act) to give trade unions the right to bargain effectively on matters (of technological change).

A model for such legislation exists in Sweden. The Joint Regulation in Working Life Act came into force in January 1977. An employer must negotiate with the trade unions on his own initiative before deciding on important changes at the workplace.

The Norwegian Federation of Trade Unions (LO) and the Norwegian Employers Confederation (NAF) have concluded a voluntary general agreement on the development, introduction and use of computer-based systems.

Any voluntary agreement would need to make adequate provision for income guarantees and retraining opportunities.

New Policies on Employment

Much more work needs to be done on assessing the impact of technological change. The Government should take the initiative here, and begin to map and monitor in a detailed way the likely areas and processes which will be affected. This should not be a one-off exercise, but a continuous function.

Jobs must be created in those areas where human skills and abilities are at a premium. Such areas include health, education and social services.

We must also consider what new products are possible. There is a large market for energy saving products, for example, a portion of which would be for energy-saving devices for the home.

Reducing the time people spend at work can be seen as a part of a broader strategy of regulating the labour supply.

We must separate income distribution from the question of employment.

We should...seriously consider the possibility of a minimum income level for everyone which does not necessarily derive from employment.

All this would mean changes in life-style and patterns of work.

Lea, D.E. _et al._

"Employment and Technology"

Report
TUC General Council to the 1979 Congress
TUC, London, July 1979

Note: This Report has been drawn up by the General Council of TUC. It is based on the work of a research group of TUC. The statement was adopted by TUC Congress in September 1979.

Excerpts

Foreword:

- The impact of the new technology on employment in the 1980s is one of the greatest challenges facing us. It is a challenge facing not only trade unions, but our industry and society as a whole.

- Deflationary policies create the worst background for tackling the problems of technological change.

Job Prospects and the Immediate Impact

The Employment Structure

The development of microelectronics is taking place against a background of longer term trends in employment - trends which may be accelerated by technological advance. Major factors in the changing employment situation have been:

a persistent increase in the number of women active in the labour market (though a large proportion of women have found employment in part-time occupations); a consistent decline in manufacturing industry, partly compensated for by an increase in services employment; and increases in non-manual employment offset by restrictions in the number of manual workers, particularly unskilled workers.

It is impossible to isolate which changes in job structure in the last ten years have been through technology.

The major job losses in manufacturing have come in the field of unskilled manual employment.

Women and Employment

It is clear that aggregate employment in occupations traditionally filled by women, at present levels of workload, could fall substantially as a result of technological innovation. The application of microelectronics to clerical and retail work - for example, in word processors, mini computers and point of sale terminals - threatens hundreds of thousands of jobs in the civil service, local authorities, banking and insurance, and offices of manufacturing companies, where women frequently comprise 70 per cent of the labour force.

There is a very real danger that these women and the additional 600,000 expected to swell the female labour force in the next four years will find many of the jobs which absorbed them in the recent past disappearing.

Future Trends

TUC recognises the need for technological change to maintain competitiveness in world markets and promote that economic growth. The above calculations are all on the basis of a normal full working week. Any moves towards a shorter working week (and also other measures which reduce working time) would affect the arithmetic.

Forecasting Employment Levels

One of the most persistent fears to have been expressed in the debate about microtechnology concerns the likely impact on employment levels. Predictions have been made of unemployment rising to nearly 3 million by the middle 1980s and even reaching the 4½ million level (16 per cent) by 1990.

The extent to which such forecasts are reliable on the one hand and helpful in framing policy objectives on the other is not, however, so clear. It is necessary in the first place to distinguish between unemployment caused by new technology and unemployment brought about by Government economic policies. As regards prediction of the effects of technology itself, as is not uncommon with such exercises, the various forecasters do not always agree amongst themselves about the magnitude of likely future levels of unemployment. In addition some of those responsible for the gloomier forecasts have now modified their position and no longer adopt so pessimistic a view of the future. More significantly most of the predictions are based on simple forward projections of past trends, whereas the effect of technological change on the scale that is expected will be, through radically changing the process of production and the pattern of output, to make these past trends an increasingly unreliable guide to the future. The impact of new technology on employment levels will depend crucially on the future relationship between productivity growth and output growth and this relationship cannot be accurately foretold without a much more precise account of the contribution of technological change in individual sectors to the overall productivity growth rate of the economy. Such evidence as does exist suggests that building up the total picture of the impact of microelectronic technology from detailed studies of the effects in specific sectors of the economy would yield a less gloomy forecast. However, such studies are still comparatively rare and in their absence any attempts to produce detailed and quantified forecasts of the effects of new technology on employment levels throughout the economy need to be treated with caution.

The TUC rejects the deterministic view that the advent of microelectronics must inevitably be associated with a particular level of unemployment.

The Effects of Microelectronics

Microelectronic technology could affect production and therefore employment in three main ways. First, through the introduction of new products and services; second, through the improvement of existing products and services; and third, through the introduction of new processes for producing existing products. Some of the job losses which will result are immediately obvious, such as those connected with computer aided designs. In other areas the extent of job displacement is as yet uncertain and will depend largely on such factors as the rate at which new processes are adopted and the structure of the industry.

The potential of microelectronics for creating new jobs is, however, even more difficult to assess with any precision. The numbers involved, however, will be relatively minor.*

Some goods and services may be relatively cheaper. If prices do fall in line with increasing productivity, then this will raise real incomes and enable consumers to increase their consumption of all goods. This process could give rise to limited multiplier effects.

The Trade Union Response to Technological Change

Clearly no accurate forecasts of the net effects on employment can be drawn from these considerations. On the one hand the extent of job creation will depend in part on factors such as the overall level of demand in the economy, the speed at which new technology is introduced and the actions of our competitors. On the other hand, the destruction of jobs can occur in a more sudden, concentrated and substantial manner than the longer-term creation of new jobs through the development of new products.

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* The experience of computerised warehouses suggests that a potential result of the introduction of microelectronics is to reduce employment in outlying warehouses whilst giving the opportunity for increased employment in central manufacturing units.

A Programme for Trade Union Action

New Technology Agreements

The first principle of such an approach would be that no new technology which has major effects on the workforce should be introduced unilaterally. Full agreement on the range of negotiating issues should be a precondition of technological change.

An essential condition for the smooth introduction of new technology is the guarantee of full job security for the existing workforce. Workers need to be given confidence that changes which are introduced are not intending to have the effect of destroying jobs without, at the same time, creating new opportunities.

Reductions in Working Hours

There will be a need to consider, at every stage, the opportunities for linking technological change with a reduction in the working week, working year and working life-time.

The old simplistic arithmetical arguments which sought to calculate the employment effects of reducing working hours from cost changes on the one hand and productivity movements on the other will become largely redundant as the adoption of new technology gathers pace. For technological change will destroy the crucial assumption in such arguments that 'other things remain equal'.

STONIER, T.

"Technological Change and the Future"

Paper
Annual Meeting of the British Association for the Advancement of Science
Edinburgh, September 1979

NOTE: Professor T. Stonier is a Professor of Science and Society,
University of Bradford.

Excerpts:

The New Threat

The greatest threat to Western Society at the moment is the rapid displacement of labour by technology. Present trends in unemployment do not represent a mere downturn in business activity or a temporary recession, which will in time correct itself. Jobs in the manufacturing sector are, and have been for some time, on the way out. What we see now is an acceleration of an historical process which can be traced back at least a couple of centuries, a process which involves a shift in the principal economic activities from manipulating land, to manipulating machines, and now to manipulating information.

The Industrial Revolution...was marked by the invention of the steam engine, not just another piece of technology but a 'meta-technology'.

The New Metatechnology

The appearance of the micro-processor is having a profound effect on labour patterns. The micro-processor does nothing radically different from its progenitor, the computer. But it does it faster, more reliably and cheaper. Coupled to existing machinery, it greatly increases productivity.

A new technology displaces an older one as a function of how much better it is. If a new technology is only 10% better, it displaces existing technology very slowly, if at all. If it is 50% better, then it begins to make inroads, although the process may take decades. When it is many times better, as clearly the new micro-processor technology is, then it moves very rapidly indeed.

Among the new micro-processor based technologies emerging are industrial and office robots.

While we all know about industrial robotization, equally startling will be the displacement in offices; as recent experience has shown, typing pools can be cut in half, and achieve an overall 300% increase in output.

In general, for every job created, five to ten will be destroyed.

It is highly probable that by early in the next century (within 30 years) it will require no more than 10% of the labour force to provide us with all our material needs, that is, all the food we eat, all the clothing we wear, all the textiles, appliances, etc.

The New Wealth Producers

The answer to the unemployment problem is to accelerate the shift away from the manufacturing and into the information sector of the economy. The most sensible way to achieve that shift is by a massive expansion of the education system. We should seriously consider doubling the education budget by the mid-80s and then redoubling it again by the mid-90s.

In addition to expanding education, the Government must also expand research and development.

The function of developing new technologies and industries is not to produce jobs - some jobs will be produced - but the main function is to produce wealth.

FRIEDRICHS, G.

"Microelectronics - A New Dimension of Technological Change and Automation"

Paper
Club of Rome Conference
Berlin (West), October 1979

NOTE: G. Friedrichs is Head, Automation and Technology Department, German Metalworkers Union, and Vice President, National Productivity Agency.

Excerpts:

The quantitative effect of technical change may be illustrated by some figures on the federal German economy. Between 1970 and 1977 the 45 sectors of industry of the Federal Republic of Germany (mining and manufacturing; excluded are building construction and electricity production) increased production (value added) by 13.5%. During the same time employment dropped by 14.5% (in total: 1,246 million persons) and the volume of employment (number of persons x worked hours) decreased by 21.3%. The potential capital per output ratio increased by 7.1%.

The advent of microelectronics seems to offer a complete new dimension to different forms of technological change and automation.

It is impossible to deal here with even a small percentage of actual or future applications of microelectronics. For this reason I intend to concentrate on major cases of application where larger numbers of persons will be affected. I will restrict my attention to development up to the end of the eighties, without mentioning exact dates.

Production

Out of a total of 45 different sectors of manufacturing and mining, the manufacturers of office and data processing machines were able to realize the third highest production increase between 1970 and 1977. In terms of employment they lost a total of 20,600 persons and are with a percentage of minus 25.8% far above the average figure of minus 14.5% for total manufacturing and mining. The big jump happened in 1977. In 1976 the production index (1970 = 100) was still 116.7. But in 1977 it jumped up to 148.9%. This was an increase of 27.8%. In spite of this huge production explosion within one year, the number of employed persons dropped by 2,300, or something like 4%. This seems to be a clear proof of the powerful effects of microelectronics, since 1977 was the year when microelectronics started to take over wider areas.

One of the most spectacular areas of production is the replacement of mechanics by microelectronics, as happened in the watch-making industry and the printing and duplicating industry, where between 1970 and 1977 production increased 12%, volume of employment decreased 21.3%, and productivity per hour increased 43.5%. The same happened with the production of telephones, telexwriters, taximeters, sewing machines, and others, since the number of individual parts that had to be produced and assembled could be greatly reduced. The result was savings in manpower between 40 and 50%.

Another area of microelectronics in production is...the numerical controlled machine tool. At present the first generation of relatively cheap NC machinery is now on the market.

Another area with similar effects is process control.

A last example that should be mentioned here is the industrial robot.

Administration and offices

According to a very careful investigation undertaken by the German Siemens Corporation with the title "Office 1990" (still classified), a high percentage of normal office work can be standardized or automated. The investigation covered 2.7 million office jobs. 43% could be standardized and between 25 and 30% could be automated. In public administration big saving potentials were recognized, since about 75% of all jobs could be standardized and 38% could be automated.

Within the private sector possible savings of between 25 and 38% were detected. The Siemens Corporation believes that the office automation potential will be covered by 1990. If this is true, a very high percentage of typists and clerks will have difficulty in finding jobs within the next decade.

Parts of the service sector with increasing employment:

- education;
- research and development;
- social services in the widest sense, including health, advising, counselling, rehabilitation, etc.;
- hotels and restaurants;
- transport by truck;
- transport by air.

There seems to be no room for an industrial or a postindustrial society. Both sectors, industry as a whole and public and private services, will lose employment possibilities which now exist.

Many highly developed countries which already have rather high rates of unemployment will not be able to reduce these rates and indeed will be in permanent danger of seeing unemployment rates rise even higher. The persons who will be affected most are women.

The Employment Problem

The most difficult problem will be to again attain and retain full employment. The introduction of microelectronics will reduce employment possibilities in production, offices, and services under present conditions.

From the employment point of view only products that are completely new are of vital importance. However, up to now the number of really new products, for example, TV games, is very limited.

Two suggestions: 1) a better distribution of available work between those who would like to work. This can be done by cutting down working time.

2) second suggestion would be to influence and to speed up the rate of economic growth.

HARMAN, Willis W.

CHRONIC UNEMPLOYMENT AND UNDEREMPLOYMENT

Menlo Park, California, SRI International,

(Research Report CSSP 4676-14).

February 1978. 36 p.

NOTE: Willis Harman is project supervisor, Center for the Study of Social Policy, SRI International, Menlo Park, California. The report was prepared for the National Science Foundation, Washington, D.C., as part of a larger study entitled: "Assessment of Future National and International Problem Areas."

This study begins by examining the arguments for and against the possibility or probability of chronic unemployment or underemployment in the long run. "This analysis concludes that there is good reason to consider chronic unemployment and underemployment to be not only a critical future problem, but also one of the most fundamental and serious problems of what many authors term 'post-industrial society'....This problem of unemployment and underemployment is intimately related to technological advance, particularly in automation, and to productivity" (pp. 23-24).

Whereas in past periods of rapid technological change, displaced labour was absorbed into expanding, relatively new sectors of the economy, now "there is no expanding area in the occupational structure to take care of the large number of people with the new aspirations for high-income, high-status, and 'high-meaning' jobs. The very productivity of the technologized economy reduces the number of such jobs." (Harman, p. 13, citing Berger in The Public Interest, Spring 1974.)

Following the thinking of Kenyon De Greene (in Human Factors, Feb. 1979), Harman postulates that we are now in a "third stage" of the automation process, which is characterized by increasing manpower dislocation, unemployment, and need for continual updating of skills. Developments in the fourth stage -- rapid diffusion at all levels of the economy in the years to come -- "are likely to render millions of workers superfluous and present societal problems defying easy solution." (p. 8)

But quantification of the precise effects of technological changes on levels of employment is not the basic purpose of this study. Indeed, Harman states that "No satisfactory statistical analyses exist that can be used to unravel the overall effects of automation from other factors on unemployment." (p. 8) Rather, the study is more interested in the evaluation of possible future policy alternatives which could be used to alleviate such problems, if in fact they do arise as predicted by others. In this respect, underemployment (due to a lack of fit between training and jobs) and for hidden unemployment are seen as problems potentially as great as overt unemployment.

Reasonably full employment is considered desirable because of the importance of each of the three current functions of work: production of needed goods and services, social participation (meaningful social role), and income distribution.

According to the author, the principal approaches to the alleviation of unemployment fall into four categories: (1) generating more jobs in the private sector or in the public sector; (2) spreading around the existing jobs; (3) devising new approaches to meaningful social participation outside of paid employment; and (4) devising new approaches to income distribution (p.18).

An appendix by Harold A. Linstone, senior consultant to the project, examines the effectiveness of various proposed solutions to the "work-manpower gap". Simple models, called "problem-solution relevance trees", are used to clarify the links between the proposed solutions and their effects on employment, the labour market, and the economy.

The proposed solutions examined center around (1) a reduction in the overall size of the labour force or of the so-called "secondary labour force" in particular; (2) a shift in the pattern of labour force activity (fewer hours, job-sharing, frequent retraining, etc.); (3) increasing the demand for labour (through income redistribution, a few major projects, or many smaller volunteer programmes). The results of this analysis show that "increasing the number of available jobs and activities is far more effective than shifting or reducing the labour force" (p. 34). Apart from a wholesale transformation to a war-economy situation, the creation of a number of voluntary programmes (such as Vista, Peace Corps, etc. -- destined to appeal to all age groups -- rather than a military-style youth draft) is found to be the most effective in reducing unemployment. Next in order of effectiveness would be new programmes based on transfer payments to bring about a more equitable distribution of income: "Because of the secondary effects of a guaranteed income...this plan emerges as having a very important long-range role" (p. 35). Last in order of effectiveness (but of most interest to futurist Harman) is the creation of very large-scale projects, such as space programme. However, "the difficulty in initiating large-scale public projects...lies primarily in obtaining broad-based public support for the expenditures" (p. 36).

HARMAN, Willis W.

"Chronic Unemployment:
An Emerging Problem in Postindustrial Society"

The Futurist
August 1978, pp. 209-214

The author is Project Supervisor, Center for the Study of Social Policy, SRI International, Menlo Park, California. This article draws on studies done by the author's group at the Stanford Research Institute (SRI).

The 1966 Report of the U.S. National Commission on Technology, Automation and Economic Progress temporarily laid to rest the "alarmist notion," current in the early 1960s, that automation and technological change would lead to massive unemployment. It became conventional wisdom to think that technology would continue to generate more jobs than it displaced (in other words, to believe that there would be no net loss). However, the economic recession of the late 1970s caused a sudden revival in the alarmist viewpoint linking technological change to increased unemployment.

"It seems apparent that the U.S. economy since the 1930s has been able to maintain a politically acceptable level of employment only by preparing for war and by becoming arms supplier to the world" (p. 211). Moreover, the official unemployment rate obscures much hidden unemployment and underemployment. We are faced now with much more than a simple problem of job displacement. In the past, shifts of workers out of agriculture and industry were accompanied by market demands for new types of jobs in other sectors. "A quite different situation exists today. No section of the occupational structure is expanding to accommodate the large number of people aspiring for jobs offering high income, high status and personal meaning" (p. 212).

"The possibility of long-term chronic unemployment and underemployment rests on two propositions: (1) over the long run, economic growth may not continue to generate enough jobs to accommodate the expanding work force, and (2) the quality of the available jobs may not be compatible with the rising educational levels of the work force" (p. 209).

The author cites Kenyon De Greene as predicting that the current stage of automation in the United States is, or will be, characterized by "technological obsolescence of many people with specialized skills, an oversupply of highly educated persons, an increased split between those whose skills are needed and those whose skills are not.... During this stage, manpower dislocation and unemployment will probably increase, and most of the work force will require a continual updating of skills." The next stage, whose main features are already evident, "is characterized by the spread of mechanization, rationalization, and cyberation to most institutions of society, and by the development of machines and systems capable of at least some of the higher-level perceptual, cognitive, and adaptive capabilities of human beings. These developments are likely to render millions of workers superfluous and present societal problems defying easy solution" (p. 210).

"Jobs in economic production have traditionally served not one but three major functions in society: Besides (1) producing needed goods and services, they also act (2) to assure equitable distribution of income and (3) to provide people with meaningful and satisfying roles in society. With industrialization, increased educational levels, and impending constraints on production, jobs no longer satisfactorily serve all three functions."

As solutions to these problems, Harman proposes (1) some sort of guaranteed annual income program to reduce the distribution problem, and (2) a major development of volunteer programs such as Peace Corps, Vista, etc., or possibly even (3) the undertaking of vast, new "great central projects" such as space colonization to accommodate needs for the production of goods and services while satisfying our needs for meaningful social roles.

CONCLUSION

Although a reduction in the growth rate of the labour force (associated with the end of the baby boom and prolonged economic slowdown) may tend to mute the unemployment effects of technological change in the next few years, the underlying problems will still be there in the long run. "Any temporary respite should be used as an opportunity to look for acceptable solutions, and not be wasted through complacency and self-deception regarding the fundamental systemic nature of the problem" (p. 214).

LEONTIEFF, W.

"Is Technological Unemployment Inevitable?"

Challenge

September-October 1979

Note: The author, a Nobel Laureate in Economics, is Director of the Institute of Economic Analysis at New York University. This article is based on his testimony earlier this year before the Joint Economic Committee of Congress.

Excerpts:

- The effect of technological advance of employment has been debated for 168 years. More than a century ago, the conventional wisdom of economists "proved" once and for all that unemployment caused by technology can be nothing but an illusion.

  Only John Stuart Mill, after deeper reflection, admitted that the technology could, indeed, depress the aggregate demand for labour.

- Technological advance is uneven. Some sectors of the economy are more affected by it than others; some types of labour are replaced than others. (Unskilled workers, in many instances but not always, are laid off first; skilled workers, later.)

- Successive waves of technological innovation have brought about a progressive shortening of the working year until the middle 1940s. However, since the end of World War II, in the USA (and for that matter Canada), the length of the normal work week has been practically the same as it was thirty-five years ago.

。The above-mentioned rigidity means that we have to face the prospect of technological unemployment turning from the voluntary into an involuntary phase。

。Unemployment, of course, does not have a single cause - technological change。 Other factors are numerous. Let us name at least the growing work force or the growing minimum wages。

There are some economists who would argue that high wages are the real cause of unemployment, not the technology。

A drastic general wage cut could temporarily arrest the adoption of labour-saving technology, but eventually, the old trend would be bound to recur。

. Some of the remedies proposed for technological unemployment is reviewed by the author:

1) preference for labour intensive processes over labour-saving technologies
   - will slow down technological progress
2) stepped-up investment (job creation programs)
   - increasingly growing investment is needed to create jobs

3) shortening work time

- this remedy is preferred by the author: will not obstruct technological advance;
- equitable sharing of technological unemployment will reduce the contrast between those who are fully employed and those who are out of work;
- co-operation between labour and management is a sine qua non for achieving this goal. Co-management models of West Germany or Sweden are inappropriate for North America. New institutional arrangements would have to be devised here.

LEONTIEFF, Wassily
"Employment Policies in the Age of Automation"
ILO Information, Vol. 14, No. 1
(1978), pp. 1, 5, 6

The author is Professor of Economics at New York University. He received the Nobel Prize in Economic Science in 1973. This article is based on a paper prepared for the World Congress of the International Metalworkers' Federation. A longer version appeared under the title "Observations on Some Worldwide Economic Issues of the Coming Years," Challenge, March/April 1978, pp. 22-30.

According to Leontieff, technology may very well eliminate more jobs than it creates, as the pace of technological change accelerates. In support of this contention, he employs the "horse analogy" (see Herbert Simow, The Shape of Automation for Men and Management, New York, Harper & Row, 1965, p. 7 for a fuller development of this argument). Increased investment can no longer be counted on to maintain full employment through economic growth, because "the rate of investment required to accomplish this end might turn out to be so high that very little would be left for current consumption." Even fairly drastic reductions in wages would not serve to retard technological change for long, so great are the economics possible with the new technologies.

A reduction in the weekly and yearly hours of work could, however, contribute greatly to full employment and increased welfare. National economic planning, with the full participation of workers, would be needed to reduce the ill effects of the dislocations foreseen (see the Challenge article on this point). But in the long run, workers' ability to profit from technological change "will increasingly depend on the direct transfer of property income derived from ownership of capital and natural resources." Thus the main question is not so much whether to automate, but how to distribute the control and the fruits of that process.

If asked to single out one force that has contributed more than any other to the phenomenal economic growth of the last two hundred years, one would say technological change. It was, however, the newly invented power-loom that deprived thousands of English weavers of their jobs about 160 years ago. Today the American Telephone and Telegraph Company is installing automatic switching equipment that will permit it to handle the anticipated increase in the volume of long-distance calls with the same number of long-distance operators.

The fact that machines do displace labour cannot be questioned, but many economic theorists hastened to point out at the time of the Luddite Rebellion that this did not mean that the total demand for labour and total employment must, because of that, diminish. An equal or even a larger number of new jobs, so they said, will necessarily be created in the machine building and its subsidiary industries. But is this, in fact, so?

The answer to that question is of crucial importance for the understanding of the economic, social and political problems faced by labour in times of accelerated technological advance, and that answer is "no." New machines, new technology introduced because it cuts production costs can, indeed, reduce the total demand for labour, that is, the total number of jobs available in all sectors of the economy taken together at any given wage rate.

To use a somewhat crass and even shocking analogy, new machines can reduce the total demand for human labour for the same reason and essentially through the same process that, a few decades ago, led to the replacement of draught horses by trucks, tractors and automobiles. To argue that workers displaced by machines should necessarily be able to find employment in building these machines does not make more sense than to expect that horses displaced by mechanical vehicles could have been directly or indirectly employed in various branches of the expanding automotive industry.

Moreover - and this is particularly important in the context of the present discussion - the transition from a horse-driven to a motorised economy was accomplished quite smoothly despite the fact that the demand for oats, harnesses and new stables was drastically cut. The flows of "purchasing power" simply changed their direction under the prodding of impersonal market forces, and so did the commodity flows. The output of goods and services required for the sustenance of horses declined, while the output of steel and gasoline, not to speak of automobiles, went up. The economic system adapted itself to the new technology quite smoothly and if the operation of blind market forces imposed some hardships on oat growers and harness makers, in a perfectly organised system capable of anticipating the impending shift and preparing for it, the transition could have been managed without the slightest hitch. If horses could have been organised and were able to vote, this, indeed, would have been quite a different story.

Meeting the threat

One way of meeting the threat of potential technological unemployment is the creation of new and maintenance of the old jobs through increased investment, that is, economic growth. But this possibility has definite limits. How fast would the economy, and with it the volume of investment, have to grow in order to keep the number of long-distance telephone operators from decreasing in face of the fact that each of them will soon be able to handle 10 million instead of 1,000 telephone calls? The rate of investment required to accomplish this end might turn out to be so high that very little would be left for current consumption. In the pursuit of full employment through a greater and greater volume of productive investment, the society ultimately would find itself in the position of the proverbial miser who deprives himself of the bare necessities of life while depositing more and more into an already swelling savings account, and this despite his steadily increasing annual income. This is exactly what might happen in the long run under the relentless pressure of technological advance, if the forces of unrestricted cutthroat competition were permitted - let's hope they will not be - to govern the operation of the labour markets and conditions of employment.

Opponents of the trade uni9n movement argue that if wage rates had not been maintained on what they call an artificially high level, the introduction of labour-saving equipment would have been retarded and the number of available jobs increased. There can hardly be any doubt that without trade union action the level of real wages would be lower and the conditions of work harsher. It is, however, doubtful whether the introduction of labour-saving equipment would have been retarded very much by the availability of "cheaper" labour: by how much would the wages of telephone operators have to be cut in order to prevent the installation of modern, automatic switching equipment? In the event that the wage rate fell, say, by ten per cent and the total employment had increased as a result of this by five, there still would be a net five per cent loss in total labour income.

Benefits

There is, of course, a problem - in case the total labour income is effectively maintained by union action - of sharing it directly or indirectly between those who are employed and those who are not. Spreading the work through reducing the number of working hours per week and of working days per year provides an answer to this question. Increasing leisure, while everyone is assured of a steady job, can contribute greatly to the general welfare in a developed society. It has done so in the past and it certainly can do so in the future.

If technological advance continues, as let us hope it will, permitting substitution of more and more capital for labour not only in mining, manufacturing, agriculture and transportation, but in the service sectors as well, the traditional union action of the type I mentioned above is bound to become less and less effective: even the most powerful monopoly cannot maintain its income, not to speak of increasing it, if the demand for its product, the supply of which it controls, tends to fall.

Thus, in the long run, the ability of large masses of the population to benefit from technological advance will increasingly depend on the direct transfer of property income derived from ownership of capital and natural resources. In a utopian society in which everyone would combine - as some of the prosperous farmers in the United States and other countries actually do - the function of a labourer with that of the owner of capital and land, technical advance involving substitution of machinery for labour would present no problem: the share of the family income entered on the labour account would gradually diminish, but that accruing to its capital and rent account would increase. Moreover, the total income derived from two different sources would grow.

Twin goals

In a complex modern society, whether capitalist or socialist, the distribution of income between groups performing different economic functions and, consequently, occupying different social positions will continue to be a major problem. So will the maintenance of sufficiently strong and steady incentives for purposeful, effective economic performance on the part of every member of the society whatever his role and responsibilities might be.

It has to be admitted that conditions favourable to the attainment of one of these twin goals - efficiency and distribution judged to be equitable - are liable, to some extent, to make more difficult the attainment of the other. A satisfactory solution of both problems will necessarily be in the nature of a compromise.

OSBORNE, A. (1979)

<u>Running Wild - The Next Industrial Revolution</u>

<u>Forthcoming</u>

Excerpts:

- We are unable to control the microelectronic revolution. To every impact that electronics has had on our society so far we have only been able to react.

- Nobody seems to know what is going on.

- One of the biggest worries is the question of the overall levels of unemployment. Some jobs are going to be eliminated in a wholesale manner. Production line workers being replaced by robots is an example.

- Trade unions will be powerless to stop this process.

- There are two ways that the introduction of automation can be handled. We can be aware of the changes, prepare for them and make them as painless as possible. Or the employer can engineer a strike for half a year after which the strikers are not rehired and the government must step in.

- We must start to analyse the areas most likely to be affected. And we must start preparing ourselves.

- We must consider massive retraining programs and other methods to facilitate the movement of people from one job or location to another.

- We must recognize that there is a limit to the number of new jobs that can be created. The information and communication industries will boom but productivity increases will cause that few new jobs will emerge from this boom.

- There will be a large overall decline in the number of manufacturing jobs.

- The slight improvement in the employment prospects in the service sector could come about.

- Computer programming as a profession will be nearly extinct in 25 years. The real impact will not start before 1983. Then we will start to see levelling off of the growth rates. It may take a decade before we start to see reductions in absolute numbers of programmers.

HINES, C.

The Chips Are Down

Discussion Paper
Earth Resources Research Ltd.
London, April 1978

Excerpts:

- Unemployment (in the U.K.) may approach 5 million by the 1990s.

- Microelectronics revolution could well prevent the government from ever solving the unemployment problem , could put back the clock for women's liberation and could make the work of middle management and many professionals resemble that of a car assembly worker.

- Microprocessors will have the most profound effect on unemployment in the final quarter of this century.

- We are on the threshold of the quantum leap in technical change.

- First casualties of this wave of automation are firms making mechanical watches (40 per cent), cash registers (50 per cent) and telephone equipment (50 per cent).

- There is of course no shortage of work to be done. A huge number of jobs could be created by a more serious attempt to provide for unmet social needs.

BARRON, Iann (INMOS)

CURNOW, Ray C. (SPRU)

<u>The Future with Microelectronics:
Forecasting the Effects of Information Technology</u>

New York, Nichols Publishing Company, 1979.

NOTE: This recently-published (April 1979) report presents the findings of a research contract carried out from 1976-1978 by the Science Policy Research Unit (SPRU) of the University of Sussex for the Computers, Systems and Electronics Requirements Board (CSERB) of the British Department of Industry. It also draws on the work of a number of other relevant research projects at SPRU.

1. METHODOLOGY

To paraphrase the authors, projections into the future have been based on discussion with knowledgeable individuals as well as on the evaluation of published information, and have been derived by consideration of analogous situations, case studies and analytical discussion. "Particular emphasis was placed on the consideration of relevant historical examples of technology diffusion. The overall technique is best described as one of intelligent extrapolation, which obviously is both subjective and imaginative" (p. 23). "The forecasts presented are totally surprise free, and represent the working through of known technological concepts and capabilities" (p. 43).

(a) In particular, the authors argue that current developments in terms of microprocessors and minicomputers are part of an on-going "information revolution," which they feel is basically analogous to the industrial revolution of two centuries ago. In the first instance, human and animal labour was gradually replaced by mechanical power, while in the second instance, much mental effort is in the process of being replaced by electronic means (see pages 39-40 for the authors' statement of this argument).

(b) This basic analogy between the two "revolutions" also allows the authors to make a case for the possible existence of a fourth Kondratieff "long wave" of economic activity. In their view, the last previous long wave was associated with the introduction of electric power and the automobile, and lasted from 1890 to 1940. According to this theory, the fourth Kondratieff long wave is associated with the electronic revolution, with an upswing period (corresponding to the developmental and introductory stages of the new technology and associated with increased employment) during the 1950s and 1960s, and a downswing period (linked to the widespread application of electronic technology in many fields, but without the surge of developmental labour inputs seen in the earlier period), beginning during the 1970s and which is expected to continue well into the future.

(c) Finally, the authors present five case studies as examples, tracing the effects of the introduction of electronic technology (as a replacement for older mechanical or electro-mechanical technologies) in the automobile, watch, newspapers, textile and materials handling industries. In the watch industry in particular, "at the national level the impact on employment and international trade has been large. For example, some 20-30% of the assembly labour in Switzerland was displaced" (p. 184).

Up to now, the range of computer applications has been severely limited by its high cost. Lower costs in the future will help bring about a much broader range of applications.

2. TIME FRAMES OF THE PROJECTIONS

The authors' time frame for their projections are as follows: short term, up to 1980; medium term, 1980-85; long term, 1985-2000; very long term, 2000 and beyond.

3. THE PREDICTIONS IN TERMS OF EMPLOYMENT

The authors make a bold attempt at predicting in quantitative fashion the employment consequences of the microelectronic revolution in terms of its net aggregate effect, in terms of its effects by several broad sectors of activity, and in terms of its effects on specific occupations or categories of occupation.

(a) Aggregate employment, taking all industrial sectors and occupations together, may decrease by 10-15%, reaching lows not experienced by Britain since the depths of the Great Depression of the 1930s. This calculation was made by taking a weighted average of the estimates by sector given below, after first assigning each sector to one of the following categories of potential job-loss rates: 25%, 10%, 1%, 0% for high-, medium-, low- and zero-risk categories respectively (p. 191).for a relatively optimistic scenario, and 50%, 25%, 10%, 0% for a more pessimistic scenario. Thus the range of 7-18% job-loss overall.

(b) In the more pessimistic scenario, employment by sector is expected to be impacted as follows, in terms of the potential job loss in percentage over the next 15 years: Information handlers, 27%; industrial workers, 22%; service industries, 9%; agricultural workers, 3%, for an overall weighted loss of 18%.

(c) The specific occupations expected to be at risk are described below. Using the higher rates of possible job loss (i.e., the pessimistic scenario) for each of 240 occupations in the U.K. data, an overall displacement of 16% is predicted. "Obviously, such projections are based on a view as to which occupations are at risk. The major classes are proof-readers, library assistants, mail carriers, telegraph operators, draftsmen, programmers, accountants, financial advisors, administrators, secretaries, billing clerks, keypunchers, cashiers, filing clerks, metre readers, shipping clerks, TV repairmen, plate-printers, telephone repairmen, light electricians, machinists, inspectors, assemblers, operatives, material handlers, warehousemen, sales clerks, stock clerks, compositors" (p. 191).

"In summary, the types of labour to be affected can be characterized in various groups: assembly workers (chiefly rote-skill based and working with fairly complex but not very high-value products), repair-maintenance workers, low-skilled (or even high-skilled but rote-based) clerical workers. Obviously, lack of competitiveness in a U.K. firm compared with an overseas competitor in an open market would affect all categories of labour" (p. 200).

The Future with Microelectronics provides us with a bold look into the future -- a reasoned opinion of what the next 25 years may hold in store for us. Taken together, the predictions of Barron and Curnow are at once the most comprehensive, most specific, and most carefully documented of any of the western studies we've examined to date.

As the reasoning behind the predictions as to employment effects of the new technology is most thoroughly developed in terms of its impact by industry sector, we will now take a closer look at the two sectors which are usually expected to be the most heavily impacted by the new technology: the tertiary or service sector and the secondary manufacturing sector. Most of the arguments presented are in the form of selected quotations taken directly from the text.

The most immediate consequence of the new technology will be its impact on employment, especially in the information sector. By comparison, the impact of the new technology on employment in the direct manufacturing industries is expected to be relatively small. But altogether, "the overall consequences must be seen as comparable with the industrial revolution of 200 years ago."

"So far, little capital has been invested in improving efficiency of workers in the information sector - secretaries, typists, clerks and managers. The use of electronic information technology must be expected to have a marked effect on the level of productivity in this sector, and therefore on patterns of employment. The information occupations are thought to amount to 65% of the working population, so that even moderate improvements in productivity could bring about unemployment levels in the 10 to 20% region (compared to 1976 unemployment rates of 5% in Britain) unless offset by compensatory increases in demand in these or other activities."

According to the authors, information sector employment is expected to decline relative to that of other sectors. Thus Barron and Curnow predict a somewhat paradoxical reversal of past trends. Their reasoning is as follows: The increase in information sector employment which has been observed over the past 50 years "can be accounted for largely by the failure to improve the productivity of this sector in comparison with agriculture and industry, the increase in demand for information products being a secondary factor. An improvement in productivity in the information sector might be expected to stimulate a further increase in demand, but this should be more than offset by the improvement in productivity, so that in total the information sector should decline in relation to agriculture and industry. Thus the paradoxical effect of the information revolution could be to increase the proportion of the population engaged in industry, agriculture or services other than information services" (pp. 34-35).

The largest changes are expected to take place in the office. "Office automation is expected to grow rapidly and to be the single most important use of information technology in the long term" (p. 142). "Paper-based information systems...will be completely replaced by electronic information systems... over a relatively short period of 10 to 15 years." Besides expected price and performance advantages, the rapidity of this changeover is explained by the fact that "the parallel operation of both paper and electronic systems is very much more expensive, and cancels out many of the potential benefits."

"Office automation is seen as having far greater social and economic impact than any other aspect of the information revolution, and must be the primary problem addressed by any government policy. It is not the worker on the shop floor who has the most to fear from the computer, but the office worker and his manager" (p. 153).

"The impact of microelectronics on the factory is expected to be less dramatic than often forecast. (1) The productivity of the manufacturing worker has already been greatly increased by a variety of techniques, and he now represents a considerable capital investment. The investment of further capital, in the form of electronic control systems, can, therefore, only be expected to have a marginal impact on his performance. (2) Finally, the number of people directly involved in the manufacturing process (that is, excluding foremen, supervisors, administrative staff and management) is relatively small - less than 20% of the working population - so the effects of microelectronics in the manufacturing sector are unlikely to be very great in overall terms" (p. 36).

"It is expected that the direct employment consequences will be small, although the indirect consequences (as improved efficiency reduces the need for new investment) could be larger" (pp. 132-3). In industry, "piecemeal automation will arise where intelligence is added to existing production processes in an ad hoc manner" (p. 35), but it is not expected that this will result in much elimination of human labour requirements, at least not in the short or medium term. "The full exploitation of microelectronic control must be expected to take a long time to develop, because it involves acts of creative intelligence to identify new ways in which to exploit control capability" (p. 36).

"From an economic point of view, it is far more important that the U.K. use the new technology than that the U.K. should provide it. The supply industry will amount to only 1% or 2% of the economy, whereas every aspect of the economy will be affected by the use of this technology" (pp. 19-20).

It is the opinion of the authors that it is social and economic factors, rather than technological factors, which will mainly determine the future development of information technology. This has two important consequences:

- "Any attempt to predict future developments exclusively on the basis of technological considerations is doomed to failure."

- "The formulation of proper social and economic policies in relation to computing is far more important than the formulation of technical policy, and will have a much greater effect in determining whether or not the U.K. benefits from the potential of information technology" (p. 23).

Simon NORA and Alain MINC
<u>L'Informatisation de la Société</u>
Paris, La Documentation Française, January 1978

NOTE: Simon NORA and Alain MINC are respectively Inspector General and Inspector of Finances in the French government. They directed this study under the terms of a mandate given them at the end of 1976 by President Valéry Giscard d'Estaing. This study -- usually referred to as the Nora Report -- was published in four volumes: a one-volume summary report representing the consensus of the study directors, two volumes of specialized studies presented as signed "annexes" -- but for which the directors accept responsibility, and a volume of other background studies -- called "contributory documents" -- for which the directors accept no responsibility.

The Nora Report is the major French government-sponsored study of the causes, characteristics and consequences of the trend towards a computer and telecommunications-based "information society."

The study tries to evaluate the employment risks inherent in the trends foreseen. Projections of potential job losses are made sector by sector. However, these projections vary widely in terms of their methodological basis, period of projection, and certainty as to the results predicted.

1. EMPLOYMENT IN THE SERVICE SECTOR

Industry studies based on confidential surveys of major French employers in the tertiary sector show that a great amount of dislocation is foreseen in the years to come.

(a) In banking, there could be a reduction in employment of "up to 30% in the next 10 years." In the past, employment in this sector was growing at rates of 5-10% annually, whereas in the last few years, net hiring has been reduced to zero. Domestic and foreign competition is a major spur pushing in this direction.

(b) In insurance, employment reductions of approximately 30% are seen as possible in the next 10 years, pushed on by competition from foreign firms.

(c) In the post office, no quantification is made of the future net effects on employment, but the authors point out that approximately 60% of today's mail, mostly in business and government, could be replaced by electronic means -- and this replacement is considered "inevitable."

(d) In the administration of social services, not foreign competition, but simply the pressure to cut costs (and taxes) will eventually cause "significant job losses." However, this evaluation is not quantified, and is unsupported except by the logic given above.

(e) In office work, changes in job tasks, especially for secretaries, will be "exceptionally rapid," facilitated by the lack of unionization of employees in this sector. "Massive" effects on employment levels are foreseen, but not quantified.

(f) Effects on other tertiary employment: Although the surveys covered only a limited (and unspecified) number of major French employers, the authors feel that the overall effects on firms not surveyed would "probably, but not necessarily" be about the same as those predicted for the surveyed firms. In other words, the massive dislocations predicted are expected to affect small as well as large firms in all types of tertiary activity. However, lack of competition is expected to cushion somewhat the initial impact on employment in the administration of social services. Apparently, employment levels in the actual provision of social services would not be affected.

2. EMPLOYMENT IN THE INDUSTRIAL SECTOR

Based on a survey of major French employers in the secondary sector (this was apparently another confidential survey done especially for their study), the authors' forecast is for jobless growth, with either stationary or slightly declining employment overall in this sector. Their reasoning is as follows:

(a) It appears that there will be no need to increase the number of administrative personnel, even under conditions of sustained growth in output.

(b) As for production personnel, robotics are expected to absorb any increased demand in fabrication.

This forecast applies to the largest firms. However, the authors feel that small and medium-sized enterprises are more dynamic, and through their innovation, might create a certain (unspecified) amount of new employment. Still, the overall prospects are for stationary, at best, or slightly declining employment in this sector.

3. EMPLOYMENT IN FOREIGN TRADE

Concerning foreign trade, no quantification of changes in employment levels were made. However, the authors feel that foreign trade is an essential ingredient of their plan for a new period of economic growth based on computers and communications in an information society. Their reasoning is as follows:

Productivity gains in the services eventually favour the growth of foreign trade. Their macroeconomic model shows that a 10% increase in the productivity of business services leads, after a three-year lag, to a "slight improvement in foreign trade." It is obvious to the authors that a big front-end investment must be absorbed, and that "determination will be needed" while waiting for the hoped-for lagged payoffs. For this strategy to be successful, investment must be concentrated in the most promising areas, where French goods are most likely to be competitive in the marketplace.

It should be noted here that while the authors think that a growth in foreign trade would lead to increased economic wealth for France, they do not see this leading directly to increased employment.

4. EMPLOYMENT IN COMMUNITY SERVICES

The authors are optimistic about overall levels of employment only if the new wealth created by (a hoped-for) economic growth is channeled back into sectors which are not directly exposed to foreign competition and automation -- that is, into community-level (social) services such as recreation, health, education and cultural activities, public transit, and to a lesser extent, housing and tourism.

This in turn would imply (a) increased transfers or redistribution of wealth directly to those who presently "under-consume" these services, and (b) renewed public support of collective services provided at the community level. Growth in employment would then come, not at the <u>administrative</u> levels, but at the community level in the actual provision of these services.

SUMMARY

In summary, the authors believe that "telematics" will bring about quite significant increases in productivity. These will lead initially to increased unemployment, particularly in the services. But increased productivity means a better competitive position internationally, which could bring new wealth to the country, although this would likely not result in much new employment. The latter would depend on increased effective demand for services in the non-competitive social and community services sectors. Thus the "informatisation de la société" is viewed as a necessary, but not sufficient quantity needed in order to get France out of its current economic problems.

The following notes are taken from the "contributory documents" and do not necessarily represent the views of Messieurs Nora and Minc:

- Computer-aided instruction (CAI)

"The results of experiments in other countries do not permit us to predict the impacts of CAI on the volume of employment" (p. 272).

- Computer-aided design (CAD)

"This should lead our engineering schools to completely rethink the content and importance accorded graphic design in the curriculum... and encourage industry to plan and organize the retraining of their design and drafting personnel" (p. 255).

Robots

"A robot, as opposed to traditional automatic machinery, also possesses the qualities of adaptation, learning and decision-making which permit it to act upon an incompletely defined or changing environment. In addition, it is able to do this based on high-level, generalized or simplified instructions" (p. 256).

"The presence of robots in manufacturing is expected to bring about significant changes in the skills required of the work force, and thus lead to a higher level of training" (p. 256).

"The first generation of robots are not necessarily a threat to workers. But future generations of robots will cause problems related to job losses and to the need for retraining much of the work force in this sector. The second generation of robots, which are not expected before 1981, will be capable of generating their own control programs after the goals of the task to be performed are explained or indicated in general terms."

BOUNINE, J.
LUSSATO, B.

"Télématique...ou Privatique? Questions à Simon Nora et Alain Minc"

Editions d'Informatique, Paris, 1979

NOTE: Bruno Lussato is a Professor at the Conservatoire Nationale des Arts et Metiers.

Jean Bounine-Cabalé is a President of Novaction and Consultant to the General Director of L'Oréal.

Excerpts:

Employment

Each time when we witness technological progress, forecasts about reduction of personnel appear. Computers do not form an exception to this rule. Lhermitte Report ten years ago has attempted to justify concentration of enterprises and information systems by the reduction of employees. However, reductions have not obtained, rather the opposite has been observed.

It is clear that "télématique" might theoretically lead to supressions of employment.

However, Parkinsonianism would contribute to creation of jobs in centralized organizations that will tend to compensate for the jobs that disappeared.

CARRE, D.
La MOIGNE, J.L.

"Pour un Contre-Rapport Nora"

Hebdo, Aix-en-Provence, November 6, 1978

Excerpts:

Risky Conclusions about Employment

The NORA-MINC report releases into the world "panic creating" figures about considerable gains in productivity, created by télématique which will exacerbate unemployment, especially in the service sector (p. 12); banks will reduce their personnel by 30 per cent (over 10 years); insurance companies by 30 per cent (again over 10 years); social security "within a time frame that is very difficult to pinpoint" (pp. 36-37).

However, the report does not state clearly that fantastic unemployment perspectives would impact above all working women, widely employed in the tertiary sectors. Furthermore, the Nora report does not suggest even a smallest measure for alleviating this eventual drama of additional four million unemployed by 1985. A tragic omission if this figure can be justified. Or, if this figure cannot be defended, it should then be seen by the authors of the counter-report only as nothing more than "some blows by a projector."

The stakes are too dramatic - the fate of many men and women - to be so played with in projections. Some indications available to the authors of the counter-report (who are without access to "powerful means of investigation" that served NORA-MINC researchers), would indicate a less pessimistic outlook. The authors base the lack of black pessimism on experiences of the USA and Japan.

In this domain, impressions should be at least scrupulously examined if one wants to enlighten political processes.

MAGNUSSON, B.

Electronic Data Processing and Manpower
Report Synopsis

National Central Bureau of Statistics
Fack, S-10250
Stockholm, Sweden, 1977

NOTE: This synopsis is a translation of the first chapter in a report by the National Central Bureau of Statistics (available in Swedish only).

Towards the end of the 1950s, considerable speculation arose as to the effects that computer technology would have on society as a whole, and in particular on employment. While the computers were surrounded by an 'aura' of glamour, the reality was different - glamour of EDP faded away.

It was the introduction of EDP by the banks and insurance companies which gave rise to fears of the adverse effects of EDP on employment.

By 1968, the productivity gains surpassed by a significant margin the increase of personnel.

As a result, AMS, the Swedish Labour Market Board, requested the National Central Bureau of Statistics to carry out a study of effects of EDP on manpower requirements.

The terms of reference included: "The type, occupation and education of the personnel categories affected, and the nature of the routines involved in various EDP options. The study should be conducted on as a wide a basis as possible and by formulating quantitive and qualitative presentations prepare recommendations for vocational and occupational training objectives. Attention should also be given to possible effects on the vocational school system, primarily the economic side but not to the exclusion of other disciplines. Likely demands on the general level of education would indicate future trends in educational policy."

SCB soon established that the project presented a number of methodological problems, would involve considerable expenditure and require a relatively long time for completion. A pilot study was proposed. A variety of factors prevented the project from getting off the ground until the early part of 1970. A decision was reached in consultation with consumer groups to draw up a review of the current status and effects of EDP and to proceed thence, industry by industry. A combination of surveys and experts reports was proposed.

The pilot study was completed by February 1971 and a decision was made to conduct a broad test survey in the engineering industry.

The British survey, Computers in Office (Manpower studies No. 4, Ministry of Labour, 1965) which involved a survey covering a wide range of companies and institutions in Great Britain which had installed computers up to January 1, 1964, was an important source of inspiration.

Some of the conclusions arrived at in the British study:

Very few companies reported that they had declared staff redundant. Other methods were used to solve the problem of staff reductions. An analysis was made of staff whose work had been taken over by computers and the number of new jobs which had arisen. Despite the curtailing action of EDP, the relative number of office workers increased in comparison with other categories. This effect could not be isolated, as the computer performed a number of tasks which would otherwise never have arisen.

As a final conclusion the report pointed out that even if the effects of EDP differed widely from those indicated by the survey and the computer took over a far larger share of office work, it did not consider it likely that such a development would be very rapid. There was no justification for fearing any serious employment problems for office workers. In fact the introduction of the computer to the office would alleviate the shortage of office workers.

The SCB Survey

Project progress report

The most important conclusion to be drawn from the survey of the engineering industry was that the effects of EDP on manpower were relatively limited. EDP had not resulted in drastic changes in employment, as had been feared in many quarters. The spectre of EDP as a revolutionary factor on the labour market leading to serious reductions in employment and the dismissal of large numbers of office workers could be laid. The engineering industry survey revealed a more subtle picture of EDP in an industry which had been regarded as advanced in many fields.

Another important disclosure was that where reductions in the workforce had proved necessary, resource was generally had to a reduction in recruitment intake. Thus the effects of reductions in manpower requirements were cushioned either by a reduction in recruitment combined with an expansion of activities or by allowing vacancies to remain unfilled. There was a rapid increase in employment in most occupational categories including those likely to be adversely affected by EDP.

The following trends were observed:

1) A short while after its introduction, EDP leads to savings in labour costs either by reducing the total number of employees or by reducing the number of new employees recruited in periods of expanding activity;

2) Most reductions in personnel were achieved through natural wastage;

3) Staff were seldom declared redundant as a means of reducing the work-force, although this was encountered in a number of companies.

The marked concentration of EDP to purely routine office work resulted in the effects of computerization becoming more obvious in office jobs.

One estimate indicates significant reductions in certain groups of office workers. In 1974 the Computer Industry Study (SOU 1974: 1) made a number of estimates based on our surveys.

In 1973 approximately 250,000 office staff were employed in industry. Of this figure about 70,000 were among the occupational groups most likely to be affected by EDP rationalization. This figure is at least 10% lower as a result of EDP than it would otherwise have been. On the basis of these estimates, more than two or three times as many jobs will be 'lost' up to 1979 compared with figures up to 1973. This would mean a 'loss' of 15,000-20,000 actual or potential jobs for industrial office personnel, or 20-30% of the office workers employed in industry in 1973.

Effects of EDP on Selected Industrial Sectors

Agriculture, Forestry

The effects of EDP on the larger occupational categories in agriculture, forestry and fishing has been marginal.

Mining, Manufacturing, Electricity, Gas, Heating and Water

It is not possible to provide any real reliable estimates of the extent to which increases in industrial productivity can be ascribed to computer systems and applications. Most of the increase in productivity can be assigned to other causes than computerization.

EDP has brought about a rationalization in clerical and administrative tasks in industry in the sense that the number of those employed has not increased at a rate commensurate with the amount of work performed. No exact figure can be given for these reductions, as we have been unable to determine the jobs in which individuals would have been employed in the absence of EDP.

Building and Construction

There is no reason for supposing that the effects of EDP are other than analogous to industry, and it would be reasonable to expect similar effects on the labour force.

Wholesale and Retail Trade, Restaurant and Hotel

Computers in the retail trade have resulted in the loss of between 15,000 and 20,000 jobs, primarily in the clerical and accounting group and occupations classified under commerce. The rapid growth of employment in the clerical and bookkeeping group has probably ceased and may in fact decline. In contrast there has been an expansion in data processing occupations in the order of 4,000-6,000 individuals, of which almost half is accounted for by punched card and input operatives.

Communications, Post and Telecommunications

All in all EDP is estimated to have saved a total of 1,000-3,000 jobs, primarily in communication and clerical occupations. What is significant, however, is the fact that jobs which have been lost to the computer are those directly engaged in the work functions of the sector in the same way as commercial occupations within the wholesale and retail trades. In the engineering industry, on the other hand, we found that EDP did not directly affect such work functions as manufacturing, but was concentrated more on the ancillary functions of clerical and administrative work.

Banking, Insurance, Real Estate Management and Commission and Agency

Banks and insurance companies are major computer users, especially for labour intensive activities. It is safe to assume that, but for EDP, there would have been a considerable growth in employment. 20,000 would appear a likely estimate of the new staff which would be required to handle roughly the same work load at present accounted for by EDP - in all probability, far more.

Government Administration, Other Services and Services n.e.c.

There would have been at least 10,000 more in employment in this sector in the absence of EDP and that the standard of service would have been appreciably lower. To achieve current service standards without EDP would probably require an additional 10,000 jobs.

The Overall Effects of EDP on Manpower

"On the basis of this synopsis we must conclude that we are unable to draw any more definite conclusions on the effects of EDP on manpower in individual sectors." All we have been able to do is to give some intimation of what has happened in terms of the effect on various occupational categories - its nature and extent.

Possible Effects of EDP on Employment in Various Sectors Up to 1975: Summary

	Jobs lost or jobs which failed to materialize as a result of EDP	Jobs created by EDP in 'computer oriented' occupational categories
Agriculture, forestry	200 - 1,000	100 - 200
Industry, mines and quarries, etc.	15,000 - 25,000	ca 10,000
Building and construction	1,000 - 2,000	200 - 500
Wholesale and retail trade, restaurants, hotels	15,000 - 20,000	2,000 - 4,000
Communications, post and telecommunications	1,000 - 3,000	1,000 - 2,000
Banking, insurance, real estate management and commission and agency	20,000 - 25,000	ca 10,000
Public administration, and other services n.e.c.	10,000 - 15,000	ca 5,000
Total	60,000 - 90,000	ca 30,000

ERLANDER, B.

Effects of Computerization on Employment and Working Environment

Stockholm, Dataeffektutredningen, 1979

NOTE: Dataeffektutredningen - Commission on Computerization and Employment - had started its work in Spring 1979, under the mandate of the Minister of Labour of Sweden. Their first report is expected by the end of 1979. The Commission's work is closely related with the work of the Commission on Computerization and Development of Industry and Commerce.

Excerpts

- In the last decade computerization has made its breakthrough and has affected working conditions in most branches of public administration, industry and commerce. It creates new opportunities for development that are important to utilize but at the same time creates great demands for readjustment and renewal. The greatest changes probably still like in the future.

- In the next few years increasing numbers of offices are expected to acquire electronic equipment for storage, processing, and output of texts.

- In industry computers are being increasingly used in various production processes.

. Some attempts have been made at quantitative assessment of the various employment effects of computerization. The 1971 Commission on the Computer Industry appointed a special Reference Group to study employment questions. The Group stated in its report* that the changed industrial structure was the main reason for changes of employment figures in different occupational groups. Technical development was named by the Reference Group as one of several explanations of changes in the industrial structure. Up to that time (1974) computerization was thought to have had the greatest effect on employment in the office sector, in which, in all likelihood, the number of employees would have increased even more, had computers not been introduced.

. The work of the Commission on the Computer Industry has been followed by continuous investigations by the National Industrial Board. Also the Central Bureau of Statistics has attempted to calculate the effects of computerization on the labour market. In a final report "ADP and Labour" (Information on Forecast Questions 1977:21) the net effect in the office sector is calculated at a loss of 30,000 to 40,000 jobs.

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* Memorandum No. 3 to the Report (SOU 1974:10) "Data and Commercial Policy."

. Since these calculations were made the total number of persons employed in the office sector has continued to increase. It is nevertheless probable that in many places computers have reduced the need for office staff. Unless total employment in the service sector continues to increase as rapidly as hitherto, computerization in the office sector may lead to new and greater problems of unemployment. In other sectors, such as the graphic industry and parts of the communications field (postal services, telecommunications, shipping, railways, etc.) the introduction of electronics has meant that certain professional groups now seem to be disappearing.

. In manufacturing industry ... industrial robots may soon replace the work of many people. The future effect of automation on total industrial employment is, however, little known. Some estimates were made in the aforementioned final report of the Central Bureau of Statistics. It is important in this context to remember that industrial employment has diminished over a number of years. This has been partly due to a progressive rationalization and technical development of production. But despite the trend to reduce employment in the long run, during boom periods industry has regularly suffered from a shortage of skilled workers, which has stimulated its efforts to automate production.

. On the international level the International Labour Organization (ILO) has issued a warning that too rapid a development may have serious consequences for employment.

. Several parliamentary motions have emphasized the need for an investigation of the effects of computerization on employment. In Autumn 1977 the Parliamentary Standing Committee on the Labour Market stated that there were indications that job opportunities would become fewer. The Committee therefore considered it urgent to make a broad survey of the future effects of computerization on working conditions and employment. The Committee requested that parliament should notify the government of its support for the Committee's opinion. Parliament acceded to the Committee's request.

. The studies made hitherto on the future effects of computerization on employment have, however, been of a general nature or had the character of examples. A commission should therefore be appointed to make a comprehensive investigation of the future effects of computerization on employment and working environment. The commission should present a basis for general decisions on matters relating to the development in the next 5 to 10 years. Its findings should also serve as basis for the continuous supervision of the effects of electronics on the labour market, exercised by the National Industrial Board among other bodies.

. A point of departure for the examination to be made by the commission must be acknowledge of the use of computers in different sections of public administration, industry and commerce, and where far-advanced plans exist for extending the use of such equipment. The Commission should be able to present an estimate of the future use of these aids. For this purpose the Commission should to a large extent be able to draw upon material produced by the commission to be appointed by the

Minister of Industry and by the National Industrial Board.

. The commission should then analyse the effects of computerization on employment for different conceivable future technical and economic developments: both on total employment and on employment in different occupational groups, in different branches of industry and commerce, and in different parts of the country. The commission should consider the extent to which different developments in the use of electronics have desirable or detrimental effects on employment and the extent to which this development can be influenced in a desirable direction.

. The commission should consider to what extent the government should take special measures to facilitate readjustment in connection with the introduction of computers and automation or to control this development in an appropriate way from the point of view of employees. The need for education and training of different occupational groups and for different labour market policy measures should be especially illustrated.

FREEMAN, C. Technical Change and Unemployment. Paper presented to Conference on "Science, Technology and Public Policy: An International Perspective," University of New South Wales, 1-2 December 1977, to be published in conference proceedings. 22 pp., tables, refs.

NOTE: The author is a director of the Science Policy Research Unit (SPRU), Sussex, England, affiliated with the OECD project on "Science and Technology in the New Economic Context."

EXCERPTS AND RESUME:

"It is often assumed that the displacement of labour through automation, mechanisation and other forms of technical change will automatically tend to be compensated by the creation of new jobs in other industries and services, or the growth of total demand. ...This is not necessarily so!" (p. 1). The rates of "job displacement" and "job generation" respond to different pressures, and need not necessarily always be in balance (p. 4). Since "the demand for labour is not simply a function of the demand for goods and services,...a pattern of 'jobless growth' or 'job-displacing growth' is conceivable in individual firms or industries, or even in the manufacturing sector as a whole. It has long been familiar in agriculture" (p. 5).

Radical innovations such as those seen recently in the electronics industry "may tend to be 'job-generating' in their early stages, but 'job-displacing' as they mature" (p. 9). Due to the momentum of educational, political and social institutions, as well as of economic and industrial structures, time-lags are substantial between the adoption of capital-intensive techniques of production and actual labour displacement. "The time lags involved in this interaction may often be measured in decades rather than years" (p. 19). "Consequently the effects would be small at first, but gradually increasing. They would be most apparent in sectors of the economy where competition is strong and relatively weak in the public sector and in those private service sectors where the effects of international and internal competition are softened" (p. 13).

In support of this line of reasoning, the author gives examples ranging from observed employment effects on specific industries to the analysis of growth prospects by product cluster, to inferential evidence from long-term economic trends and a discussion of the overall direction of pressures for technical change.

1. For example, in the cash register industry, the use of microcircuits has caused the leading manufacturer, NCR, to cease being a mechanical engineering company. NCR's 1975 annual report shows that the result of this change has been that NCR total employment has fallen off 30% over five years (from nearly 100,000 in 1970 to 70,000 in 1975) while manufacturing employment has fallen off more than 50% (from 37,000 to 18,000). (p. 10)

2. In the telephone industry, Western Electric's switching division employment dropped by over 50% in six years (from 39,200 direct employees in 1970 to 19,000 in 1976, with a planned further reduction to 17,400 by 1980). However, "volume of production is expected to increase, so that output per employee will more than double. All this is the result of the shift from electro-mechanical to electronics technology... Indirect labour is expected to fall by as much as direct labour, but will be slightly compensated by an increase of about 600 in the numbers working on software." However..."Western Electric estimates that their installation work force will be cut by 75%" (p. 11).

3. Results of an OECD industrial interview program show that "the leading multinational electronic firms within the USA, Japan and the EEC do not expect to increase their employment over the next few years, although they do expect an enormous increase in output, especially in micro-processors and capital goods, but also in consumer goods" (p. 16). Thus in forty years, the labour-intensive character of this industry has been completely transformed by the application of new technologies.

4. Analysis of the six fastest-growing product "clusters" of the 1950s and 1960s (electronics, consumer durables, synthetic materials, drugs, agricultural chemicals, energy) reveals a number of reasonable grounds for anticipating slower rates of growth in each of these fields in the future than what was seen in the past. Depending on the field, these grounds include one or more of the following factors: market saturation, reduced prospects for further radical innovation, more stringent environmental and safety regulations, competition from OPEC and other countries, etc. (pp. 17-19).

5. For the manufacturing sector in particular, "although labour productivity may continue to grow at a high rate, manufacturing will no longer be a source of increased employment. It may (like agriculture) be a sector of steadily decreasing opportunities for employment" (p. 16). This conclusion is supported by statistics showing a general lack of growth or decline in manufacturing employment during the 1970s in the OECD countries -- i.e., a pattern of "jobless growth."

6. Indirect evidence also suggests the conclusion that manufacturing cannot be relied upon to provide future growth of employment. "Data from France, Germany and Japan (but not from the USA) show a significant fall in the productivity of capital over the last 18 years" (p. 14). In the U.S.A., Germany, France, Japan and Italy (and to a lesser extent, in the U.K.) there has been over the past decade a change in the pattern of investment, from an emphasis on the construction of new plants and factories towards replacement and rationalisation within existing plants and factories; that is to say, there has been less investment in buildings and more in machinery. (pp. 15-16)

7. Overall, there are a number of pressures pushing all OECD countries in the direction of job-displacing technical change, such as rising labour costs, labour militancy, and higher social benefits; increasing difficulties for employers who want to lay off or retire workers; increased international competition from countries with lower labour costs; government tax and incentive policies favouring capital-intensive techniques.

8. "The services thus remain...as the only sector which apparently offers expanding opportunities for employment in the next decade, unless the trends clearly evident in the period 1964-1977 in the other sectors are to be reversed. But within the services, those such as banking, insurance, repair and distribution are particularly vulnerable to the microprocessor revolution, since one of their main activities is handling large quantities of simple information." This leaves the genuine personal services (such as hair dressing and catering) and the social services (such as education, health, etc.). "One of the main conclusions of this analysis therefore is that public investments and expenditures in these fields may be an important element of full employment strategy in the

1980s despite the many political pressures to reduce them" (p. 21).

FREEMAN, C.

"The Kondratiev Long Waves, Technical Change and Unemployment"

Paper
SPRU, University of Sussex, U.K., January 1977

NOTE: Professor Freeman is a Head of the Science Policy Research Unit, University of Sussex.

Excerpts:

Technical Change and Unemployment

Clearly a process of labour-displacing technical change at the level of the firm is not in principle inconsistent with steady growth and relatively full employment at the macro-level, provided certain conditions are satisfied, including mobility and adaptability of labour, and a level of new investment sufficient to absorb the displaced labour plus any growth of the labour force.

For the economy as a whole, the direction of technical change is indeed the outcome of an enormous variety of partly independent events and decisions and the overall bias might well change over time. The ways in which the economy adjusts to maintain a balance are complex. Neisser has argued that whether the problem is approached through classical economic theory, neo-classical theory, or Marxist theory, there is no reason to expect that the full employment equilibrium will be automatically or easily sustained.

The difficulties of measurement and the complexities of the classification problems should not obscure the essential fact, that what is occurring is a fairly rapid and continuous displacement in labour in many different industries and even more in agriculture. Nor should it obscure the fact that there is no inherent reason why this process of displacement should not accelerate or decelerate periodically, partly in response to exogenous events, such as the availability of radically new technologies and the ease with which they can be applied.

Such changes, if they occurred, might or might not be compensated by changes elsewhere in the economy, which would absorb the labour continually being displaced by labour-saving technical change. Among the factors which hinder the adjustment process are the "stickiness" of prices and of wage rates, and the relatively low elasticity of substitution between capital and labour in many production processes.

Technical Change and the Kondratiev

Neither Kondratiev nor Schumpeter explicitly discuss the possibility that a particular wave of innovation might first of all have employment generating effects but at a late stage employment displacing effects.

Consider the possibility that some big changes in technology might help to tilt the balance of the system every quarter of a century or so, first in one direction (the upswing of the Kondratiev) and then in the other direction (the downswing).

Discontinuities in the introduction of major new technologies on the one hand, and an accumulation of secondary consequences on the other, may be one of the important contributory factors to the long waves, whose specific form will differ from country to country. The point at which labour-displacing effects begin to dominate over the labour-generating effects of the major new technologies in the country or countries which lead the world economy could be the point of inflection of the Kondratiev wave. This "point of inflection" may of course be a period of several years or even a decade in which the balance is fairly evenly held, and national variations will be important.

The Electronics Industry and Technical Change

The growth of the electronics industry (is) a possible exemplar of the (Kondratiev wave) pattern.

Employment in the computer industry itself, although of course it grew very rapidly in the 1950's and 1960's, is not actually very big. In the United States it is only just over 200,000. The really important employment effects are outside the industry itself. The statistics are very unsatisfactory, but it is estimated that at least ten times as many people, i.e., about 2 million, are working on computer installations.

Computers were sometimes sold to customers on the basis that they would "save" labour by eliminating routine clerical and "number-crunching" activities. In some cases they may have had this effect, and again it is extremely difficult to get reliable statistical information, but the evidence which it has been possible to assemble suggests that in the vast majority of cases, the first effect of installing a computer was to add to existing employment, not to reduce it. Labour-displacing effects may have followed, but almost always with considerable delays. Since almost all comptuers now in operation were only installed since 1960, any effects of this kind are probably still to come, at least for Europe and Japan.

Total employment in the United States electronics industry grew from 56,000 in 1939 to 350,000 in 1950. It reached its peak in 1969 at 1,254,000. Since then, it has fluctuated a little around a slight downward trend and in 1975 stood at 1,115,000.

The cheap reliable micro-processor makes it possible to eliminate almost all the mechanical moving parts from a cash register, as with a watch, and replace them with a chip.

The result of this change over 5 years has been that National Cash Register (NCR) total employment has fallen from nearly 100,000 to 70,000, while the fall in manufacturing employment has been more than 50%.

"The electronic products we are manufacturing today have a labour content about 25% of their predecessors. Today the manufacturing operation primarily involves the assembly of purchased components.... Accordingly our total employment in manufacturing plants is down to 18,000 today compared with 37,000 in 1970."

As a result of the intense competition, a leading German manufacturer of cash registers, Anker Werke, went bankrupt in 1976.

The second example is from the telephone industry. Western Electric is the manufacturing arm for American Telephone and Telegraph and hence for the greatest part of the North American telephone system. Their switching equipment division, which in 1970 had 39,200 direct employees, was planned to have 17,400 by 1980. It had already fallen to 19,000 by 1976. Indirect labour is expected to fall by as much as direct labour. Western Electric estimates that their installation work force will be cut by 75%.

All major telephone equipment companies in Europe are faced with the same problems of transition. In the UK, the labour force is expected to fall by 30% during the three years 1976 to 1979, despite the slower shift to electronic technology.

These examples illustrate the type of labour-displacing technical change which is now possible as the result of mature, cheap, reliable electronic technology. Among other industries which may expect major effects over the next decade or two, are banking, printing, insurance, publishing, machine shops, meters, instruments, and many types of assembly.

LAMBORGHINI, B.

"The Diffusion of Microelectronics in Industrial Companies"

Unidentified paper, 1979

NOTE: Dr. Lamborghini is a Director of Economic Studies for Olivetti S.p.A., Torino, Italy.

Excerpts:

(Microelectronics) has already caused, and promises for the future, radical changes in numerous industrial sectors.

The "microelectronics revolution,"...seems oriented to pass into history as the "fourth industrial revolution."

The aspect of this "revolution"...causing the greatest concern, is the labour saving or job killing effect.

The reduction of employment directly caused by new technology in manufacturing companies is however today part of an international industrial economic framework.

The current situation makes it more difficult to evaluate which direct labour saving effects are really of a technological origin.

This prevents the phenomenon from being more thoroughly and objectively analyzed and above all slows down the adoption of "active" political actions designed to emphasize the "strong points" which microelectronics' capacity for innovation creates and vice versa to minimize the socially negative elements.

The impact on employment is only one of the aspects to which attention should be called when analyzing the prospects of the "microelectronics revolution."

Indirect effects

Increased productivity is not synonymous with a worsening of unemployment: in fact, during the fifties and sixties when the industrialized countries made large fixed investments in automized machinery and plants, high rates of productivity accompanied low unemployment indices: on the other hand, during the seventies, productivity has fallen in the presence of growing unemployment.

A second important indirect effect is the chance to create new goods and services using the new technology.

Examples of employment decreases:

1) The British information processing industry as a whole registered a 20% reduction in employment between 1970 and 1977.

2) Considering a sample of mixed companies (that is with mechanical and electronic products) of which four are American, three German and one Italian, one observes an employment reduction of close to 20% between 1969 and 1978: in detail, a 40% reduction in employment at N.C.R. (National Cash Register), 35% at Olympia Werke, 20% at Adler Werke, 18% at SCM, 10% at Olivetti.

3) Within these overall employment figures there is a strong reduction of production personnel in these companies: the percentage of production employees in total personnel fell between 1970 and 1978 from 44% to 31% at Burroughs Inc., from 37% to 27% at N.C.R., from 38% to 22% at Nixdorf, from 45% to 31% at Olivetti.

4) The percentage of blue collar workers tends to decrease dramatically: for example in the Italian information processing industry (where important mechanical production still subsists) the percentage of blue collar workers in total personnel decreased from 53% to 38% between 1970 and 1977; at Olivetti this percentage decreased from 64% to 47%.

5) At Olivetti electro-mechanical typewriters are currently being replaced by electronic models. The first evaluations show that the electronic model launched last year has a direct productive labour content equal to 50% of that necessary for the corresponding mechanical product (and this percentage will presumably decrease as technology develops).

LAMBERTON, D. McL.

Social Costs of Change, Employment, Professional Skills and Curricula

Paris, OECD
November 1978 (34 pp., mimeo).

NOTE: This paper was done for the OECD Expert Group on Information Activities and the Role of Electronics and Telecommunications Technologies.

The polarisation of thought on technological unemployment has been a feature of the historical debate at least since the time of Adam Smith. Lamberton's paper criticizes both extremes of this debate (represented respectively by neo-classical academic economists and technologically-oriented researchers), and argues for a policy-oriented approach based on an understanding of the complexity of the process and an appreciation of the real social problems as well as the economic benefits it entails. He explains what is meant by "social costs," he points out the usefulness of an "information sector" concept and of input-output models of information flow for purposes of analysis and theoretical understanding, and he discusses at some length the findings of the ACARD Report of the U.K. Advisory Council for Applied Research and Development (see Baron and Curnow for a published version of this report).

Both the optimistic and pessimistic forecasts of the employment effects of technological change are criticized. According to Lamberton each of these views stems from a limited perception of the process of change.

The pessimistic vision is shaped by the obvious and immediate displacement impact on employment and "usually results in forecasts of X millions of additional unemployed in the next few years." This view focusses, for example, on "the immediate job displacement as the word processor is adopted in the office or as digital switchgear is put into operation in telecommunications systems." To a large extent this means "continuing to see the process in the same way as did those responsible for the innovation and ignoring the consequence of the change itself." Thus Lamberton does not reproduce or even cite these forecasts because "to do so might lend credence to their results."

On the other hand, the optimistic view is "simply the old notion that the future will take care of itself; that resources will always have prices that ensure their proper use. It presupposes a great deal more knowledge of the future than we in fact have... It is remarkable how far economists have managed to avert their gaze from the extreme unrealities of the abstractions involved... But recognition is growing that equilibrium ways of thinking may be inapplicable; that the important role of information may endanger the stability and even the existence of equilibrium."

In fact, it is not so much the eventual long-term consequences of the information revolution which preoccupies most observers. It is rather the short term consequences "which generate and shape much of the current debate about the employment impact of the information revolution." Looking only at the long-term consequences, as does the "optimistic" school of economists, sidesteps the very real and immediate issues of adjustment problems in the short and medium term. "It leaves room for a serious gap between displacement and generation. It assumes that one kind of labour can be transformed into another kind of labour. It assumes also that the sharing of rewards of technological progress raises no insuperable problems. These are big assumptions. The all-pervasive nature of information technology suggests that the gap between displacement and generation could be very wide.... Nor can we be confident that the sharing of benefits will proceed smoothly.... Social costs are not a myth;" negative impacts of computers on working life have been frequent.

The transition to a knowledge-based information society entails a process of structural change which generates social costs as well as benefits. While the very long-run effects of this transition are presumed to be positive, it is really what happens along the way which should concern policy makers. There is a general consensus that, in the context of international competition, failure to adopt the new technologies would be nearly suicidal. Hence various manners of encouraging this transition are clearly indicated.

To be able to respond adequately to the problems entailed by this transition, policy makers must remain flexible and open-minded. Understanding of the events as they unfold and the ability to adapt and adjust quickly will be very important. However, work sharing and variation in annual hours of work per job "are not measures that can be used wholly or even largely as control devices.... Approaches to policy that see instruments as purely economic, or as controls that can be switched on and off at will, are doomed to failure."

"We need a model of the future information society which falls between the extremes" of the two views discussed above. Input/output analyses, by pointing out and quantifying the interrelations and complexity of information flows within and between the various sectors, may prove of use in this respect.

Insistence upon rigid quantification as the basis for policy can be misleading and have undesirable consequences. "The net effect of job displacement is very difficult to predict and cannot be expected to be uniform amongst industries or nations; (moreover) there are a number of retarding factors." International competition will continue to push implementation, but "the process will not be nearly as fast as a view based solely on technological aspects would lead us to expect. It will be slowed by economic and social brakes." This slowing can reduce the social costs in an important way. In this respect, "the ability to avoid or minimize social costs may prove to be just as beneficial as the realization of direct productivity gains."

MACHLUP, F. <u>et al.</u> (1974)
<u>Effects of Innovations on Demand for and Earnings of Productive Factors</u>
Report, National Science Foundation
Washington, D.C., U.S.A.

NOTE: Professor F. Machlup and his co-authors are associated with the Economics Department of the New York University, New York.

The report surveys and summarizes the present state of the arts on effects of innovation on the demand for and earning of productive factors.

The study surveys theoretical and empirical economic literature on shifts in input demands resulting from various types of technological changes (process, product, supply induced, etc.) and on innovation's effects on the relative earnings of management, labour and capital.

A part of the voluminous report deals with the effects of technological change on labour employment.

Excerpts:

<u>A Review of Theoretical Studies</u>

It is useful to make a distinction between labour displacement and labour unemployment.

Labour displacement may be regarded as a short-run consequence of a mis-match between existing workers' skills and geographic attachment, and other factors of production.

Permanent labour unemployment, on the other hand, is usually thought of as the consequence of a failure of the economic system to adjust to changing conditions, including changing technology, over the long-run.

Labour Displacement

It has been recognized that technological change may cause labour displacement if workers are constrained from moving to those places where they can be reabsorbed into production at wage rates prevailing there.

Technological improvements may render a low quality of labour more or less obsolete and require the employment of more skilled labour. Alternatively, the technological change may lower the level of skill required of complementary labour, or leave it relatively unchanged.

Structuralists vs expansionists

While the authors of the report recognize that determining real consequences of technological change on employment is largely an empirical question, they refer to controversy surrounding technological unemployment among theoretical labour economists.

The literature of this topic is couched in a rather confusing language. The term "structural unemployment" is used to distinguish from unemployment due to deficiencies in demand used by "expansionists." It is used without stating whether one refers to the cause or to the possible cure of unemployment.

If the reference was to causes, then the rate of unemployment can be attributed to structural changes that have occurred by "structuralists," while it can be attributed to unduly restrictive fiscal and monetary policies by "expansionists." If the reference is to possible cures, the first group refers to unemployment that can be remedied only by structural adjustments such as reschooling, retraining, relocation or wage differentials, whereas the other group sees the unemployment cure in an expansion of effective demand.

The authors warn against illegitimately narrow use of the expression "structural" when what is referred to is merely a technological unemployment. In their view, there are also other non-technological components in structural unemployment, such as changes in wage structure.

Permanent Labour Unemployment

The authors review the theoretical arguments that consider possibility of technological change causing permanent labour unemployment.

On the basis of general equlibrium analysis, it is theoretically possible to deny that technological change can create present unemployment. The analysis is based on the model of automatic adjustment which postulates:

1) perfect elasticity of demand;
2) a simple production process with a smooth production function only;
3) perfect elasticity of all individual factors of production.

Indeed, given these assumptions, technological unemployment is next to impossible, except for transitional "frictional" unemployment of one kind or another.

The logic of adjustment model has been demonstrated since classics Quesney (1758) and Turgot (1776) by neo-classics such as Walras (1874) and Pareto (1897). In modern literature it was treated by Leontieff (1951), Kuenne (1963) and others.

Some theoreticians dissented from this view. Ricardo (1817), Marx (1867) and Schumpeter (1954), for instance, pointed out that continuity of technological change is producing lasting condition: chronic state of unemployment.

Today, the most widely held position admits the possibility of permanent labour unemployment. It is not difficult to understand why: most, if not all assumptions in the model can be barely called realistic.

To illustrate, the model relies on the basic assumption: a price of a productive factor - labour in our case - will fall with relation to factors still in use. In the real world, however, the existence of minimum wage legislation and the presence of powerful labour unions prevents prices of labour falling below certain thresholds. The prices then cannot play the roles assigned to them. Or take the case of perfect substitution. Perfect substitution between labour and capital factors of production is also illusory. The empirical data from North American economies imply that the factor of substitution is clustering around a value of less than one - between 0.5 and 0.7 - indicating less than perfect substitution.

Review of Empirical Studies

The empirical studies are reviewed on several levels.

Macro Level

While the structuralists maintain that technological changes may be expected to produce unemployment, the expansionists deny this assertion and hold that empirical studies do not confirm the structuralist propositions.

The expectations that technological change may lead to increasing mismatch of workers and jobs - unemployment and shortages of labour at the same time - is based on core assumptions that technological change shifts the demand towards higher skills and better education.

This proposition was tested by Heller (1965) in analysis of the compositional shifts of the ranks of unemployed, using data from 1960s period. Heller's results appeared to give little support to the tested structuralist hypothesis.

A test of expansionist hypothesis, relating employment and demand, was carried out by economists who attempted to determine the relationship between changes of wages and changes in levels of unemployment. As the first researchers, led by Perry (1970), found erosion in the trade off between inflation and unemployment in 1970s, the expansionists seem to lose the day: technological change is seen to contribute significantly to an increase in labour unemployment.

A number of empirical studies from agriculture, mining and railway transportation point in the same direction.

Nevertheless, there remains a group of economists, such as Terbourgh (1965), who suggest that technological change may create short-term displacement but will expand employment opportunities in the long run.

Sectoral Studies

While there can exist no doubt in general that technological change releases workers, the purpose of sectoral studies is above all to determine the magnitude of the employment impact in particular industries.

The study of employment impacts in 82 banks carried out by Wiener in 1962 concluded that although technological change is working to reduce the growth of employment relative to what it might be in its absence, the absolute number of employment opportunities continues to rise.

Similar conclusions were drawn from the 1960 U.S. Department of Labour study of 20 offices. On the other hand, two studies of the maritime industries in 1960s pointed out that employment opportunities in the U.S. merchant fleet were reduced four times between 1945 and 1965 from 160,000 to 40,000 jobs.

The case studies thus demonstrated that technological change had contributed to either a reduction of employment in some industries, or that while it reduced employment in certain functions, the employment opportunities for the industry as a whole continued to expand.

Studies of Individual Firms and Processes

All studies point in an obvious direction: the introduction of more automatized methods is associated with substantial reductions in total man-hours of direct labour per unit of output.

Findings of Crossman et al (1966) lend some support to the "labour static hypothesis" - the loosening of relationship between employment and volume of output, mostly owing to technological change.

The question opened up by Von Auben's study (1953) has not been elaborated upon by the authors: are the released workers reassigned within the firm or are they let go?

Review of Empirical Studies

The authors conclude that despite the lack of consensus, the results seem to indicate that during the 20th century technological change may have been, on the average, labour-saving.

They make a distinction between two types of technologies. Labour-saving caused by "autonomous"* technological change would aggravate labour unemployment, while "induced" technological change would only chill rapid increases for demand on employment.

The authors conclude that, should the rate of technological change increase, the level of unemployment may increase as well.

* Technological change dependent upon expected changes in the relative factor prices is referred to as "induced," while technological changes which result from other forces are called "autonomous."

PEITCHINIS, Stephen G.

The Effect of Technological Changes on Educational and Skill Requirements of Industry Research Report, Technological Innovation Studies Program, Technology Branch, Department of Industry, Trade and Commerce, Ottawa, 1978.

NOTE: The author is Professor of Economics at the University of Calgary, Calgary, Alberta.

While not primarily concerned with the effect of computers and telecommunications technology on employment volume, this study nevertheless contains a more thorough treatment of the subject than any other Canadian study we know of. The Peitchinis study is unique in this country in so far as it is based largely on industry response to a mail survey which was then followed up with other, less-structured written communication and oral interviews. In addition, Appendix B contains employment projections for selected occupational categories, based on the author's reading of the corresponding trade and professional journals. Appendix C contains trend data from published statistical series concerning the employment and output of "production" and "non-production" workers in Canada, by industry, from 1961-1974. Finally, an extensive annotated bibliography is provided, based on computerized searches of a number of bibliographic data bases, as well as on traditional library research.

It is difficult to determine how representative was the sample of 104 firms which actually responded to the survey questionnaire. As the survey was originally mailed to 1,200 industrial and commercial enterprises in Canada, the response rate was less than 10%. It should be noted, however, that "although the questionnaire asked the respondents to consider technological changes of all kinds, new materials, processes, services, etc., over 50% of the changes reported were computer related" (Scrimgeour Memo, Technology Branch).

EFFECTS OF TECHNOLOGICAL CHANGE UP TO THE PRESENT (Survey Results)

Of 25,000 workers employed by the surveyed enterprises at the beginning of the period considered, 3,000 (13%) were subsequently displaced by technological change, over half of whom (50-75%) were simply fired ("released from employment"), while the others were transferred and/or retrained within the firm. In contrast, only 600 new positions were created, these being mostly for systems analysts, computer operators, and "mechanics, technicians and installers." In other words, it appears that in the 102 firms surveyed, for each new position created as a result of technological change in this period, at least three workers lost their jobs. Whether or not the "released" workers found employment in other firms or industries, we are not told.

EXPECTED FUTURE EFFECTS

"Approximately 85% of the respondents said they did expect significant technological changes in the next 5 to 10 years. ...In the future, 60% of the people affected will require greater technical knowledge, compared to only 17% requiring upgrading in the recent past" (pp. 146-7). In other words, "employers are anticipating a very large increase in the level of technical knowledge required. If this is indeed the case, greater problems in the areas of shortages of qualified manpower, retraining, and possibly redundancies can be expected."

"The effect of technological changes on manpower appears to be six-phased: (1) they complement the manual and semi-mechanized work functions of personnel, thereby enabling them to perform a larger quantity of work; (2) they increase the efficiency of processes; (3) they facilitate the performance of some work functions which could not have been performed in the absence of the new technology; (4) they create new categories of labour; (5) they displace labour and (6) they reduce the employment intensity of production processes" (p. 50).

Aggregate effects on employment

"The effect of employment in the aggregate depends upon demand and the consequent increase in output: where demand and the volume of output increase faster than the rate of increase of productivity, employment should increase; where output increases proportionately to the increase in productivity, employment, on the aggregate, can be expected to remain unchanged; and where demand and the volume of output increase by less than the increase in productivity, employment should decrease" (p. 50).

Up to now, "employment does not appear to have been affected adversely in the aggregate" (p. 18). However, in the future, "large scale manpower displacement should be anticipated ... substantial retraining programmes will be necessary" (p. 35). Moreover, as the labour intensity and hence, the labour absorptive capacity of the service sector is being reduced, this will entail important risks for employment and unemployment generally, since it is in the services that three-quarters of Canada's new jobs have been created in the past.

EDUCATIONAL IMPLICATIONS OF TECHNOLOGICAL CHANGE

"People with high degrees of specific technical knowledge are going to be rendered increasingly obsolete.... High levels of education facilitate greater flexibility in the transference of work functions amongst related occupations, and make adaptability to industrial and social change somewhat easier.... (Therefore) It would be a disservice to students and society at large to limit the educational content of their programmes to that knowledge only which has immediate application in the world of work" (pp. 151-153).

EMPLOYMENT EFFECTS ON PRODUCTION AND NON-PRODUCTION WORKERS
(analysis of trend data)

"An examination of employment in goods-producing industries (Appendix C) reveals that a significant number of industries seem to have reached a plateau in the employment of non-production workers -- managerial, clerical, sales, and such other. While output has been increasing, and increases are (still) recorded in the number of production workers, the number of non-production workers employed has remained relatively constant" (p. 153).

EFFECTS OF TECHNOLOGICAL CHANGES BY INDUSTRY (pp. 87-118)

<u>Manufacturing</u>: There will be "positive employment effects on inspectors and skilled tradesmen, negative employment effects on production process operators, and hardly any effect on factory service personnel." "In some companies the rate of technological change has been held down by the lack of an adequate supply of specialized manpower."

<u>Textiles</u>: "Technological changes have revolutionized the textile industry." Further changes can still be expected, even in the most modern sectors of the industry, while parts of the industry remain backwards and old-fashioned.

<u>Energy</u>: The entire energy sector is characterized by a high degree of automated or semi-automatic processes. (Presumably this implies that further important job losses are not to be expected in this industry.)

<u>Construction</u>: Should prefabrication be permitted, there will be "very significant implications" for the nature and level of employment in the construction trades.

<u>Petro-chemicals</u>: "The petro-chemicals industry is expected to have a relatively stable labour force."

<u>Agriculture</u>: "Technological development will require specialized high level manpower" and "depend increasingly on cooperation among specialists from different scientific disciplines."

<u>Pulp and Paper</u>: "The computerization of pulp and paper manufacturing activity is in its infancy," but "manpower needs will continue to be met through internal training." "It is anticipated that employment of managers, sales workers, professional and technical workers, and clerical workers will increase, whereas employment of operatives will continue to fall."

<u>Mining</u>: "Process control computers with associated analytical equipment are being introduced...helping to make possible the exploitation and processing of low grade ores." "Scarcity of specialized manpower will continue to be a serious problem in the industry, particularly in coal mining."

<u>Telephones</u>: "In the telephone industry technological changes...have virtually eliminated manual operational activities" and "facilitated a substantial increase in the volume of calls, with essentially an <u>unchanged</u> number of operators." Potential applications of computer technologies in other aspects of the industry are (severely) limited by "scarcity of specialized manpower: computer software specialists, systems analysts and programmers are scarce throughout the industry."

<u>Banking</u>: In response to the introduction of more electronic processes, "(1) there should be a reduction in the rate of increase in employment; and (2) there should emerge a number of new employment categories." "...while employment in routine low-skilled activities may decline, employment in high-level positions is likely to continue its upward

climb. If banks being (or continue) to undertake accounting and billing services for small businesses, trade, and professionals, "on the balance, a decrease in employment may be anticipated." Ultimately, when EFTS become generalized, self-service will replace tellers.

Libraries: "The implementation of technological changes is still in its infancy phase." "The elimination of routine and mechanical functions permits the allocation of more time to higher level functions" which may spark a renewed interest in professional library work.

PROJECTIONS FOR SELECTED OCCUPATIONS

The author obtained the information for this section "from the professional and trade journals of the indicated occupations" (see Appendix B).

Accountants and auditors: "The trend to 1980 is for continued absolute increase in employment, but at a lower growth rate as computer systems take over many accounting functions" (p. 164).

Architects: "Increases in job openings are expected to continue as computer-based project analysis increases the speed and efficiency of design work, allowing more projects to be undertaken per year" (p. 165).

Draftsmen: "The occupation of draftsmen will likely be eliminated by the 1990's for all but a highly qualified few" (p. 166).

<u>Engineers and related occupations</u>: "The widespread automation and computerization of the industrial sector will continue to have highly positive effects on the growth of the engineering profession, with demand for qualified engineering personnel <u>increasing</u> in many new areas" (p. 167). In chemical engineering, the "trend favours the chemical engineer over the chemist or technologist, whose functions tend to be de-skilled by the incorporation of computer control in laboratory analysis" (p. 169).

<u>Chemists, laboratory and research</u>: It is expected that a relatively rapid rate of <u>increase</u> in the employment of research chemists will continue to prevail over the next decade, but "laboratory chemists are expected to experience a <u>negative</u> rate of employment growth"(p. 170).

<u>Managers and administrators</u>: "Distribution of employment among sectors will, of course, follow the anticipated developments in the sectors: smaller increase in manufacturing than in communications industries, smaller in communications than in service industries, and so on" (p. 171).

<u>Clerical workers</u>: "Developments in electronic technology...are expected to <u>retard</u> the employment of clerical occupations.... By contrast the employment of secretaries and receptionists is not likely to be affected adversely by technological changes..." (p. 172).

Retail sales workers: The rate of increase in employment will be slowed by the introduction of new technologies, but "the retail industry does not expect any problems in relation to redundancies" (p. 173).

Employment in wholesaling: "The effect of computerisation on employment has been favourable for non-production workers...but very unfavorable for production workers" (p. 174).

Machinists: With the advent of numerical machine control, machinists have been replaced by less-skilled machine operators.

Tool and die makers: "The use of computers for measurement, calibration and assembly has eliminated most employment positions for tool and die makers" (p. 180).

"Technological Changes and the Sectoral Distribution of Employment"
Peitchinis, S.G., paper presented at the 1979 Annual Meeting of the Western Economic Association, June 21, 1979 at Las Vegas, Nevada

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The paper forms part of a research project on the nature of technological changes and their effects on employment, education and skills, funded by the Technology branch of the Department of Industry, Trade and Commerce of Canada.

In the context of Sectoral Shift Employment the author states:

- By 1977, one-third of the work force is engaged in goods production, two-thirds in services.

- Ninety percent of new jobs in Canada between 1946 and 1977 were created in the service sector.

- There is no evidence of any significant shift in the composition of real output (GDP) from goods to services (approximately 40:60 since 1951).

- The substantial increase of employment in the services sector cannot be accounted for by the substantial increase in demand for services. The increase must be seen in conjunction with the low rate of increase of productivity (long term average approximately 1 per cent per year compared with 4 per cent a year in goods producing industries).

- The lower productivity of the service sector is attributed to the lower quality of labour, shorter hours of work, lower net capital investment and, above all, to a far slower rate of technological change.

In the context of discussing the potential impact of the new triggering technologies (microelectronics, computers, CAD/CAM), the author states:

Goods producing

- General decline of employment in goods sector could probably be expected.

- CAD/CAM may well drastically change the employment situation in manufacturing within a decade. Shop floor labour may well be eliminated. The earliest inroads are expected in car and aircraft industries.

- Unlike mechanical technology, this electronic technology has widespread applications in the services sector.

- The employment impact of the electronic revolution may well be greater in the service sector than in manufacturing.

- By reducing the worker-machine ratio the labour absorptive capacity of the service sector might well be significantly eroded in the forthcoming decade.

- This erosion could be further exacerbated by a shift of repairs of self-diagnosing consumer durables from the market place to the home; as well as the overall trend to substitute market services by self-service.

- Computerization will have largest impact on employment in financial institutions and in trade.

- Job destruction in manufacturing is to be expected.

- Job destruction in service sector is to be most likely expected.

- It is problematical whether new services could be generated to offset the labour substitution effect of the new technology.

LEMOINE, P.

Informatisation and Economic Development

Working document presented to The Group of Experts on Economic Analysis of Information Activities and the Role of Electronics and Telecommunications Technologies

Produced by the Working Party on Information Computer and Communications Policy, Directorate for Science, Technology and Industry of OECD in Paris, June 11-12, 1979

NOTE: Philippe Lemoine is with the Mission à l'Informatique of the Ministère de l'Industrie of France. He was the author of one of the Annexes for NORA-MINC report.

Excerpts:

Informatisation of the society is seen as a milestone in historical change, created by exceeding critical levels in population employed in information occupations (33 per cent, 50 per cent?).

Ill-directed informatisation, laissez-faire or worse still immature decisions by the governments,may well have more serious consequences: more unemployment coupled with lower quality of work and with subsequent reduction of interest in it.

Technological change has seldom been oriented and developed to serve economic or social goals. Certainly the period since World War Two illustrates well their relative independence.

The economic literature of the period reflects well this situation: economic analysts usually concentrated on cyclical issues, while technological changes - more structural in nature - were largely ignored.

The economists who attempted to include the assumption of technological change in the economic analysis were Solow, who introduced the technology factor into the production function, and Leontieff who introduced a technical coefficient into input-output tables.

The linking of technological change and economy, including the level of employment has been considered extremely difficult. Witness the conclusions of the 1966 U.S. Commission on Automation, Technical Progress and Economic Growth that there existed insufficient grounds for such a connection.

Today, we witness efforts to reintroduce technological change into macro-economic analysis. Many OECD governments attempt to harness the new information technology to achieve macro-economic equilibria, including a reduction in unemployment. The economists see the link in the concept of productivity.

The report from CPRS in the U.K. and the Nora-Minc report from France assume that informatisation will lead to the increased productivity, which in turn might increase national competitive strength and therefore lead towards more exports which in the final run mean more jobs.

This process would take place in two stages: In the first stage, informatisation in fact reduces employment. However, the productivity gains enable the process to restore general equilibrium in the second stage. Unfortunately, there are at least two problems with this well-meant argument proposed by Saint-Geours within the Nora-Minc Report: firstly, it can be achieved only in the long term, and secondly, it is by no means certain that the transition between the two stages will take place.

Is informatisation really equivalent to an increase in productivity? In the absence of statistics on company or national levels, one has to study this question by approximations. One method of approximation proposed by Lemoine is to try to estimate the effects of informatisation on labour productivity by comparing the trend of employment in industries which make wide use of data processing with increased informatisation of the society (expressed by a fraction of GNP dedicated to EDP).

While the author sees the two trends more or less parallel, we think that simple numerical comparisons indicate that the ratio of the two variables changed by a factor of 3 over a decade, proving the increase in productivity! Author's pessimistic conclusion that informatisation does not generate productivity gains seems totally unwarranted.

While overall increases of productivity in the services sector grows at about 3 per cent a year, increases connected with informatisation grow at some 10 per cent a year.

However, informatisation is a very heterogenous productivity factor and the equating of informatisation automatically with increased productivity can be done only with extreme caution.

Assuming then that in the near future informatisation indeed yields considerable increases in productivity, it may have negative repercussions on the general level of employment.

Over the last decade, the government of France relied mainly on the increase of jobs in the tertiary sector. However, informatisation is liable to put a brake on growth in this sector.

The classical remedy of developing sales and especially exports are not without difficulties here, as tertiary activities are not easily exportable.

Informatisation will focus on public bureaucracies, banking and insurance, as well as on trading and transport.

Productivity gains obtained in these sectors should be redistributed throughout the economy, either by decontrols or by lengthening of the production cycle of marketable tertiary services.

The service sector is seriously threatened by informatisation that will reduce employment there at the time when the effective demand for services is being reduced by shifting services towards an informal sector of economy, according to the proponents of the theory of the self-service economy, such as Gershuny (1978) or towards subterranean economy, Gutmann (1977).

LUND, R.T. et al. (1978)

Industrial Automation - Its Nature, Effects and Management: Critical Issues Report

Report, Center for Policy Alternatives, M.I.T., Cambridge, U.S.A.
September, 1978

NOTE: This report completes the first stage of research into the nature, effects and management of automation. The study has been sponsored by General Motors Corporation, "prompted by concern for the long-term strategic issues connected with automation technology in U.S. industry."

Excerpts:

- Definition: automation is the purposeful process of changing the nature of the man/machine relationship in the workplace towards increasing autonomy of the machine. This definition, derived from James R. Bright's 1958 book, Automation and Management, considers automation as an evolutionary process. This approach is at variance with other recent writings that tend to consider automation as a technological event.

- The project measures effects of automation along at least three dimensions: human, technological and economic, stressing that published works on effects of automation have so far tended to be unidimensional. Consequently, the areas of interaction among the three aspects - as critical as each taken alone - have been neglected.

- The project analyses automation by means of a dynamic model that combines the three static dimensions of automation (human, technological and economic) with the time dimension of the process of automation.

The following relevant critical issues have been identified:

1) The process of automating is itself a variable affecting the consequences of automation: the way the process develops will substantially influence the results.

2) The employment consequences of automation extend beyond the impact on directly affected workers: the impact on supervisory, technical and managerial personnel increases with rising levels of automation.

3) Automation can cause major change in labour skill mix: elimination of moderately skilled group, creating a barrier to upward mobility in the factory.

4) If the rate of application of automation and the consequence restructuring of the labour force advances faster than the U.S. ability to cope with such a change, the result may be a substantial permanent sector of unemployment in the labour force. Such a sector would have important political and economic weight.

The fourth issue is clearly at the heart of the current international debates about the employment effect of automation.

Evoking the reports of OECD, French and British goverments as well as the Siemens report from Germany, the report concludes that automation has been outpacing governments' ability to cope with the resulting changes in labour force requirements.

While in 1960s automation was seen as a net job creator, it is now perceived as a net job destroyer.

The key question asked is who should bear the burden of employment impacts of automation - individuals, firms or the society?

There is already evidence of the development of a technology induced sector of unemployed labour force.

The report concludes with acceptance of the new permanent fact of life: automation-induced population of unemployed. There even exists a possibility of a permanent reduction of the labour force, resulting in growing members of "unemployables." Unemployables can become a powerful anti-automation lobby. If however displaced population is turned over fast, automation will be a lesser threat.

The research in this area has to be fundamentally reoriented.

LUND, R.T.

Microprocessor Applications: Cases and Observations

Report
Center for Policy Alternatives
MIT, Cambridge, Massachusetts, U.S.A., 1979

NOTE: A report was prepared for the Chief Scientist, the Department of Industry, United Kingdom

The report explores a number of microprocessor applications in the United States. It contains case studies on eight products within a spectrum of existing applications:

- Heating, ventilation, and air conditioning controls
- Automobiles
- Word Processing
- Electronic Postage Scales
- Process control in discrete product manufacturing
- Medical Equipment
- Monitors for Hydraulic Cranes
- Sewing Machines

Excerpts:

The case studies indicate that the application of microprocessors can have important impacts on people - those in the producer companies and those using the product. Production workers are affected, but so too are inspectors, maintenance technicians, supervisors, engineers, salespeople and service personnel. Numbers of jobs may change.

The employment effects due to microprocessor applications tend to be hidden. A shift in jobs within the same firm may actually cause simultaneous layoffs and new hirings. There may be reduced labour used per unit of output, but market expansion obscures this fact by requiring greater employment on the whole. The combination of effects makes it difficult to determine which are specifically attributable to the advent of product using a microprocessor.

With the exception of sewing machines (Singer Company), short term employment effects in the cases studied tended to be toward higher employment in the produce firms. This appears to have been caused by increases in market share or general market expansion. The longer term effects on producers, however, are less clear. For instance, employment gains by early entrants in microelectronics race may prove to be temporary.

Employment effects on suppliers to the firms studied in the cases were also generally reported to be positive. The firms buy parts to replace many things which it was previously making internally.

No increases in users' employment were reported either by the producing firms or the users interviewed. All effects on users' employment levels appeared to be either neutral or negative.

The more important employment effects will probably involve competitors that shift with conventional technology. The most serious employment effects may be our firms making products and parts which perform functions that can be done better electronically.

We would also speculate that there is a very great and very dynamic job creation potential in the area of software and applications.

For instance, a billion dollars' worth of programming has already been created for the Intel 8080 microprocessor alone. It is likely that the total value of application and development systems, and of software sold by suppliers and service firms will ultimately exceed the value of microprocessor chips themselves.

Automobiles

No conclusion about employment effects can be made because the technology is too new and the number of units in use is too small.

Electronic Postage Scales

Savings have been realized in terms of postage and labour. Mailroom jobs lost through automation will not be made up by increased mail volume.

Word Processing

The effects on employment are by no means settled. In some instances, a greater demand for word processing services, resulting from improved service and lowered costs or from corporate growth, has offset gains in productivity so that the level of staffing has either remained the same or has increased. However in some instances, secretarial staff has been reduced considerably:

- The California Federal Savings and Loan Association in Los Angeles reduced its total number of secretaries from 200 to 100 by creating a word processing center employing 40 people. This produced a net reduction of 60 employees.

- In the Newark (N.J.) Redevelopment and Housing Authority, an installation of six stand-alone systems with a staff of 12 operators also resulted in staff reductions. Candy Levine, Chief of Office Services, noted "eleven clerical staff have left with no loss in productivity."

HAYMAN, C.

"Social and Employment Implications of Microelectronics"

Paper
Central Policy Review Staff (CPRS)
London, U.K., November 1978

NOTE: CPRS is a government think tank charged to oversee and co-ordinate all the work done in the U.K. on the employment consequences of microelectronics.

Excerpts

There exists a striking contrast between the vehemence of those who claim that microelectronics will have a catastrophic effect on employment and inadequacy of the analysis underlying the certainty of that prediction.

It is extremely difficult to translate the technological developments into estimates of probable jobs and losses over a 15-year horizon.

Long-term effects of microelectronics on employment is complex and uncertain.

A number of forecasts estimating job loss effects of microelectronics in the U.K. were made, giving a rise in the U.K. unemployment of 3 to 5 million.

These forecasts:

a) overestimate the takeover speed of microelectronics;

b) underestimate the potential for job creation in new applications.

The spectrum of forecasts about the possible impact of microelectronics ranges from devastating job loss to potential job gain. .

The predictions about automation impacts on employment were made 20 years ago and they did not materialize.

Computers in Government

- While a number of direct jobs were reduced, some were created (ratio 4:1).

- The overall employment in civil service computer services grew by 15 per cent between 1970-1977.

- Some new computer applications suggested new areas of work.

Word Processors

- The productivity gain is determined to be something in excess of 100 per cent.

- In theory the employment of typists may then be reduced by 50 per cent.

- However, the productivity gains do not automatically translate into job losses.

Other Cases in the Service Sector

- Automatic warehousing - actually used to improve quality of stock-taking, not to reduce labour force.

- Hotel reservation - reducing paperwork not jobs.

Manufacturing

- The food, engineering and clothing industries - job reductions are not dominant.

The Car Industry

- Whether the numbers employed will actually fall, will depend crucially upon market conditions, U.K. global market share rather than on micro-electronics proper.

The Telecommunications Switching Equipment

- Here it is recognized that only 10 per cent of the direct labour would be needed.

Conclusions to Date

- Applications rarely involve the straightforward substitution of labour or capital by microprocessors.

- Applications often lead to possibilities for new or improved services.

- The major change is not in number of employed but on the organizational structures and product ranges of the companies impacted.

- The penetration of microelectronics into products and processes is a great deal less advanced than many people assume.

- This technological change is likely to be as well evolutionary rather than revolutionary.

- The biggest danger for the U.K. is the loss of competitiveness.

TOPFER, P.

"Auswirkungen der Technologie - Entwicklung auf Arbeitsplatze und Unternehmen in der deutschen Unrenindustrie"

("Impacts of Technology: Developments in the Workplace in German Watch Industry")

Nieder-Roden, 1978

Excerpts:

Electronisation was given as a reason for job losses between 1972 and 1977 of only about 10 per cent. Within 1977-1985 time frame, however, 80 per cent of jobs will be changed by microelectronics.

Job Loss 1972-1977:	27%
Estimated Job Loss 1977-1985:	26% - 55%

MANAGEMENT INSTITUT HOHENSTEIN

"Umfrage zur 3. Technologischen Revolution"

("Inquiry into the Third Technological Revolution")

Excerpts:

Expected Change in Number of Jobs:

In the next 2-3 years:

15% of companies expect job creation

40% of companies expect job loss

45% of companies expect both job creation and loss

3/4 of companies expect an increase of high qualification jobs

1/3 of companies expect a decrease of low qualification jobs

AHFELDT, H.

"Langerfristige Wirtschafts - und Arbeitsmarktentrwicklung in der Bundesrepublik Dentschland und Baden - Wurttemberg sowie Handlungs - Moglichkeiten zu Sicherung der Vollbeschaftigung und des Wirtschaftwachstums"

Report

Prognos, A.G., Basel, Switzerland, 1978

This project offers both projections to 1990 that include the employment effects of microelectronics in different branches of the economy and different quantified strategies for compensation. The report provides an interesting table of rates of productivity growth with and without the presence of microelectronics (microprocessors).

Productivity Growth Rates

		75/80	80/85	85/90
Manufacturing	Status quo	4.0	3.9	3.0
	With MP	4.5	3.0	3.5
Capital Investment Goods	Status quo	3.4	3.3	3.4
	With MP	4.0	5.0	6.9
Finance		2.2	2.0	2.0
	With MP	2.2	2.0	2.5
Agriculture		6.3	5.4	3.0
	With MP	6.3	6.0	6.0

Note: MP - Microprocessors

New technologies increase the productivity growth rates from 3.7 per cent to 6.1 per cent (1990-1995).

The highest productivity gains are identified in agriculture!

Unemployment level will be by 1990 at the level of 4 per cent without microelectronics, while at the level of about 12 per cent with microelectronics.

ISI

"Auswirkungen der Mikroelektronik auf die bayerische Wirtschaft"

("Impacts of Microelectronics on Bavarian Economy")

ISI, Karlsruhe, 1978

Excerpts:

"Introduction of microelectronics into instrumentation and its impacts on workplace are lighter than was often assumed."

Areas studied:	Job Displacement
Control Technology:	-13% since 1975
Machine Tool Machinery:	-20% since 1970
Office and Information Technology:	-24% since 1972

BATTELLE

Der Arbeitsmarket in Baden-Wurttemberg/Labour Market in Baden-Wurttemberg

"Technologische Entwicklungen und ihre Auswirkungen auf Arbeitsplatze in den Bereichen Maschinenbau und Feinmechanik/Optik"

("Technological Development and its Impacts on Work Place in Machine Manufacturing and Precision Engineering")

Report
Frankfurt/M
Battelle Institut e.v., 1978

Excerpts:

- "Net impact on jobs (enumeration of positive and negative effects) cannot be determined with our present state of knowledge."

- "Within the time horizon up to 1990, our results show no revolutionary developments, from which technologically created employment crisis in machine manufacturing, and precision engineering, could be deduced.

Areas of study

Machine manufacturing:

- 14 new technologies were analysed

Savings:

- up to 5 per cent of total number of jobs for each technology

Outlook:

- not quantified, many disclaimers

Precision Engineering:

- 15 new technologies were studied

Savings:

- up to 6 per cent of total number of jobs for each technology

Outlook:

- not quantified, many disclaimers

DOSTAL, W.
ULRICH, E. et al.

"Auswirkungen technischer Anderungen auf Arbeitskrafte"

("Impacts of Technological Change on Labour")

IAB, Nuremberg, 1977

NOTE: IAB, Institute for Labour Market and Occupation Research, in Nuremberg, has conducted a large number of sectorial and general studies (40 reports).

Summary

The impacts of technological changes are in the affected area or plant quite heavy. However, in the framework of total consideration the impacts on personnel are lighter than hitherto assumed.

DYMMEL, M.D.

"Technology in Telecommunications: Its Effect on Labour and Skills"

Monthly Labor Review, January 1979

NOTE: M. Dymmel was an economist with the Division of Technological Studies, Bureau of Labor Statistics. He is presently a researcher with the Communications Workers of America (trade union in the U.S.A.).

Excerpts:

Newer technologies, such as electronic switching and higher capacity cables, and tightening economic conditions, slowed employment growth through 1974. With the recession of 1974-75, employment declined almost 5 per cent by 1976. It then increased slightly in 1977. In spite of the adverse effects on employment of reduced unit labor requirements and short term economic weaknesses, the longrun demand was strong enough to result in employment growth. Overall, in the period from 1960 to 1977, employment rose from 706,000 to 950,600 at an average annual rate of 2.6 per cent.

The pattern of employment growth in the 1970's was, in part, the result of cyclical influences. Longer term factors were operative, however, such as reduced unit labor requirements. Therefore, the decline that began in 1974 is expected to continue as the industry's labor intensity is reduced further to meet the economic and competitive challenges of the coming decade. The outlook, as expected by some within the industry, is for a slow decline in employment through the mid-1980's.

ILO

Effects of Technological Changes on Conditions of Work and Employment in Postal and Telecommunications Services

ILO, Geneva, 1977

NOTE: ILO has prepared this report for the Joint Meeting on Conditions of Work and Employment in Postal and Telecommunications Services held in Geneva, 1977.

It is based on responses to its questionnaires by the Governments of 58 member states.

Excerpts:

Effects on Employment

Technological changes have not resulted in fluctuations in the general level of employment in postal and telecommunications services. In fact, although mechanised and automated systems have led to an increase in productivity, the growth in the volume of traffic has kept up a certain demand for manpower. Over-all, the level of employment is continuing to rise although at a very slow rate; in some cases, it has stabilised itself.

Technological changes have obviously affected employment in the sectors in which they have been introduced. However, reductions in staff and even the elimination of certain categories of staff have been offset by the increase in the demand in other sectors or the creation of new jobs and, except in one instance (the Western Union Telegraph Company (United States) reports a drop in the level of employment: 8.2 per cent of the staff were laid off in October 1975), the replies to the questionnaire do not indicate any mass lay-offs.

Scale of staff reductions

The automation of the mail sorting centres has led to staff reductions in the postal services (particularly in the manipulative tasks) but the number of mechanics and technicians responsible for the upkeep of the sorting machines has increased. It must be added that the sorting staff generally only make up half the mail service staff and that the unloading and reloading staff have not been affected by the introduction of the sorting machines. Furthermore, automatic sorting only applies to a part of the mail (of a certain format and weight).

In the financial or administrative departments the introduction of data-processing methods seems likely to lead to staff reductions. In Belgium, where postal cheques are still dealt with by hand, as well as electronically, it is thought that staff could be laid off once the service is entirely computerised. In France there have been reductions in personnel in the staff pay offices despite an increase in the tasks to be performed; in the postal cheques service 7,910 posts were abolished between 1970 and 1975. In Japan the tabulating and billing staff in the NTT has been cut back. In Ireland and in the United Kingdom certain routine tasks such as sorting of telephone tickets have been eliminated, while an on-line payment system in the Swedish postal service could have far-reaching effects on counter activities.

It is questionable, however, whether the use of computers in these services has so far affected the level of employment as much as might have been feared. It does not entirely eliminate the use of traditional methods; for example, the preparation of documents for treatment and the gathering of data remain, to some extent, outside its orbit. In addition, since the transfer of operations to computers takes place gradually, the old system continues to function for some time alongside the new one, with the result that during this transitional period there is a tendency for more staff to be taken on. Furthermore, the computer operations themselves involve new job openings. Finally, as has been shown, electronic data processing makes it possible to cope with a range and volume of operations which could not otherwise have been carried out; its very introduction has therefore brought an increase in the business handled which, in its turn, has had certain repercussions on the volume of employment. As a result, the possible effects of the use of computers on the level of employment are not easy to measure and hitherto hidden repercussions are liable to become apparent once the use of these techniques has become generalised, or if the volume of business handled reaches a point of stabilisation.

The reductions due to automation of operations have been most marked in the telecommunications sector. Thus, although satellite transmissions have given a major boost to long-distance telecommunications, this has only resulted in a limited number of new jobs (e.g. in the installation and maintenance of antennae on earth stations) since the increase in the volume of communications can be absorbed immediately by the greater capacity of the network. Similarly, it seems unlikely that the establishment and development of data-processing networks will result in any very marked increase in staff, since the planning of these networks and their operation, control, supervision and even the billing of customers could be carried out by computers.

In Australia the elimination of telephonists' posts in the automated exchanges has been offset by an increase of employment in the remaining manual systems, a rise in the volume of international calls and the new customer information and assistance services. In the United States Western Union has closed down most of its public telegraph offices (the messages are dealt with by private undertakings such as hotels, cab companies, drugstores, etc., under an agency contract). Between 1970 and 1978, in France, 12,183 jobs will have been abolished in the telephone service. In India, although the number of manual operators has been reduced in the communications centres, the increase in the volume of traffic and the need for a greater number of technical personnel have increased the chances of employment. Automation of the telephone service in Ireland has resulted in a reduction in the number of operators. In the NTT in Japan the number of workers engaged in manual connection in the telephone and telegraph services has been reduced; in the KDD also there has been a sizable reduction in telegraph service staff. In Norway manual jobs in the telephone service will continue to be cut back until the networks have been completely automated, while the number of technical staff will go on rising. In New Zealand there has been a decrease in the number of operators and maintenance workers in telecommunications. In the telegraph services in Singapore a great many people of low educational background and limited capacity for development are currently engaged in simple manipulative tasks in the processing of telegrams before transmission or delivery; as soon as the new computerised systems are operational these employees will have lost their raison d'être. In Sri Lanka there has been a slight rise in the number of staff in the telegraph and telephone sector due to the creation of new positions for operators and maintenance staff for installations. In Thailand the cross-over from the land-line system to the radio system has led to a reduction in the number of linemen.

New jobs

The new technologies have resulted in the creation of new jobs, particularly in the technical sectors and those involving the use of computers. New jobs have been opened for installation and maintenance technicians specialising in electromechanics or electronics, as well as for data processing specialists (for systems analysis, programming and data collection). Some new jobs have been introduced in the postal services, such as keyboard sorting operators or mail code controllers.

Jenness, R.A.

Manpower and Employment: Problems and Prospects

Paris, OECD, 1978

Note: This study was submitted as background documentation to the Experts' meeting on "Structural Determinants of Employment and Unemployment."

The author is a researcher with the Economic Council of Canada. Several other members of the ECC staff helped to prepare the draft of the Report.

Excerpts:

During the late 1950s and 1960s, widespread apprehensions were expressed about the impact of automation and the electronic revolution on the employment opportunities in North America and in Europe. The main concern had to do with the inevitable displacement of labour and the fear that the numbers of technologically displaced unemployed would be too great for nations to absorb elsewhere in the economy. These apprenehsions soon gave way before the relative economic buoyancy of the mid and later sixties and the gradualness by which enterprises introduced the automated and technically advanced productive techniques in keeping with their costs and potential profits. The careful phasing-in of modern automated technology has largely marked the extent of its adoption and diffusion in industrial enterprises. In the process, industrial productivity in OECD countries has increased on the average by about 4.5 per cent annually over the past fifteen years.

Maintaining the pace of improvement in industrial productivity is essential for coping with growing expectations of the population. Moreover, new innovations are essential if enterprises are to retain their international competitive advantage. If output per unit of labour is to grow without a substantial reduction in the work force, it will have to evolve through economies of scale derived from a continuing enlargement of demand and consumption. How much is consumer demand for manufactured and other industrial goods expanding in OECD countries? So far, real industrial output has outpaced population growth by a very substantial margin.

Will there be markets for industrial goods? The likelihood is that the demands for industrial goods will from now on increase only modestly - they may be expected to increase proportionately to the population growth, with some further increase in the volume consumed. In the final analysis there are limits of manufactured and durable goods that a household would purchase. Throughout the OECD countries family expenditure patterns have been shifting away from goods to personal services, public services or savings.

To maintain the rates of increases in real income enjoyed over the past two decades will require that OECD countries achieve real gains in industrial productivity averaging again about 4.5 per cent annually. If this is to be accomplished without major displacements of labour, there must be corresponding increase in the demand for industrial output and manufactured goods. It is not at all clear that the demand will in fact keep pace with such growth of output. OECD countries would have to look to other markets for their industrial output to maintain the level of industrial employment. Otherwise, some decrease in industrial employment seems inevitable.

The increases of productivity in the tertiary sector will reduce the opportunity for the labour released from the secondary sector.

It could well be that to help to offset these processes, labour in the future will opt to take more of its returns in the form of additional leisure time, and thus spread of employment over a larger number of workers. Manufacturing of course is less flexible than servicers.

In many European countries there have been substantial reductions in weekly hours in manufacturing and increases in the number of paid holidays per year. In the English-speaking OECD countries, on the other hand, there has been little if any reduction in the average weekly hours worked - in the U.S., Canada and the United Kingdom the 40-hour week is still the norm.

Put another way, in the fact of the labour displacement associated with increased industrial productivity, the English-speaking countries have evolved with smaller industrial labour force working more hours instead of a larger industrial labour force working less hours a year.

The consumer preferences shift away from manufactured goods to the services and savings. However, it is not clear how far the Application of Engel's Law will hold over the next two decades.

The combination of patterns does, however, raise the possibility for the years ahead of so-called "deflationary gap," where savings run in excess of investment to the point where (despite government fiscal policy of a public deficit) investment dries up, the pace of economic activity slows down and unemployment increases.

MASUDA, Y. et al. (1974)
Social and Economic Effects of Information-Oriented Investment
Tokyo, Japan Computer Usage Development Institute (JACUDI)

NOTE: This report was prepared for the International Symposium on Information in Tokyo. It represents a co-operative effort of JACUDI, Nippon Time-Share Co. Ltd., Nihon Keizai Shimbun, Nomura Research Institute, SMC Group and Software Management Company Ltd.

Excerpts:

The transformation of Japanese economy towards the information oriented investment will keep the real economic growth rates high at at least the 5 per cent level.

Of the four different patterns of economic development of Japan up to 1985, the information oriented pattern, emphasizing knowledge, was evaluated as superior to any other.

To this end, computer educated population is to be doubled by 1980 and nearly quadrupled by 1985, compared to 1975 level of 3.5 million people, to reach the 15.5 million level by 1985. In 1974, there existed no fear that computer-related development would increase unemployment.

The situation has apparently not substantially changed by 1979. Personal communication with the Japanese research institutes produced this typical assessment of "electronic unemployment" by Ken'ichiro Hirota, President of the Institute for Future Technology in Tokyo, Japan.

Notes on Technological Unemployment in Japan

If the term "technological unemployment" means the unemployment resulted from rapid technological innovation, this has not been seriously discussed in this country, at least for the past three decades. The main reason for this is considered to be that in most Japanese industries, except primary, the rapid economic growth and the equipment modernization continued concurrently until recently, and that the possibility of unemployment due to the latter was overridden by the demand for labour due to the former.

An example is in the telephone industry. When NTT was inaugurated in 1952, the number of main telephones was 1.4 million, of which 60% was manual, and practically all the trunk traffic was handled manually. At that time, the NTT employees numbered 160 thousand. Right now, the number of main telephones is 36 million with fully automatic trunk call service and the number of employees is 320 thousand. During the 27-year period of time, no unemployment problem occurred because telephone operators got new jobs within NTT such as information service, equipment maintenance, etc.

Regarding the unemployment issue, there is another peculiar aspect in Japan which cannot be overlooked. That is the traditional "Life-Time Employment System." Most Japanese enterprises have not dismissed their employees even if technological innovation would justify doing so. Instead, the enterprises endeavoured to find new jobs for their employees within their own activities or in their subsidiary companies, providing them with training courses when necessary. The attitude was supported by the other two situations which are also peculiar to Japan: the diffusion of relatively high-level education for the people, and the labour union structure primarily closed within an enterprise.

It is a general view in this country that the labour problem will become gradually serious because the economic growth rate is decreasing. However, the main factor in the problem would be the change in industrial structure resulting from a change in market and not the technical innovation. An evidence thereof may be the fact that there are very few institutions to deal with technological unemployment, according to the NIRA Report which summarizes activities of independent institutes in this country.

Nevertheless, not all assessment is cloudless. Witness the (edited) communication from Tsutomu Sato, Executive Managing Director of the Hitachi Research Institute in Tokyo, Japan:

The Effects on the Employment Situation in Japan by Progressive Computerization

The following two aspects should be of interest:

1) The increase in number of computer-related employees resulting from introducing computer technology. 425,000 new jobs are to be created between 1977 and 1985.

Prospects of Computer-Related Employees

(unit: thousand persons)

	1972	1985	Average growth rate
System Engineers	19.6	120.4	15.0 %
Programmers	43.5	154.8	10.3
Operators	21.6	80.1	10.6
Key Punchers	68.0	223.0	7.6
Total	152.7	578.3	10.8

Source: Japan Data Processing Association "White Paper of Electric Computer"

2) The labour-saving effects owing to the introduction of computer.

It has been difficult to obtain the picture of what has been happening. First of all, the data concerning computer-related displacement effects are not published, because they may touch the area of corporate confidentiality. Nevertheless, between 1970 and 1975 nearly half a million jobs - about one per cent of the work force - were lost in the following three industrial sectors alone:

General Machinery	41,135
Electrical Machinery	131,980
Metals	299,995
Sub-total	463,110

The brunt of the job losses was borne by the production line workers and metal processors, where close to 600,000 jobs disappeared. As some white-collar jobs were created within these industries, the net overall job losses were lower.

Note that the job losses in 5 years in these three sectors alone are higher than all jobs to be created in computer-related fields over a much longer period.

The principal analytical difficulty is presented by the coincidence of the wave of automation that occurred in parallel with the recession following the 1973 oil shock. It is extremely difficult to disaggregate these joint effects into the two phenomena.

The only effects that can be determined is the information about the impacts of a specific event of technological change - for instance, of an introduction of a large scale computer such as HITAC M-180 or HIDEC.

MACUT, J.J. et al.

Technological Change and Manpower Trends in Major American Industries
Bureau of Labor Statistics, U.S. Department of Labor, Washington, D.C., 1974, 1975, 1977 and 1979

Note: The four bulletins appraise some of the major technological changes and discuss the impacts on occupations over the next five to ten years. They were prepared in the Office of Productivity and Technology. Individual industry reports were written by various authors under the supervision of Morton Levine and Richard W. Riche.

All the 1974 and 1975 projections of employment assume an overall unemployment rate of 4 per cent until 1985, and an inflation rate of 3 per cent a year.

1977 projections assume an unemployment rate of 47 per cent in 1980 and declining to 4 per cent by 1985.

1979 projections assume an overall unemployment rate of 5 per cent until 1985. Both 1977 and 1979 assume a 3.6 per cent average annual rate of growth derived for GNP.

Textile Mill Products (1974)

Technological changes in the textile industry are reducing most manpower requirements, particularly for semi-skilled and unskilled workers, in addition to changing job content.

Microelectronics represents a major step forward in mill instrumentation, reducing downtime and maintenance. For almost every stage of production, some type of device is being introduced which controls process parameters.

Growing interest in minicomputers more adaptable to smaller textile operations, might increase the use of computers in this industry which has not adopted computers widely up to the present time.

Definitive measurements of productivity in the textile industry are not available. However, productivity improvement over the last two decades is suggested by an average annual rise in output of 4.5 - 6.0, while man-hours grew only at less than one per cent annual rate.

From 1980 to 1985, the projected level of employment is to decline--at an annual rate of 0.2 per cent--back to the 1973 level of about a million workers.

Lumber and Wood Products (1974)

Automatic storing and stacking machinery greatly reduces the manpower required for these operations. Fully automated grader system can also provide substantial manpower savings. Using the same computer logic, the equipment for automatic trimming and clipping reduces a number of clippermen and trim sawyers.

Finally, the automated also have reduced labour requirements.

Total employment for the industry is projected to decrease by 6.5 per cent between 1980 and 1985.

Tires and Tubes (1974)

One interesting major technological change evolving in the manufacture is that of the automated instrumentation.

Use of computers for process control is mostly limited to optimizing ingredients for rubber formation, although it is lately used also for calendering. Data processing in the office remains the major computer application.

Employment in tire plants is projected to grow between 1980 and 1985, although at lower rates of growth than in the 1970s.

Aluminum (1974)

The most significant advances in reduction plant operations is the computer control of the process, using microprocessors. Computerized management have virtually eliminated all manual record-keeping, reducing clerical effort to a minimum.

A computer-controlled cold-rolled products mills, started in the 1970s tend to increase productivity; so does computer-controlled continuous casing of molten aluminum.

While employment in the primary aluminum industry between 1980 and 1985 is projected to stabilize, a moderate annual growth (0.5 per cent annually) is expected in aluminum fabrication.

Banking (1974)

Labour-saving innovations in banking have been introduced during a period of increasing demand for banking services.

Computers are being used to automate such in-house functions as managing demand deposit and savings accounts, and improving information retrieval. The automation of these processes has enabled banks to handle larger transaction volumes without proportional manpower increases.

Automatic tellers and cash dispensers enable banks to carry out limited banking transactions beyond normal banking hours, in some cases away from the bank proper. These machines reduce teller manpower needs.

Using excess computer capacity, banks have broadened the range of services available to the public, to offer such services as professional billing services, and payroll handling.

Electronic funds transfer systems substitute--the electronic transfer of financial data for the actual transfer of cheques or cash. Major parts include automatic payroll depositing, preauthorized bill payments, point-of-sale transfers and larger volume financial transfers.

According to BLS projections, a 3.3 per cent annual growth in employment until 1985 is likely, increasing the number of bank employees to 1.7 million.

Health Services (1974)

New technology will continue to be a source of efficiency and productivity gains in health services.

Computers and advanced automatic test equipment are being introduced in clinical laboratories to handle tests more rapidly. Sometimes, online processing of data fed directly to the computer from laboratory test equipment have been introduced.

Computers are widely used for routine business applications such as billing, payroll and inventory. Increasingly patient record-keeping is computerized.

Computers are being used along with closed circuit TV, EKG machines, oscilloscopes, blood pressure indicators and other devices to monitor a patient's condition. Computers have been used on a limited basis for diagnosis and to select forms of treatment. Savings in medical manpower have been reported. In multiphasic screening, computers and advanced laboratory testing equipment save manpower as well.

The outlook is for continued higher levels of employment in health services, but a slowdown in the annual growth rate. According to BLS projections, the employment growth rates up to 1985 would average 4.3 per cent.

Pulp and Paper (1975)

Electronic computers and advanced instruments increasingly are being introduced for control of pulp and papermaking equipment. More widespread use of process control is anticipated by industry experts as both computer and instrumentation technology are further improved.

Computer control systems are achieving a net increase of some 20 per cent in production.

Employment in the pulp, paper and board industry has remained relatively stable. BLS employment projections to 1985 anticipate an average annual growth rate of 0.4 per cent.

Trends in the major industry subgroups show considerable disparity. While board employment has declined substantially, paperboard mill employment increased during 1960-1971.

Wiring of major production processes--especially raw and finish grinding--into a central control panel, permitting total production control by one or two control room operators. Introduction of this automation results in substantial manpower savings, reducing the number of semi-skilled workers.

A BLS projection for 1985 indicates that employment in this industry will continue to decline at about the same historical rate of 1.4 per cent.

Steel (1975)

Computer use is increasing for both processing data and controlling operations. Rolling mills accounted for the largest number of computer installations. Minicomputers are widely used to control discrete functions or as satellites to larger systems. Although large computers will continue to grow in number, smaller controls such as minicomputers and programmable controllers will become increasingly important.

Hot strip mills are well suited for computer control. In one installation, for instance, a complete automatic control requires only 32 workers on each shift compared to about 80 in older facilities.

According to BLA projections, steel employment would decline from 1980 to 1985 by an average 0.5 per cent annually.

Aircraft and Missiles (1975)

The adoption of new technology in the aerospace industry may lead to further reductions in manpower requirements for laborers and for service and clerical workers.

The aerospace industry is one in which technological changes, in both products and manufacturing process, take place very rapidly.

Numerical control has gained widespread acceptance in aerospace industry. The process involves the automatic operation and control of machine tools by means of a system of electronic devices, servomechanisms and coded instructions. It cuts labour costs.

A further refinement of numerical control--adaptive control--allows a continuous automatic adjustment of the cutting process. It increases machine productivity.

Direct numerical control uses a central processing unit to run the various machine tools. It is likely that users of numerical control and adaptivee control may switch to direct numerical control.

And finally, computers are being used to create models which permit the study of dynamic systems.

Employment in aircraft, missile and space, industry declined vertiginously in the early 1970s. BLS projections to 1985 indicate continuing growth at an average annual rate of 1.2 per cent for aircraft industry, and 3.6 per cent for missile and space industry.

Wholesale Trade (1975)

Further adoption of recent technological changes in coding, computerizing, warehousing and customer services is likely to increase productivity and impact employment in wholesale trade.

Universal Products Code (UPC) covers most consumer products in grocery outlets. Code markings are underway in electrical, electronic, HVAC and automotive industries. In the health field, drugs and other products are also using UPC symbols.

Computerization of in-house accounting and inventory control tasks, was extended to over one-half of wholesale firms already by 1974. comprehensive reports are being generated which expedite shipments, streamline preparation of invoices and billings and increase inventory turnover.

Automated warehousing uses a stacker/retrieval crane, combined with random access storage. Both storage and order pickup are controlled automatically by a computer. The computer performs all information functions and directs the sequence of operations of the material handling equipment. While other reasons for automated warehouse preference are given, such as less damage to a product, reduced pilferage, reduced cost of controlling environment, undoubtedly fewer man hours of employment per unit of output are required of stock handlers and store clerks.

Computerized billing for accounts payable, computer-prepared catalogues complete the roundup of technological innovation in wholesale trade.

The rate of employment in wholesale trade is projected by BLS to slow down in the 1980s to 0.8 per cent a year from the historical growth figure of 2.4 per cent a year.

Coal Mining (1979)

Computers are increasingly used to design new mines and modify layouts, and to set up more efficient mine operations and to revise production and preparation methods at older mine complexes.

Computerization of design increases the workload for engineers and computer tedhnicians. Computers affect more the work of workers on the surface than workers in underground mines.

The outlook for coal mining employment up to 1985 is for continuing growth at the average annual rate of 3.9 per cent.

Oil and Gas Extraction (1979)

Computer-related technological changes prevail in exploration and drilling. In exploration, new seismic technology and methods of computer data analysis are being applied.

Sophisticated data collection and analysis systems using ouside computers are being introduced on a limited but growing basis in drilling operations. Although experts differ regarding the extent of future use of computer monitoring systems, most expect its applications to expand over the next decade.

The outlook is for total employment in oil and gas extraction to further increase as exploration and development activities are accelerated. The average annual rate of employment increase until 1985 is projected to slow down to 1.7 per cent a year, compared to 3.7 per cent a year over the last decade.

Petroleum Refining (1979)

High-speed digital computers, in association with highly complex instrumentation, monitor and/or control various refining processes: they are used in testing and research laboratories and for management information. As of 1979, more than two-thirds of industry's capacity is computer-controlled.

Refinery employment is projected to decline. BLS projects a decline of 1.9 per cent annually to 1985.

Petroleum Pipeline Transportation (1979)

On-line computers read temperatures, pressures, gravity, and/or flow rates from tank gauges and meters. These data are transferred to the central computer at headquarters for tracking inventory, scheduled delivery times and making dispatch calculations. The central computer stores information, performs operating procedures and carries out non-operating functions, such as accounting tasks, engineering calculations and pipeline design.

Some of the labour implications have been observed, such as reduction of workload for schedules and accounting clerks, reduction of workload of process control operations; work is also lessened for gauges in the field and for accounting clerks with direct input of data. On the other hand, the need for computer specialists and technicians rises as the computerization expands.

An increase of 0.3 per cent a year in total employment is projected for the period ending in 1985.

Electric and Gas Utilities (1979)

Major innovations underway include the more widespread use of computers to assist generating plant control room operations in logging data, monitoring equipment, and performing calculations.

Process control computers are commonly used in dispatching power over transmission lines and coordinating generating and interchange operations. Computer scheduling of labour and vehicles has been used in maintenance and construction operations.

BLS project to 1985 is that growth in employment may slow down to 0.7 per cent a year, compared to historical rate (1967-1977) of 1.3 per cent.

Apparel (1977)

Technological changes underway in the apparel industry involve...the limited application of new technologies such as lasers, computers, and ultrasonics.

Electronic computers are being used by management for sales analysis and forecasting, process inventory, and workflow management. In the production process they are being used in conjunction with numerical control equipment and marker preparation.

The apparel industry is one of the nation's largest manufacturing industries, employing over 1.2 million workers in 1975 (BLS data), or about 7 per cent of the manufacturing work force.

The 0.6 per cent annual rate of growth projected by BLS for 1973-85 is about the same as the industry's rate of employment growth during 1960-75.

Footwear (1977)

Major technology changes in the footwear industry are computer-controlled laser for pattern cutting; considerably faster than conventional methods and numerically controlled sewing system; permits rapid style change, but is only economically feasible with long production runs.

The long-term outlook is for continued slow decline of -1.3 per cent a year until 1985.

Motor Vehicles and Equipment (1977)

New equipment and manufacturing methods are expected to continue to be introduced in the motor vehicle and equipment industry. Specific innovations which may be applied more widely include electronic computers, improved equipment for automatic assembly, use of plastic and powdered metal materials, numerical control, and improved transfer lines.

The use of graphic display terminals can integrate and speed workflow between design, tooling, and production. Time requirements for R&D work are lowered. Numerous applications in quality control increase productivity of inspection personnel. Computer control of machining and assembly operations may increase production rates and reduce labor requirements.

Automated assembly applications range from tightening bolts to welding car bodies together. Automatic assembly stations are frequently intermixed with manual stations, depending upon the nature of the job.

Automatic operation of machine tools by electronic control devices and coded tape instructions can reduce machining time and labor costs.

The long-term trend, however, is for a decline in employment. The BLS projections for 1973-85....indicate a particularly sharp decline from 1973, when employment was at an all-time high at a rate of -1.3 per cent a year until 1985.

Railroads (1977)

The widespread use of computers are among the technological advances that have led to continuing reductions in labor requirements among Class I line haul railroads, which account for over 90 per cent of total railroad employment.

Automatic classification yards are large yards in which cars are sorted and switched by destination. Digital and analog computers used to control car speeds and to aid in switching. Small yards equipped with automatic features now feasible, increased car utilization, customer service, and laborsavings result.

Both digital and analog computers are in use. Computers have provided information processing and switching capacity that gives management better freight car information and control. Also, computerized data are used by management in forecasting traffice trends and analyzing the market.

Central control of train movement over stretches of track of 50-100 miles or more, is in place. A model of the track is operated by one worker who pushes buttons or switches to keep trains moving in accordance with their priorities. Capacity of track is expanded and laborsavings result.

Detectors - mechanical or infra-red devices - locate and report dangerous conditions in equipment along the right of way. Several types developed for different purposes.

Microwave - high-capacity radio carrier wave are currently being used by railroads to supplement or supplant wire message carriers.

Automatic car identification (ACI) - reflect labels picked up by transmitter, decoded, and sent to central operations. Equipment location and progress easily recorded.

During the next decade, industry experts expect employment in this industry to level off or decrease only slightly. Some of the factors underlying this view of future employment include the expected increase in railroad traffic, the termination of the past decline of the very labor-intensive passenger operations, the near-complete decline of the very labor-intensive "less than-carload" service, and the expected substantial increase in long-needed maintenance work.

Retail Trade

Major technology changes in retail trade are vendor source-marked merchandise identification tickets and electronic cash registers - one design of on-line point-of-scale terminals reads magnetically encoded vendor marked merchandise tickets by contact and a second design reads color-coded tickets with an optical scanner. Both designs require an automatic on-line ticketmaker to process hand-entered data and a computer to record transactional and inventory data on magnetic tape and to compute sales expense.

Additional computer functions - store charge account credit is audited by an electronic cash register which informs the salesperson directly and quickly on customer credit status; for bank check and credit card authorization the salesperson communicates with and is answered by the bank computer. Terminals at major retail outlets connected by telephone to the vendor's computer reduce delivery time lags. Data entered at point of sale and stored in store's mini-computer are transferred nightly to data centers for automatic processing of purchases, audit, sales commissions, and inventory needs. Summary reports provide information for managerial decision-making on such matters as store hours and staffing patterns.

Central retail distribution: groceries and drugs selected from a catalog are delivered from warehouses to system's members who order by telephones connected to the distributor's computer.

Supermarket automation: Universal Product Code (UPC) provides a unique identification to each product; an electronic supermarket checkout counter, through an optical scanner, reads the code, flashes prices on a screen for the customer, and transmits information to a central computer for processing. Advantages include pricing savings and tighter inventory control. Almost 65 per cent of consumer products marketed in grocery outlets were marked by UPC by the 1975 year-end.

Retail trade engaged a total of 15.2 million persons in 1975, of whom 88 per cent were employees, 10 per cent proprietors, and the remainder unpaid family workers. Compared to 1960, the number of persons working in retail trade was up 40 per cent; the number of supervisory workers increased by 87 per cent and nonsupervisory workers by 49 per cent. Employment of all persons is expected to reach 18.1 million in 1985, continuing to grow at 1.6 per cent a year until 1985.

MARK, J.A.

"Impact of Technological Change on Labor"

Paper
National Conference on the Impacts of Technological Change on the Work Place
St. Louis, Missouri
June 5-7, 1979

NOTE: J.A. Mark is the Assistant Commissioner for Productivity and Technology Bureau of Labor Statistics, U.S. Department of Labor. The Conference was organized by Professional Employees AFL-CIO.

Excerpts:

Technological change and its impact on labor is a very difficult subject and does not lend itself to many general conclusions. While there are certain limited generalizations which can be developed, by and large, the relationship between changing technology and employment, for example, is very complex.

The BLS has responsibility for developing measures of productivity of the economy and of specific industries and it has a research program to study some of the factors underlying productivity change. This research program includes examining the role of changing technology as it affects productivity and labor.

While BLS studies have been concerned with developments in "automation," particularly in anticipating long-term trends in the future, automation developments are not the only technological changes taking place that affect labor requirements and labor relations.

Effect on Employment

The effect of technological change on employment, as (was) indicated, is very difficult to measure. The employment effects are indirect and diffused because technological change does not take place in isolation. Technological changes interact with and are modified by other factors that affect employment, such as changes in output, consumer tastes, international competition, etc.

Furthermore, the effects of technological change on employment do not necessarily occur only at the plant which introduces the technological change. More often the effects occur, through the mechanism of competition and industrial structure, to other plants and industries throughout the economy.

There is however, abundant evidence in our experience over the last three decades to indicate that as long as the economy is expanding and demand is increasing, steady technological advance is compatible with rising employment. Between 1950 and 1978, a period of technological change, employment of all persons in the nonfarm business sector grew by 67 percent from about 44 million to 78 million workers. During this same period output increased by 163 percent.

Similarly, our measures of productivity, indicators of technological change, show that from 1960 to 1974, for example, productivity went up in every industry for which we publish measures. At the same time, employment grew in almost two-thirds of them.

In many industries, large productivity increases are accompanied by increases in output that require more labor input. This situation occurred, for example, in the air transportation and synthetic fiber industries.

On the other hand, there have been industries where increases in productivity have been accompanied by a reduction in employment. This was true in the highly mechanized petroleum pipeline industry, as well as in such activities as railroads and agriculture, where employment reductions were associated with strong productivity gains and only moderate increases in output.

The same trend in labor productivity can reflect vastly different trends in employment, depending on the nature of the industry. For instance, between 1960 and 1974, productivity grew over 5 percent a year in telephone communications, railroad transportation, and gas and electric utilities, but each of these industries had a different output and employment pattern. High productivity growth in telephone communications was associated with a large increase in output, and the industry experienced a substantial growth in employment. A similar rate of productivity growth was achieved in railroads with a moderate increase in output and the industry had a large reduction in employment. The rate of productivity increase in gas and electric utilities stayed close to the output growth, and employment barely changed.

Nevertheless, although there is no way of measuring its effects on employment precisely, we recognize that technological change can cause job displacement in particular industries. Sometimes the employment impact of technological change is direct as in the case of agriculture. Or, when the industry is concentrated in a particular region or locality, dislocations do occur. In most cases, however, the employment effect is less obvious. Output does not advance at the same rate as productivity in all industries or plants and consequently some industries register employment declines while others register employment increases.

Moreover, the employment impact of a technological change may occur long after the change has taken place and in an entirely different location. When the market for a product is weak, the inefficient, less mechanized plants of competitors may shut down and lay workers off. Thus, directly or indirectly, technological change can cause employment problems in some industries even while jobs in the Nation as a whole are increasing.

It is not possible to draw clear generalizations about the role of changing technology on employment.

The Bureau of Labor Statistics also undertakes research on the labor impact of specific new technologies. The computer, a technological development that has spread throughout all sectors of the economy, is a major innovation studied. We have examined the use of computers for office data applications in the government, banking, insurance, airlines, and a large number of other manufacturing and nonmanufacturing industries.

When computers were first introduced for office data applications, predictions were made that large numbers of clerical and kindred workers would be displaced; and job opportunities for millions of people, in what was one of the largest occupational employment categories, would be curtailed.

What actually did happen was quite different. In 1960, clerical workers amounted to about 10 million workers and accounted for about 15 percent of the total U.S. employment. By 1978, they increased to about 17 million workers and accounted for about 18 percent of total U.S. employment. Thus, instead of clerical and kindred workers employment decreasing because of the introduction of the computer as had been predicted, employment actually increased about 73 percent between 1960 and 1978. Clerical employment (is likely) to continue to increase significantly to 1985.

Why did clerical employment increase and not decrease as predicted? First of all, normal growth in the volume of clerical work offset clerical jobs eliminated by the computer. Second, the introduction of computers made possible work that was previously impractical because it would have been too costly and would have taken too long by precomputer technology. This is true in everyday management functions where it is now possible to prepare reports and analysis that previously were deemed desirable but too costly and time-consuming. Thus, the computer extended the scope of possible activities and services for many industries, creating more clerical employment opportunities.

In addition, the introduction of the computer created job opportunities in new occupations such as systems analysts, programmers, keypunch operators, console operators, tape librarians and other computer related occupations. The computer also created new industries to manufacture the computer and its related equipment creating employment for thousands of workers in all types of occupations--traditional and new.

The BLS has also studied the use of the computer to control production processes.

One of the industries we studied was the steel industry.

Computer control led to an increase in managerial and technical manpower without a decrease in operating manpower. Most of the employees recruited for the new jobs were selected from among the existing workforce at the plant.

No employee in the plants we studied was displaced because of the installation of process computers.

(BLS has also) undertaken studies of computer assisted operations for typesetting in the printing industry, particularly in newspaper printing. Technology can have considerable impact on the occupational structure of the composing room and printing trade craft workers where compositors and typesetters account for 39 percent of the printing trade craftsmen. Between 1978 and 1985, employment of compositors and typesetters is projected to decrease by 25 percent.

In general, very few employees were laid off because of a technological change.

WASSERMAN, J. et al.

Strategic Impacts of Intelligent Electronics in U.S. and Western Europe 1977-1987

Report, Arthur D. Little Ltd., Cambridge, Mass., U.S.A.

NOTE: ADL is a U.S. industrial research, engineering, economic and management consulting firm - one of the oldest, largest and most diversified consulting firms in the world.

This study attempted to assess the strategic impact of intelligent electronics on those companies that are "creating, threatened by or concerned about the revolution it will cause in the marketplace." It focusses on automative, business communication, consumer, and industrial applications.

This $2 million study, conducted over the last three years, examined the markets for microelectronics in the U.S.A., France, West Germany and the U.K.

Excerpts:

Fears that increasing use of the microprocessor could cause widespread unemployment could be totally misplaced. These kind of fears ignore history which repeatedly has demonstrated that major technological advances have resulted in net gain rather than loss of jobs.

The use of microprocessors can have a widespread potential impact but exactly how these effects are seen depends on many other factors such as the state of the world economy and the use the individual national industries make of the opportunities.

The effects of microelectronics on employment are dynamic and therefore almost impossible to predict.

It is however possible to identify some areas where there will be job losses as a result of predictable changes in technology, such as printing, post office, etc. We may see the disappearance of many generalist and middle management jobs. Other middle managers will be degraded in their status.

Microprocessors are not fundamentally different from any other technological changes, and it is wrong to exaggerate their employment impact. The microprocessor is not an extraordinary monster. It is important not to sensationalize its impacts.

However, microprocessors do have the potential to cause a tremendous acceleration in the rate of technology change.

On the other hand, microelectronics is likely to create more than one million extra jobs in western Europe and the U.S.A.

Using microprocessors one can create new products. That in turn means a survival of jobs otherwise gone.

In the long run the new technology might well create new jobs to replace those displaced but in the short run one may experience an increase in industrial friction.

Microelectronics is expected to create within a decade in these four countries $30-35 billion of extra wealth. It is next to impossible to predict how this pie would be divided.

What actually looms as a problem more critical than unemployment is the related issue of dislocation.

Americans' lack of awareness about the social implications of technological change is even more surprising when compared to European initiatives. Europe is also far ahead of the U.S. in labour/management collaboration, that remains a <u>sine qua non</u> for orderly introduction of this new wave of technological change. In making the transition from an industrial society to one based on information and technology, the U.S. might well start looking to Europe for examples.

RADA, Dr. Juan F.

<u>Microelectronics: A Tentative Appraisal of the Impact of Information Technology</u>

Geneva, Unpublished draft, April 1979. 202 p.

Dr. Rada is a member of the Latin American Faculty of Social Science (FLASCO); he can be contacted at the European Coordination Centre for Research and Documentation in Social Sciences, Vienna, Austria. His report was written in close co-operation with researchers at the International Labour Organization (ILO) in Geneva.

Microelectronics: A Tentative Appraisal of the Impact of Information Technology is an ambitious synthesis piece which draws upon a wide range of very recent (to April 1979) published reports from various European and North American sources. Although the employment effects of information technologies are only a part of the impacts considered, the author emphasizes that the issue of labour displacement is what gives impetus to the current debate, and he argues that the most important social impacts will be related to the effects of these technologies on unemployment levels. While the study is focussed on the industrialized market economy countries (IMEC), it includes a chapter on the impacts on the underdeveloped world; also included is a section on trade union response to the prospects and problems arising out of the "information revolution."

While the author seems most familiar with the British literature assessing the impacts of technological change, his international affiliations (ILO, FLASCO, Vienna Centre) are apparent in the geographical inclusiveness of his bibliography -- and in his serious attempt to evaluate the impacts of these technologies on the underdeveloped world.

In this manuscript, Dr. Rada not only brings together the findings of more than a dozen recent studies and reports, he also takes a position on the issues, based on his evaluation of the arguments and statistics he has assembled and presented to the reader. In addition, he doesn't shy away from the difficult, but politically-sensitive questions which are important to the formulation of public policy towards the application of these new technologies. For example, he discusses issues related to union and management reactions, the political and economic bargaining power of the giant multinational corporations, "offshore" production in countries where labour costs are lower, the possible effects of short-term nationalistic protectionism, the case for public ownership in key computer industries, the changing nature and functions of work, and the implications for education of all of these changes.

* * *

An "Information Revolution" is in the making

"Information technology is the collective name referring to the convergence of electronics, computing and communications" (p. 1). The use of microelectronics, because of its all pervasive character, exceptional reliability and exceptionally low cost, "implies tremendous changes in the way societies produce, service and govern themselves" (p. 2).

"We are witnessing technological innovations that will mark the end of an era and the beginning of a new one" (p. 8). "While man's first technological breakthrough related to ensuring survival (the Agricultural Revolution of the Neolithic Age), and the second to extending and replacing muscular power and mechanical dexterity (The Industrial Revolution), the third break through, which is facing us today, concerns the extension and/or replacement of human intelligence functions (the Information Revolution)" (p. 14).

"As the steam engine replaced water and wind mills, the information machine will replace inconvenient and less-reliable (mechanical) forms of information handling" (p. 18).

The context of the current debate

"The jump in productivity and communications capabilities made possible by the new technologies has started a public debate in the industrialized market economy countries (IMEC)" (p. 3). In contrast to earlier debates on the possible effects of automation and/or cybernation, this debate is taking place in the context of slow growth worldwide, already high levels of unemployment, and vociferous demands by the developing countries for mere favourable terms of trade.

The issue of employment

"So far this debate has been largely concentrated on the possible labour displacement effects of the new technologies, although projections in this area are difficult and should be treated with caution.... The field is wide and new. Much collective research and open debate is needed to fully explore the whole issue of information technology and what it means for the world as we know it.... In the numerous works which exist in this area the tendency has been to treat technology as an exogenous variable or as a factor of production. What is lacking is a comprehensive framework and explanatory variables to enable the assessment of concrete technological developments. The theoretical and empirical limits make it difficult to make any firm predictions about issues such as labour displacement. It is extremely difficult to isolate the introduction of microelectronics (either in products or processes) from organizational or other changes which generally accompany them. Predictions exist for some sectors of particular countries but they should be considered as orders of magnitude rather than 'hard facts' since they are based on the methodological problems already mentioned. Therefore we have to rely on post-factum evaluation of experiences in selected industries and services, predictions for certain sectors and, perhaps most important at this stage, the understanding of the potential use of the technologies. These constraints make difficult the formulation of clear policy recommendations in the innumerable issues involved as long as more comprehensive and in-depth understanding of the field does not exist. This is not to say that immediate action should not be taken...but to emphasize the need for debate, research and above all the need for a social and political will capable of looking beyond the next few weeks ahead."

"Optimists" and "pessimists"

If those who are involved in the current debate can be roughly divided into two camps, the "optimists" and the "pessimists," a certain amount of consensus nevertheless emerges: "In general they agree on the benefits of the technology and the inevitability of its application in the industrialized market economy countries" (p. 4). "In relation to the labour displacement issue, optimists and pessimists tend to disagree on the timing and speed of change rather than the final outcome." Serious dislocations are seen as inevitable by both groups. Their disagreement is rather "on whether the number of jobs created will keep pace with the number of jobs lost."

Gross and net effects on employment

Dr. Rada reviews the findings of recent studies analysing past trends and predicting future employment levels. He does this in terms of broad sectors (agriculture, industry, services), particular industries, and specific occupations likely to be impacted by the new technologies.

The greatest impacts on employment are expected to be in the services, with lesser, though significant impacts to be expected in industry and to a lesser extent, even in agriculture. Rather than repeat those findings in detail, suffice it to enumerate the areas for which he has found figures or arguments from one source or another. These include office automation, banking, electronic mail, printing, liberal professions, health and education, manufacturing, watch industry, automobile industry, diecasting, assembly of electrical alternators, cash registers, telephones, mining, agriculture.

In the opinion of Dr. Rada, "The prospects for employment creation are dim.... What is happening today represents a major shift towards a society that no longer needs its full potential labour force to produce the necessary goods and services" (p. 144).

"It is a blind policy to expect automatic adjustment to these changes. The problems of the 1980s should not be confronted with the mentality of the 60's and 70's..." (p. 158).

International competitiveness as an impetus

"The maintenance of international competitiveness is seen as essential in curbing the labour displacement effects of the technology (but) maintaining competitiveness will reduce rather than neutralize labour displacement. Improved international competitivity will not guarantee full employment. In order to compensate for the displacement effects of increased productivity, "it would be necessary to increase external outlets to an extent that would seem implausible...."

Lack of options

There appears to be little choice for the industrialized countries -- making the use of the new technologies "almost compulsory."

"This no option "alternative" produces a number of demands on social and economic policy as well as on the trade unions. The trade unions are facing the option of destroying an industry or losing jobs, and this has led to a complicated pattern of (bargaining over) hours of work, job security, compensation and settlements. In this context government, management and unions tend to agree on the need for the application of the technology, however reluctantly" (p. 109).

The preceding paragraphs apply mainly to competition among the developed countries. As far as competition against the underdeveloped countries is concerned, "automation, by affecting the relative importance of direct labour costs, diminishes the importance of one of the major comparative advantages of developing countries in their international competitiveness: cheap labour" (p. 28). The feasibility of automated assembly and testing makes overseas operations less attractive, despite lower prevailing wage rates - in the face of highly automated domestic assembly. A number of examples are cited in support of this contention (INMOS, ITT, GEC-Fairchild, etc.).

Factors retarding the diffusion of the new technologies

"The development of information technology is limited by social and political rather than technical factors." "The major social-political constraint is obviously the possible labour displacement effects of the technology." The other major constraint is a widespread lack of awareness of the potential uses of information technology. Cultural, organizational and legal practices also impede the rapid diffusion of these technologies. Office automation, for example, involves much more than the purchase of a few machines. It generally involves a re-organization of the work structure and the adoption of a systematic approach (systems design) to office work which is usually lacking. Other barriers to increased productivity are "related not to trade union action, but to managerial practices which more often than not are archaic in their approach to productivity" (p. III-54).

Conclusions

"Scientific and technological changes are man-made and also man-shaping. Changes of this nature are not external to social priorities, political decisions and cultural trends. A deterministic view is not only incorrect but also a self-defeating exercise. It is becoming increasingly obvious that progress is <u>not</u> an end in itself.... Technologies are <u>not</u> neutral; they embody implicit forms of organisation and use" (p. 159). The time is ripe to question the current concept of progress, for its redefinition is "a necessary factor in meeting the basic material and human needs of the population" (p. 170). An alternative concept of progress should be elaborated that would move us away from the pursuit of endless profit, output, growth and wasteful competition" (p. 170).

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BRIEFS, U.

"The Effects of Computerization on Human Work"

Paper
Second IFIP Conference
Baden, Austria, 4-8 June 1979

NOTE: The author is a Research Director with WSI (Wirtschafts-und Sozialwissenschaftlichen Institut des Deutschen Gerverkschaftsbundes/ Economic and Social Science Institute of the German Trade Unions), Dusseldorf.

Excerpts:

Computers and employment

A first basic opportunity and danger of computerization may be seen in its very work - substituting property, the fact that computers replace human work - and increasingly, replace intelligent human work.

Contrary to the spreading of former new technologies, computerization in its present form is possibly not so much aimed at the production of "new products" and of new "use values." The bulk of computer applications thus replaces work performed in already existing information production lines, work done up to now by human workers, especially by clerical workers.

The labour substituting aspects of computerization - have a marked impact on the use of the computer in the work-place. They are influencing it directly, by the way in which they transform the work with the computer systems, by the way in which certain functions are taken over by the system while others are left to human work, by the way in which this repartition between machine and human work is altered.

They are influencing it indirectly by the pressure on the workers which is generated by the process of computerization, and by the fear which accompanies computerization.

This latter fact has of course to be seen especially against the background of high-level unemployment existing in most western countries. And we have to ask, whether it is a coincidence that the very last years of increased computerization have seen the coming-up and perseverance of mass unemployment, especially among white collar workers, too.

In the FRG (Federal Republic of Germany) for example we have in this economic crisis of the year 1975 and onwards for the first time an unemployment which is as marked among white collar workers as among blue collar workers.

Unemployment, even that which is caused by computerization, however, cannot be abolished by merely renouncing further computerization; it has to be solved by deliberate social action to provide for a better use of computers in terms of the numbers of applications, in terms of their use on the work-place and in terms of their products. That part of the scientific community which contributes to the production and spreading of computers has to be conscious of the necessity to establish full employment in order to avoid the negative consequences of the labour-substituting effects of computerization.

ELLING, Karl A.

"Co-determination by decree is not a panacea."

Labour Gazette, Vol. 76, No. 10 (October 1976), pp. 533-534.

NOTE: The author is Associate Professor, Business Administration, St. John's University, New York.

EXCERPTS: According to a 1975 Labour Canada survey of collective agreements in Canada, "30 per cent of the agreements provide for clauses relating to advance notice or consultation with the employees or union prior to the introduction of new methods of production." About 16 per cent of agreements provide for a wage or salary guarantee in the case of technological change. In 13 per cent of agreements, clauses exist providing for a labour-management committee. "This committee addresses itself primarily to the effect of technological change."

YOUNG, Howard

Jobs, Technology, and Hours of Labour:
The Future of Work in the U.S.

Paper presented at hearings of the Joint Economic Committee's Special Study on Economic Change, Washington, D.C., June 14, 1978 (17 pp., mimeo)

The author is Special Consultant to the President, International Union, United Auto Workers (UAW).

"It is our belief that...the level of aggregate output will not grow fast enough to provide a satisfactory level of employment unless hours per job decrease substantially." "Public policy to combat unemployment - which is itself an inequitable form of reduced work time - must face up to the centrality of reducing the regularly scheduled hours of paid work" (p. 1).

(1) If indeed we are beginning to witness some signs of a relative satiation with material satisfactions, "the demand side impetus to rapidly growing output will decrease" (p. 2).

(2) Higher labour force participation (of women, young and older workers) is likely.

(3) "Over the long haul technological change will reduce per capita requirements for direct labor" (p. 3).

In GM's Lordstown, Ohio plant, Unimate robots help to produce 20% more cars per hour using 10% fewer workers. "Knowing the cost of Unimates, we can be certain that the effect of their introduction was an absolute decline in total labor time, and not merely a shift from auto industry labor to steel and robot industry labor" (p. 10).

There is also a noticeable tendency to substitute unpaid consumer labour for paid employee labour - a move to a "self-service" economy, which has the effect of reducing the number of jobs available. Examples are direct distance dialing and self-service gas stations, which have each resulted in worker displacement."

Society as a whole benefits from technological change which reduces labour inputs but at present certain groups of workers (the displaced) are expected to shoulder an unfair proportion of its costs.

"The dual aims of progress and equity, then, require us to affirm our commitment to labour saving modernization, but to constrain our support by requiring a redistribution of its costs" by reducing substantially and redistributing the number of hours of work per job.

ROSS, David P.

"Unemployment in the Industrialized World"
<u>Perception</u> (Ottawa), Vol. 1, No. 4 (March/April 1978), pp. 7-10

NOTE: The author is principal administrator of the Manpower Policies Division, OECD, and has been affiliated with the Canadian Council on Social Development (CSSD).

The results of a ten-country study of long-term trends in unemployment rates in OECD countries suggest that "technological advance in combination with other factors is reducing the need for labor" and contributing to rising aggregate levels of unemployment.

The rate of unemployment in peak years of each economic cycle, the "full-employment unemployment rate," has, without exception, been rising with each successive economic peak. (The increase in the full-employment unemployment rate averaged 1% over 8 years in the nine OECD countries; in Canada the increase was 2%.) Because of reduced labour requirements, even maximum growth is now associated with more unemployment. "Consequently, economic growth policies are no longer able to reduce the rate of unemployment."

On the other hand, growth of employment in the public sector, expenditure on positive manpower programs and continued reduction in the average annual number of hours worked (falling by 5% per decade in eight OECD countries) have considerably softened the impact of these changes.

Thus the net effect of technological change in present conditions would be <-1 or -2% per 8 years.

BENN, A.

"Eight in Ten Secretaries Will Lose Jobs"

Presentation to the Labour Women's Conference in Felixstowe, U.K.
June 17-19, 1979

NOTE: A. Benn is a former Energy Minister in the Labour Government of the U.K.

- Microprocessor will impact women's employment more than men's.

- Eight out of ten secretaries in London would have their jobs taken away by the microprocessor.

- The effect of microelectronics on clerical and white-collar workers would be more dramatic than the mechanisation of the manufacturing industry.

McINTOSH, T.

"Union Agreement Could Herald Electronic Office"

Electronics Times, June 7, 1979

- NEI Parsons, one of Britain's major engineering groups has reached a landmark agreement with the Association of Professional Executive,, Clerical and Computer Staff (APEX) on introducing NEI Parsons office in microelectronics technology in general and word processors in particular.

- The agreement guarantees status earnings and job security. This means that no clerical staff will be downgraded, and that no redundancy can be declared. If the labour excess develops, the redeployment will be fully discussed.

- Comment: If this model agreement becomes widespread, the wave closures of uncomputerized officies, with parallel openings of new electronic offices, can be expected.

JACK M. NILES

"Opportunities and threats from the personal computer"
Futures, Vol. 11, No. 2 (April 1979), pp. 172-176

This is a report of preliminary conclusions from a U.S.C.-N.S.F. technology assessment project to be completed by the end of 1980. The author is Director, Interdisciplinary Programs, University of Southern California, Los Angeles 90007. Other project researchers include Paul Gray, F. Roy Carlson, Jr., and John Hayes.

The report foresees "increased employment in personal computers production and in service sectors," "reduction in unskilled jobs," "improved work skills," and greater opportunity for the education and employment of handicapped persons, due to the application of personal computer technology (p. 174). Other implications of some of the direct applications of personal computers include "alterations in the structure, availability, and work modes of the labour force, (and) new forms of unionisation" (p. 173).

- Basis of predictions: Unspecified. In this summary text, they are made by simple, unsupported affirmation.

- Period of predictions: Vague, but appears to be about 10 years from 1979.

ENGBERG, Ole

"Who will lead the way to the 'information society'?" Impact of Science on Society (UNESCO), Vol. 28, No. 3 (July-September 1978), pp. 283-295.

NOTE: The author is a Danish information scientist and mechanical engineer.

According to a study by the Swedish National Central Bureau of Statistics (ABD och Arbetskraften, Stockholm, 1977), "EDP has taken over 60,000 to 90,000 jobs and created 30,000 new jobs. This amounts to a net decrease of approximately 1% of the total labour force (p. 285).

Since computerisation of a number of other sectors is now technically possible, the potential for future unemployment is great. Sales forecasts of text processing equipment by EDP suppliers indicate the "secretaries, middle-grade managerial staff and several other categories" are the next likely candidates for job losses and mutation of function due to computerisation.

Increasing use of automated production and telecommunication of information is necessary because of local, national and international competition, and this will inevitably tend to increase the ranks of the unemployed. As shortages of resources and environmental considerations make continued unlimited growth in the production and consumption of material goods unthinkable, unemployment is bound to increase in the future, unless working hours are greatly reduced, or labour force participation is decreased through early retirement, longer schooling, etc.

In large companies, reasonable personnel policies and natural attrition could ensure that "staff dismissals can be reduced or avoided completely."

Small companies will have no choice but to reduce staff if they wish to survive the new competitive conditions.

Although the author suggests certain new activities based on the creative usage of computer networks for intellectual purposes, he feels that the overall outlook for (traditional) employment is really quite bleak, and concludes that continued "respect for a work-oriented ethic...is incompatible with an automated society" (p. 295).

Electronics in Supermarkets

Report, Post News, Somerset, U.K., 1979

- More than half of all supermarket checkouts will be electronically controlled in the next few years.

- There will be 33,000 electronic checkouts in use in five years.

- The equipment is based on IBM 3660. The central computer is linked to "intelligent" cash registers, coupled to laser scanners, which read a bar code printed on grocery products, providing information for both the shopper and the store staff. Vast majority of products in the U.S.A. and Canada have been marked in this way.

- The advantages of the equipment are above all the faster throughput at checkouts and greater efficiency in stocktaking. The chores of price marking each item would be eliminated.

- Bar Code System scanning was introduced in North America in a small way two to three years ago. It was stopped by consumer organizations (spearheaded by Ralph Nader) that criticized "unpriced products" by claims that shoppers could be hoodwinked by sneaking the price increases to the central computer file while not posting them on the shelves.

- The tide resisting this new technology appears to have turned now, as the attention of consumer groups has been sidetracked to the energy problems.

- The North American markets seem to be taking off in a big way.

- The biggest labour impact will be in labour savings in inventory control.

ROSEN, A.

"Percentage of the Labour Force in Manufacturing in the Year 2000"

Personal Note
Stanford Research International
Menlo Park. California, May 15, 1979

"There is no formal report regarding the estimate I made that by year 2000, 5-10% of the labor force will be occupied in the manufacturing sector. I have arrived at this estimate from personal examination of the impending (slow) revolution in manufacturing being made possible by adaptive programmable automation, and by other estimates from various experts in this field. Some facts are:

> About 25% (as of 1976) of the U.S. workforce are now engaged in "hands-on" work in the manufacturing industries, which do <u>not</u> include farming, services, mining, etc. but do include the durable goods as listed in Dept. of Commerce statistics. I estimate that approximately 4/5 of this group are performing material handling, inspection, and assembly tasks which are candidates for either complete replacement by programmable robot systems or to increase productivity of those who still interface. The remaining 10-20% will be required to supervise, retrain, maintain, set-up, etc., these robot systems. In other words, the remaining staff will be skilled, trained personnel on the level of supervisors and foremen.

The above transition will be fairly slow at first but is now gathering momentum, and soon we will have the benefit of several pilot systems being developed now, as well as new robots and visual sensing systems.

The major impediment to introduction of these new systems into factories will be the capital cost. Many of these systems will cost in the range of $50,000 and up initially and will decrease in cost later, but not quickly."

A quick calculation shows that if one considers that 20 million workers will be replaced by $50,000 capital/worker, one trillion dollar investment would be required.

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STUDY ON IMPACTS OF COMPUTER/COMMUNICATIONS ON EMPLOYMENT IN CANADA
AN OVERVIEW OF CURRENT DEBATES

July 18, 1979

IRPP

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