THE EMPLOYMENT IMPLICATIONS OF COMPUTERS AND TELECOMMUNICATIONS TECHNOLOGY.*

By

Professor S. G. Peitchinis, Ph.D.
The University of Calgary
Calgary, Alberta

Calgary, Alberta

April, 1981

* Research for this study has been funded by the Department of Communications, Ottawa, DSS Contract No. OST80-00035.

DOC File: 5412-4-5
DEA File: 31.27
DGCE Document No. 170(L)

THE EMPLOYMENT IMPLICATIONS OF COMPUTERS AND TELECOMMUNICATIONS TECHNOLOGY.*

By

Professor S. G. Peitchinis, Ph.D.
The University of Calgary
Calgary, Alberta

Calgary, Alberta
April, 1981

* Research for this study has been funded by the Department of Communications, Ottawa, DSS Contract No. OST80-00035.

DOC File: 5412-4-5
DEA File: 31.27
DGCE Document No. 170(L)

TABLE OF CONTENTS

Preface

This report contains an exploratory investigation into the employment effects of computers and telecommunications technology. The investigation started with a design which provided for three or four in-depth case studies involving establishments which have had in operation computer systems for some time. We intended to determine the effects on:

(a) the nature and quantity of manpower mix that is required for the efficient operation of computers and computer-related systems;

(b) the nature of knowledge that is required of those who input the systems and those who utilize the outputs of the systems, for the efficient utilization of the systems;

(c) the nature of work functions that have been rendered redundant by the systems;

(d) the nature of work functions that have been created, other than computer and computer-related occupations and employments;

(e) the nature of industry links that are maintained for the efficient operation and utilization of the systems, and their manpower implications;

(f) the nature of operational bottlenecks that have arisen and the extent to which such bottlenecks are associated with the nature and quantity of manpower;

(g) the extent of deficiencies in specialist manpower and ancillary manpower;

(h) the degree of transfer of functions from one location to another brought about by the use of computers and communications technology;

(i) the impact of the utilization of information technologies on female employment opportunities;

(j) the impact of utilization of the technology on 'in-house' vis-a-vis contracting out of certain activities;

(k) how firms have planned for technological change with respect to labour-management relations and the acquisition and training of skilled labour;

(l) current plans of firms with regard to technological changes, and how issues of skilled labour requirements and labour-management relations are approached.

In due course it became evident that the nature of information we required was either not available or would not be made available to us. Some companies deemed the information to be confidential; others thought the task of compiling such information too onerous and labour-consuming; and still others simply said they did not wish to be involved. Concerns appear to pervade that publicity of negative employment effects may bring social pressures against electronic technology and retard the rate of implementation.

Nevertheless, we proceeded with interviews, and extracted more information than initial responses to our enquiries had indicated possible: three establishments provided information on the nature and quantity of manpower mixes employed in the operation of their computer and computer-related systems; one establishment provided information on the effects of its on-line system on clerical and secretarial employment; we obtained some rather detailed information on the effect of electronic systems and processes generally on employment, occupations, and skill content in the telephone industry; and we collected some rather instructive information on office automation and its effects on office employment.

Interviews on office automation and its employment implications were conducted by research assistants Lynn Maltman and Margaret Insley; the author conducted interviews with executives of a Bank, an Insurance Company, an academic institution, an electrical manufacturing company, and a transportation company. On behalf of my assistants and myself, I should like to express appreciation to all who gave of their time and who provided us with information. Mrs. Maureen Samuels performed all of the typing and administrative functions.

Calgary
April 30, 1981.

Stephen G. Peitchinis

Executive Summary

1. Technological change has been characterized as interdependent, cumulative and irreversible: its application in one activity stimulates innovation and application to other activities; each successive application becomes the basis in whole or in part for further applications; and its application often dictates changes in the structure of processes and in the organization of enterprises. Given these sequential effects, it is extremely difficult to determine the overall employment effects, particularly in the early phases of development and application of a new technology.

2. The employment effects of computers and computer-related electronic systems have been generally positive. Some employments and occupations have been effected negatively, but such negative effects appear to have been more than offset by positive effects on other employments and occupations: for example, clerical functions related to the filing and retrieving of information are being eliminated, but functions involving data entry, data control, computer time scheduling are being created; typing functions are being reduced significantly, but a form of typing function is being combined with other functions in word processor operations; the functions of secretary/clerk/typists are being re-adjusted, dropping most of the clerical and typing functions and adding functions related to administrative support, counselling, information preparation and analysis, and such other.

3. Predictions of widespread unemployment are based upon three major assumptions, none of which is sustained by the available evidence.

(a) The first assumption is that the availability of computers and microelectronic technology is a sufficient condition for the widespread application of the technology. Yet, computer technology has been employed in production processes for over 25 years and it is still in the developmental stage; and other forms of electronic technology, such as office technology for example, are just making their uncertain debut. The evidence indicates that the rate of introduction and efficiency of utilization are conditional upon appropriate physical structures, the availability of efficient and effective support services, and appropriate organizations of work processes. In addition, the technology dictates changes in inter-occupational relationships, and demands responses from functionally associated capital and human resources that are significantly different from the responses to which people generally are accustomed. All these dictate a slow rate of implementation. A new technological infrastructure cannot evolve and sustain itself if its ends are alien to the ends of society.

(b) The second assumption is that the rate of implementation of microelectronic processes will accelerate very significantly. Falling prices of electronic instruments tend to suggest greater demand. But, to any enterprise the replacement of one production process with another entails considerable capital investment, which has to be justified in itself as well as in relation to other claimants for the investment funds. This reality, and the factors detailed under (a)

above, suggest a rate of implementation no different from that recorded over the past 25 years.

(c) The third assumption is that productivity will increase substantially more than demand for services. This is based on recorded instances of significant increases in output upon the replacement of manual/mechanical/electro-mechanical processes with electronic processes. But individual instances do not make an establishment. A significant increase in efficiency at the typing and clerical levels of an office does not mean efficiency in office operations generally will equally increase, nor does it mean that efficiency in the establishment at large will increase. Furthermore, the increase in efficiency deals with the supply side of the equation only. Its effect on employment will be determined by what happens on the demand side. The cases that we have examined suggest that demand for services can rise faster than the increase in efficiency, even when the rate of implementation of electronic technology is above average.

4. An examination of the technological infrastructure of the Canadian economy reveals the concurrent operation of three phases of productive/technological/organizational processes: "mature" processes, such as steel, aluminum, paper, electric appliances and instruments; "innovative" processes, such as those of IBM, Xerox and 3M; and "young high technology" processes, such as those of Digital Equipment, Control Data Canada Ltd., and such other. The evidence indicates that the implementation of automated electronic processes is having and will continue to have negative employment effects in the mature companies. But, the evidence also indicates positive employment

effects in innovative and young high technology companies whose electronic instruments are responsible for the negative employment effects in mature companies. Although we have not attempted to estimate the effect on balance, the evidence suggests that the positive employment effects of computers and computer-related systems have exceeded substantially the negative effects.

5. The operation of computer systems involves considerable employment. We examined the computer services systems of three establishments, and found that the operation of each involved the full-time employment of about 100 employees. There are hundreds of such systems in Canada.

   Furthermore, the Canadian Data Processing Directory for 1980 lists 1087 enterprises which provide computer services and access to computer facilities, consulting services on management proposals, projects, computer installations, hardware, software and communications, and supply hardware and software to the data processing industry. Very substantial employment is associated with these activities.

6. Employment related to the operation of computer systems manifests three characteristics which have important implications for manpower planning:

   (a) There is considerable uniformity in the numbers employed in the operation of different computer systems. We examined three systems, differing in size, volume and range of activity, yet the employment associated with their operations ranged between 99 and 109.

(b) A significant expansion in system capacity can be introduced with only minimal increments in manpower. That is, once a computer system is established and an appropriate mix of manpower is attached to it, the system can be converted into a widespread computer/communications network, and the volume of information can be increased manyfold, with only a small addition to the manpower complement.

(c) There is considerable uniformity in the occupational distribution of employment amongst different systems. Managerial occupations, analysts and programmers constitute 40-60% of total employment, and computer operators, data entry clerks, and data control clerks 30-40%. We have speculated on whether so many managerial positions are actually necessary, or whether they are dictated at present by the tightness of the market for personnel knowledgeable in different aspects of systems operation and utilization.

7. Negative effects on overall office employment were reported in two cases: an insurance company, and the telephone industry.

(a) In the insurance company, introduction of an on-line electronic network linking the company's regional and branch offices to head office has had significant negative effects on overall office employment. The effect has been particularly negative on clerical/typing/secretarial occupations, in which employment fell in the order of 30%. But, this significant negative effect was regarded only temporary: it resulted from a relatively short term and substantial increase in efficiency in the handling of information, in a period when demand

for insurance services increased substantially less. It was generally expected that over time demand will catch-up to the increase in efficiency, and employment will be restored to previous levels, although its composition will be somewhat different.

(b) In the telephone industry, significant overall negative employment effects were recorded amongst telephone operators, in offices, and amongst the various installation and maintenance trades. The introduction of automatic testing of lines, the use of plug-in modular component systems, the introduction of computer assisted toll switchboards, and the computer logging of calls and calculation, posting and billing of charges, all have had negative effects on related employment. But, in this case too, it was expected that when the industry attained the capacity to supply the very substantial increase in anticipated demand for services, employment will be restored to the high levels of the past, although, as in the case of the insurance company, the occupational mix will be different.

8. We examined seven offices in which varying phases of electronic technology is being utilized, and found the following effects:

(a) In all cases the decision to invest in electronic technology was based largely on (i) anticipated continuing increase in demand for office services, (ii) the incapacity of conventional manual/mechanical/electromechanical systems to satisfy the anticipated demand, and (iii) the persistent shortages in office manpower.

(b) The use of electronic technology had varying effects on the functional activities of office occupations--typing functions became word processor operating functions, filing and retrieval functions became general clerical support functions, secretarial functions expanded to incorporate various management support functions, and proofing and editing activities were given functional identity. As a result, redundant clerks became data entry clerks, redundant typists became word processor operators, and secretaries relieved of typing responsibilities became "advisors," "consultants," "research assistants," and "administrative secretaries."

(c) Productivity at the typing and report preparation level of office activity increased significantly. But, reference is made to the fact that the office is constituted of more than secretaries, typists and clerks, and office activities involve much more than typing and preparation of reports. We have not been able to determine whether <u>overall</u> office productivity has actually risen.

(d) Developments to-date suggest a relatively slow rate of progress towards the fully integrated electronic office system. The science and technology do not appear to present any problem, even though some difficulties have been encountered in the linking together of different devices into efficient systems. But, an integrated electronic system involves much more than science and

technology: it involves the physical structure of the office, the organization of office processes, inter-occupational functional relationships, and the total working environment. We have characterized the environment of a partly integrated office as "eerie--a graveyard of silence," which causes the unaccustomed "to whisper or to want to scream."

(e) The effect on overall office employment has been positive: the increase in productivity has been more than offset by the increase in demand for office services. The major factor accounting for the divergence of our findings from the general predictions of negative effects on office employment is found in the nature of cases we have examined. All cases involved establishments which have been experiencing very rapid growth in activity and which faced very rapid increase in demand for office work. Hence, the increase in office efficiency, which in all cases was very substantial at the clerical/secretarial/typing levels, was more than offset by the increase in demand for office services. This provides the basis for the following general postulate: the effect of electronic office technology on overall employment in the office will depend upon the rate of increase in office efficiency relative to the rate of increase in demand for office services. As long as demand for office services increases faster than the rate of increase in efficiency, positive employment effects can be expected, regardless how rapidly efficiency increases. Thus, even where the output

of a word processor was equal to that of four to five typists operating standard typewriters, the effect on employment of secretary/typists was neutral.

9. The effect on the level of knowledge is difficult to establish at this time. The occupational mix of manpower employed in the utilization of computer systems suggests an upward shift in knowledge. But, whether that is a true reflection of the level of knowledge required, or a consequence of the tight market conditions for people knowledgeable in computer operations, remains to be determined. An examination of the academic qualifications of managerial and professional personnel employed in the operation and utilization of computer systems tends to support the latter consequence. Formalized knowledge appears to vary widely: there is no evidence of any standards of required knowledge. The possibility of certification is being discussed amongst computer managers, professionals and operatives, but the flow of new knowledge would have to stabilize somewhat before action of that nature can be taken. In the meantime, scarcity of manpower persists, and establishments are prepared to "train" anyone who demonstrates aptitude for the nature of work functions that are involved.

10. We attempted to determine the nature and quantity of manpower mix that is required for <u>the efficient</u> operation and utilization of computer systems. Questions on the issue emitted responses which indicated the absence of criteria for the measurement of efficiency. Undoubtedly, frequent changes in system capacities, and the continuous undertaking of new service functions makes the establish-

ment of criteria rather difficult. Nevertheless, systems managers have asserted that inadequate supply of specialized manpower has been responsible for system underutilization and misutilization.

EMPLOYMENT IMPLICATIONS OF COMPUTER AND TELECOMMUNICATIONS TECHNOLOGY

Section I: INTRODUCTION - TECHNOLOGY AND EMPLOYMENT

Employment is an important social activity; it is not mere participation in economic activity for the purpose of earning an income; and the structure of employment, in the form of occupations and their distribution amongst activities in the economy and society, bears significantly on the economic and social structure of society. Given this relationship between the structure of employment and the economic and social structure, it can be expected that society will resist the implementation of technological innovations which entail unacceptable implications for employment.

In years past, when laissez faire conditions predominated in society and the economy, considerations of impact on society at large did not enter into decisions on implementation. Whatever the outcome, it was attributed to the interplay of market forces, and it was accepted. To-day, society is more activistic;it does not accept the consequences of market forces as inevitable; it recognizes that the interplay of market forces is manipulated; and it does not accept the implicit proposition that the outcome of market forces is in the best interest of society.

Commonly, the nature of technology, the level of technology, and the rate of technological change are viewed as catalysts in social organization, social structure and social change. The concept of "technological society" conjures up the impression of a society fashioned and ruled by the dominant force of a technological infrastructure.

Technological change has been characterized as "interdependent, cummulative and irreversible."[1] It is interdependent, in the sense that its application in one activity stimulates innovation and application to other activities. For example, application of the steam engine in mines and factories stimulated research, development and application to boats and locomotives. It is cummulative, in the sense that each application opens a multitude of possibilities for further applications, and each successive application is based on some knowledge from prior applications. It is irreversible, in the sense that the structural and organizational changes are irreversible. Depending on their nature and magnitude, technological changes "impart a degree of determinism to the future course of economic development."[2] This suggests that the organization of production processes and forms of business enterprise have been dictated to some degree by the nature of technology in existence.

Acceptance of these three propositions would justify the anticipation of significant changes in the structure of employment. The pattern of development in electronic technology fits well with the indicated outcomes: the application of electronic innovations to individual activities has stimulated innovation and application to many other activities; we have witnessed innovations over the past two decades which suggest that successive applications have been based on knowledge gained from prior applications; and one of the issues that is being discussed currently is the extent to which

---

[1] Dillard, Dudley, Economic Development of the North Atlantic Community, Prentice-Hall Inc., N.Y., 1967, p. 246.

[2] Ibid., p. 247.

the pending introduction of integrated electronic office networks will bring about increasing centralization in the management of organizations.

But, the three propositions also seem to suggest a technological imperative: that technological change can evolve and find widespread application on its own, and dictate responsive societal accommodation. This is an issue of cardinal importance to society, particularly with new innovations which have the potential for widespread application. Is it possible that a technological infrastructure can so evolve as to dictate changes in employments, occupations, organizations and relationships which are counter to the interests of society and the preferences of the people? Could a technological infrastructure evolve and sustain itself in a society that is alien to its purposes?

The prognosticators of pending mass unemployment, social chaos, and manipulation of people by inanimate objects, assume implicitly that society bears no influence on the nature, level and rate of technological change, regardless of the nature and magnitude of its implications. Such an assumption, and the utopian scenario that evolves from it, cannot be sustained by the prevailing social and economic reality--a reality which is founded on massive retrospective technological change.

The reality is that our society, like other technologically advanced industrial societies, has evolved a capacity to diffuse and absorb the bumps of technological change. Over the many decades of continuous technological change, and the concomitant social and economic changes, society has evolved stabilizers and shock absorbers which smooth out and absorb the impacts of change. In addition, social, economic and institutional mechanisms have evolved which ensure that the benefits of technological change are distributed widely through society.

Writers such as Jenkins and Sherman,[3] Nora and Minc,[4] and other prognosticators of doom and gloom have a very narrow view of society, and very limited understanding of how the economy works. In the context of the whole of society and the economy, their "comprehensive" studies are but limited studies, and the general principles they evolved are but principles based on limited premises.

The Application of Electronic Technology

Apprehensions about the employment implications of electronic technology are based upon predictions of applications that are too rapid and too widespread for orderly accommodation and effective manpower adjustments. It is alleged that, unlike technological changes of the historical past, electronic technology, and particularly microelectronic technology, will find easy and widespread application at a historically unprecedented rate.

Electronic technology has been operative in production processes for over 25 years, and it is still in the innovative phase of development. Rapid and widespread applications were forecast twenty years ago based on: (a) significant improvements in the technology of computers, which made individual units less cumbersome than the early models; (b) actual and anticipated decreases in computer prices, making them accessible to smaller institutions and enterprises, and thereby expanding the market for them; (c) increase in computer services, which was expected to bring about lower prices and costs; and (d) the development of a wider range of software which

---

[3] Jenkins, C., and Sherman, B., The Collapse of Work, Eyre Metheun, London, 1979.

[4] Nora, S., and Minc, A., L'Informatisation de la Societe, La Documentation Francaise, Paris, 1978.

was expected to facilitate computer applications to a wider range of activities.

The rate of application has been considerably lower than the projected rate. Over time the exaggerated expectations gave way to the reality that the computer was an instrument which could perform a wide range of functions substantially faster than mechanical and electro-mechanical processes, and that it could perform many functions which could not be performed by conventional processes, but that it was, nevertheless, an instrument, partly complementary to existing instruments and factors, partly supplementary, and a substitute for capital and labour in varying magnitudes. Applications have not been as widespread as expected, and the employment effects have not been as negative as projected. Indeed, on balance the effects on employment appear positive: new occupations and employments have been created, which remain in short supply even after twenty years of operation; and there is no evidence that computer applications have destroyed more jobs than they have created.

Currently, there is a renewal of exaggerated expectations, based largely on the advent of microelectronics. This new phase of the electronic "revolution" is expected to find very rapid and very widespread application in all production processes as well as in consumer durables. Amongst the most frequently cited positive application characteristics are the following:[5]

---

[5]Some of these characteristics are identified by the U.K. Advisory Council for Applied Research and Development (ACARD) in The Applications of Semiconductor Technology, HMSO, London, 1978.

1. It is appropriate for the performance of a wide range of service activities which heretofore have been largely or entirely labour intensive, such as clerical, retail, and other.
2. The small size of microelectronic chips makes them appropriate for insertion into most consumer durables.
3. It is relatively cheap, and it is expected to become cheaper.
4. It is exceptionally reliable and precise in the activities it performs.
5. It is all pervasive.
6. It has a universal range of application.
7. It is developing on an international scale, which means it will become abundant in supply.
8. It is environmentally benign.
9. Its size and cost means access to it by individuals and the smallest of enterprises.
10. It has the capacity to both extend and displace a wide range of intellectual and intuitive skills.

In addition to these characteristics, which are expected to facilitate widespread application of microelectronics, impetus to application is expected from the following:

1. Inability of enterprises to undertake the production and distribution of certain goods and services with existing technology and existing processes. The computer facilitated the production of goods and services which were not even conceived possible prior to its introduction; on-line transmission of information established new possibilities for services; and microelectronics is conceived as opening-up further possibilities for the production of goods and services.

2. Inability to meet potential demand with existing processes. The capital-labour ratios in existence within individual processes impose limitations on the volume of output that can be produced. In the absence of new technology, output can only be increased through increments in capital and labour. Enterprises encounter limitations on the extent to which they can add successive increments. The technology will facilitate an increase in the volume of output without a proportionate increase in production facilities and manpower.

3. The need for instruments and processes which can be applied to activities requiring greater precision than can be obtained with existing processes. Programmed performance is expected to provide such precision.

4. Increasing competition in both domestic and international markets dictates,

    (a) greater consistency in product quality, and

    (b) faster response to orders.

5. The reduction of down-time and wastage dictate the introduction of more effective process control.

6. Enterprises face a compelling requirement for more efficient management of inventory.

It is generally recognized that we are gradually moving towards integrated production-distribution-communication electronic network systems. At present, most technology is still relatively primitive--relatively untidy and inefficient. It is "untidy" because it still consists of one central processor and several peripherals--input and output terminals, tape stores, printers, etc.--scattered around and dependent on the processor for their operation. It is "inefficient" because the entire network operation depends upon the operative efficiency of the central processor. When the central processor stops, the entire system comes to a standstill.

Efficiency considerations dictate that entire electronic systems--central processor, minicomputers and peripherals--be linked together into integrated interactive networks. The advent of microprocessors makes possible the transformation of peripherals from dependent dummy devices into intelligent, independent, interresponsive system instruments.

A most significant part of the electronic networks will be the integrated office--an interactive system of computers, mini-computers, and intelligent peripherals, processing information, editing texts, reproducing documents, storing and retrieving information, and facilitating communication through electronic mail and teleconferencing.

Employment Effects

Concerns about the employment effects of electronic processes are based upon three assumptions: one is the assumption that demand for

services will not increase as fast as the increase in the output of services. It is expected that new processes will enable enterprises to increase their services manyfold with the same or even with reduced numbers of employees. This is based on reports from establishments which instituted electronic processes to the effect that productive capacity has been enhanced. Specific information is lacking, but general statements abound of "more of the same services and a large number of other services with the same numbers of people." The second assumption derives from an exaggerated notion of the new technology. Electronic processes are viewed as fundamentally different from mechanical and electromechanical processes, and with different capabilities. They are viewed as displacing not only human muscle power, but also human intelligence. The utopian vision of a small group of software specialists packaging programmes and microchips, thereby enabling processes to perform all sorts of functions without human intervention, is disturbing indeed. Equally disturbing is the vision of "intelligent" instruments and processes outperforming people, and thereby doing to humans what the automobile and tractors did to horses and carriages. The third assumption derives from the inability to determine the possible sources of alternative employment opportunities. In the past, employment in service activities was a theoretical and practical possibility. A relationship was established between productivity, income and the demand for services; and since the production of services was largely labour intensive, a close relationship existed between the demand for services and the demand for labour. Hence, when mechanical and electromechanical processes reduced employment in agriculture, and limited substantially the rate of increase in employment in manufacturing, it was fully expected that the resultant increase in productivity and incomes will increase demand for services, which in turn will increase

employment in service activities. The outcome is shown in Table 1.

The critical question is what will happen to employment in the industry groups which recorded increasing rates of employment over the past three decades, namely, trade, finance, insurance and real estate, and services. If the application of electronic instruments and processes to the production of services has the same effect on employment in service activities as the application of mechanical and electromechanical instruments and processes has had on employment in goods-producing activities, then the issue of alternative employment activities assumes prominence.

A superficial examination of the evidence legitimizes expressions of concern: in Trade activities, the introduction of information processing, text processing, nationwide on-line communication, integrated transaction terminals, and pending automatic debiting and crediting of commercial transactions in bank accounts, suggest a potential decrease of employment opportunities. On the other hand, trade activities involve considerable personal services, and there are thousands of small enterpreneurs who will continue to provide individual services. It is conceivable that many services currently performed by members of households will in future be performed by commercial establishments. In Finance, Insurance and Real Estate activities similar developments have been in progress: information processing, text processing, nationwide on-line communication, and gradual integration of electronic processes in offices, are expected to reduce employment substantially. On the other hand, there is evidence of increasing competition in the three activities, and the respective industries have responded with increasing emphasis on consultative services. It is conceivable that the decrease in numbers of clerks will be

Table 1

Distribution of Employment by Industry Group, Canada, 1950-1979. (Thousands)

Industry Group	1950		1960		Increasing/ Decreasing % of Total
	No.	%	No.	%	
Total Employment	4,976	100.0	10,369	100.0	
Agriculture	1,020	20.5	483	4.6	Decreasing
Other Primary	194	3.9	273	2.6	Decreasing
Manufacturing	1,314	26.4	2,070	20.0	Decreasing
Construction	333	6.7	640	6.2	Stable/ Decreasing
Transportation/Communi- cation & Other Utilities	423	8.5	900	8.7	Stable
Trade	642	12.9	1,806	17.4	Increasing
Finance, Insurance, Real Estate	144	2.9	553	5.3	Increasing
Services (including Public Ad'tion	906	18.2	3,645	35.2	Increasing

Source: Statistics Canada.

more than offset by an increase in numbers of "customer services consultants," sales personnel, market analysts, and such other activities focusing on the analysis and stimulus of demand. Furthermore, there is increasing evidence that electronic storage and transmission of information create legal and security problems, which give rise to scores of employment activities.

Assessment of the effect on employment in activities grouped under "Services" is very difficult: we know that the widespread introduction of integrated electronic processes in offices, involving information processing, text editing, electronic mail, electrographics, and other activities, will arrest and eventually reverse the upward trend in general office employment in effect heretofore. But, we also know that the professional, semi-professional, and managerial/administrative component of office employment has been increasing. Furthermore, although office employment is a significant proportion of total employment in the service sector, there are scores of other service activities in the sector.

Almost twenty years ago, a study of office automation in the United States concluded:

> "Although the immediate effect of electronic data processing suggests some retardation in the growth of office employment, particularly part-time work, the experience of some offices suggests the possibility of expanding employment in new areas of office activity to handle information which had previously been uneconomical to acquire."[6]

---

[6]U.S. Bureau of Labor Statistics, Adjustments to the Introduction of Office Automation, Bulletin No. 1276, U.S. Government Printing Office, Washington, D.C., 1960, p. 4.

This statement describes precisely developments in Canada today: there is a suggestion of retardation in the rate of increase in office employment, but also a strong suggestion of the emergence of services which could not have been produced by non-electronic processes, or it was uneconomical to produce them. The production of such services will generate employment in new areas of activity.

The service sector is highly heterogeneous in the nature and structure of processes and services; and its heterogeneity is manifested in the heterogeneity of the labour force employed in it. From the chambermaid to the Governor General, the labour force of the sector contains almost all of the occupations employed in the goods-producing sector and many more. There are found in it workers with very low levels of education and very high levels; low skill, no skill and very high skill; the very young delivering papers house to house and the very old commissionaire; the politician and the bureaucrat, the lobbyist and the gambler, the croupier and the bouncer, the day-care workers, the counsellor, the artist, the performer, and thousands of other work classifications.

The very wide range of services, and the concomitant heterogeneity of the labour force means lesser vulnerability to changes in technology and processes of production, than would be the case when the range of services is narrow, and when the services and the processes are standardized. Even areas of activity in which the range of services appears concentrated, such as "office work," "services to business," and "personal services," the nature of work involved is so diverse, and the institutional and commercial settings in which the work is performed are so wide-ranging, that it is difficult to generalize about the nature of the

impact or about the extent of the impact on work and employment. When one moves away from these conceptually concentrated activities and into the realm of general personal and family services rendered in a multitide of settings by a multitude of workers, the task is doubly difficult.

Furthermore, the service sector is the knowledge sector, and the quest for knowledge, whether for its own sake or for its application to work activity, will not be arrested by computer technology. On the contrary, there are indications that by facilitating the performance of functions which could not have been performed by conventional methods, computer technology has stimulated quest for knowledge.

A further characteristic of the service sector which makes its processes less vulnerable to computer technology is the relatively unstructured nature of many work activities. The computer, the word processor and the information bank can complement and speed-up the work of the secretary, lawyer, the writer, the doctor, the bus driver, the policeman, but will not reduce significantly the wide range and continuously changing work variables they encounter. Every work activity involving people rendering services to people is subject to continuous change; and the more changeable it is, the more unstructured its functions must be; and the more unstructured the work functions, the less likely it is to introduce substitute electronic processes.

Structural changes in employment and occupations <u>will</u> take place, and changes in the content of many jobs are inevitable. But, such changes are common in dynamic economies, and they are preferable to the stability that characterizes periods of economic stagnation. History is replete with examples of changes in instruments, processes, products and knowledge which caused serious dislocations in employment and skills. Indeed, since "technology" is commonly associated with capital instruments,

it is relevant to note that historically, changes in products, and changes in demand for goods and services have caused more unemployment and changes in employment, than all of the changes in capital instruments (machinery, equipment and technical processes) put together. The critical task for society has been to create the institutions and programmes that will facilitate the effective accommodation of change.

Increases in efficiency and the manifested decrease in labour input per unit of output is a threat to employment only when the volume of work to be done is fixed. Between 1961 and 1979 output per man-hour in Canada's commercial non-agricultural industries increased at an average annual rate of 2.75%, and employment increased at an average annual rate of 3.13%. In 1961, employment in all activities excepting agriculture and public administration, stood at 5,018,000. In 1979 it was 9,181,000--an increase of 4,163,000!

Technological changes and concomitant increases in efficiency do not reduce employment; the absence of technological changes and the failure of efficiency to increase are more likely causes of employment retardation. Structural imbalances notwithstanding, prolonged periods of concurrence in rising efficiency and employment deficiency are more likely the result of demand deficiency than the result of improvements in efficiency.

This relationship is well demonstrated by developments in Alberta, where the introduction of computers and computer-related processes has been widespread, yet there have been persistent shortages of manpower, particularly office, professional and technical, managerial, and of course, computer-related occupations. The explanation will be found in the rate of increase in economic activity: the increase in efficiency has been more than offset by the increase in demand for services. The Alberta experience suggests that computers and computer-related electronic systems do not reduce

the total number of jobs available. On the contrary, by making it possible to produce goods and services more efficiently, and by making it possible to produce many goods and services which could not or would not have been produced, computers and computer-related systems facilitate the generation of higher incomes, higher demand for goods and services, and higher employment. If, instead of increase, employment is in fact retarded, the fault will be found elsewhere, not in the application of computer technology. The fault will be found in the variables responsible for the failure of the economy to expand at whatever rate is necessary for the accommodation with employment of everyone able and willing to work.

Attempting to Predict Changes in Employment and Occupations

Attempts to predict changes in manpower requirements have generally proven unsatisfactory, even under the assumption of fixed technology. Changes in technology complicate the problem further: not only do changes in technology bear on the occupational structure of the labour force, but they affect also the labour-output ratio, and thereby neutralize one of the key variables in employment determination.

Technological changes which depart from the traditional electromechanical infrastructure present special difficulties, because they create uncertainties regarding the operational aspects of the technologies, and the kinds of human interventions that will be required upstream, downstream, and directly on the operational system. In traditional electromechanical systems the functional relationships of capital instruments and processes are generally known, and the manpower requirements can be estimated. The departure from such systems, which is the essence of electronic processes, introduces different relationships and unknown complementarities and substitutabilities. The

technology transcends boundaries, jumps over space, and impacts on areas of activity which are seemingly unrelated or only remotely related. For example, we know that audio-visual electronic systems will impact on manual and manual/mechanical grapho-visual processing, which is the imbedding of letters on paper by hand or typewriter. It is too early to speculate on the impact of this on employment and occupations: we know that transmission of information on paper will decrease, and we know also that the physical distribution of information by paper will diminish. Inevitably, employment activities which relate to the manual placing of information on paper, and those which relate to the physical distribution of paper will decrease. But, how much, where, what, remain unanswered questions. At the extreme, the technology will impact on the process of writing itself--the learning of letter-formation, the physical imbedding of letters on paper by hand will not be necessary--and thereby impact on the related teaching activity.

The uncertainty regarding implications for employment and occupations, and the rapid rate at which changes in technology are proceeding, dictate the establishment of direct links between the conception-production-distribution of electronic instruments and processes, and the preparation of manpower. The training of new personnel, and manpower adjustments to the new technology, must take place within the internal markets of individual establishments.

Job Changes

By definition, a job is a range of work functions. References to job changes mean changes in the nature and range of work functions performed by individuals.

The ranges of work functions associated with individual jobs change continuously: they are affected by changes in knowledge, changes in the organization of production processes, product changes, changes in the instruments used in work, and through the redistribution of work functions amongst related occupations and employments.

Changes in the work functions of occupations signal the existence of dynamic processes: they mean new knowledge is displacing old knowledge; work that was done manually, is now being done with the assistance of instruments or by instruments; work is being done that could not be done with the old instruments and processes; and some of the work that was done is no longer done, because it is no longer necessary. In addition, changes in work functions are frequently dictated by the state of the market for individual occupations. For example, a rational response to the emergence of serious shortages of electronic engineers would be to transfer away from electronic engineers all work functions which related occupations can perform, so that electronic engineers will concentrate their efforts to those functions which only they can perform.

Computer and computer-related electronic systems impact on both the nature and range of work functions. For example, the computerization of accounting systems reduced the work functions that related to the recording of entries, balancing accounts, calculating, and the preparing of financial statements. At the same time, the improved access to information, and the automatic generation of a wide variety of statistical and informational configurations facilitated the allocation of more time to work functions that related to the examination and analysis of information.

Similarly, the introduction of text editing equipment has changed significantly the work functions of secretary-typists: typing work functions decreased, while administrative support work functions increased. Our information indicates that most secretary-typists have been found adequately qualified to assume the new work functions. Also, the transfer of clerical functions to computers, and typing-related functions to word processors, has resulted in the assignment of administrative support functions and computer support functions to clerks and secretary-typists who have not trained to word processor functions. The most common references to the nature of "administrative support" functions have been "research" in the form of "putting-together information," and the most common references to the nature of "computer support" functions have been "data entry," "data control" and "operator."

The introduction of medical information systems in hospitals enabled pharmacists to drop work functions related to the typing of medication labels, keeping records of prescriptions (by physician, nature of medication, etc.), and compiling reports, and to expand the work functions that related to the review of medications for possible reactions, consultation with physicians on their patients' medication profiles, and such other professional activities. Similarly, the virtual elimination of clerical work functions, and the almost instantaneous access to patient profiles, enabled nurses to expand significantly their patient care functions.

These developments could be interpreted to constitute a manifestation of (a) professional groups expanding the range of their services as a protectionist response to the displacing effects of computers, and (b) employer concerns that adverse employment effects on their employees may cause

resistance to computer technology, and arrest its implementation. Such interpretations would imply that the new work functions and expanded work functions have not been necessary, but were introduced as an interim measure to accommodate existing employees, until natural attrition brought about appropriate adjustments.

But, an examination of the work functions that were created or expanded to fill the time-gap created by the elimination or undertaking of work functions by computers, will find that most such work functions were not carried out prior to computerization. Some could not be carried out by the standard processes, whereas others were either not known, or could not be afforded. Hence it is not a question of such functions not being necessary. Undoubtedly, some are make-work functions, motivated in part by uncertainties about the ultimate employment effect of the systems, and in part by labour-management relations policy considerations. Nevertheless, the evidence suggests that more work functions were created as a result of the introduction of computers and computer-related systems than were eliminated. Furthermore, for the most part the eliminated work functions were the routine and low level work functions, whereas the created and emergent work functions have been higher order work functions. Professionals are being enabled to allocate more of their time to work functions that require their professional knowledge; and non-professionals, such as clerks, typists and secretaries are removed from their routine functions and type-cast roles, and given opportunities to perform more varied work functions, often of a higher order.

It is perhaps relevant to record that changes in jobs and changes in job functions are a very common occurance, and involve very large

numbers of people. The Economic Council of Canada carried out a detailed study of the subject and reported that during 1975 about 13 million people participated in the labour force, of whom "as many as 5 million, or possibly more, changed jobs with or without a bout of unemployment, entered, re-entered, left the labour force, or became unemployed. In the process, millions of jobs were vacated and refilled."[7] This is characteristic of a dynamic economy: new ideas, new instruments and processes, new products, new services and new problems, generating new work activities, new enterprises and new employments. At the same time old instruments and processes are replaced, products disappear, enterprises decline and go out of business, some relocate, and some change the nature and range of products they produce, causing unemployment, relocation of workers, and the erosion of knowledge and skills. An efficient market system will take these displaced and deskilled workers equip them in the required knowledge and skills, and place them into the new work activities. If the market fails to function efficiently, a lag will devleop in the adjustment process which will be reflected in unemployment. In such case, the cause is not the economic change; it is rather the failure of the adjustment process. The existence concurrently of unemployment and vacancies is manifestation of such a situation.

It is relevant to note the scores of enterprises that have been established in recent years in response to the advent of the computer, and the multitude of new work activities that have evolved over time. The Canadian Data Processing Directory for 1980 lists 1087 enterprises that provide computer services and access to computer facilities, consulting services on management proposals, projects, computer installations, hardware,

---

[7] Economic Council of Canada, People and Jobs, Information Canada, Ottawa, 1976, p. 81.

software and communications, and supply hardware and software to the data processing industry. Very substantial employment is associated with those activities.

In addition, the storage of information, the ways in which stored information can be accessed, and the transmission of information have created legal and security problems. Unauthorized use of computer time and services, unauthorized use of data stored in computers, the alteration of information, and erasure of information, involve consultants in law, physical security, information security, EDP auditing, risk analysis, contingency and recovery planning, and the planning, establishment and management of computer backup facilities. Concurrently, hundreds are involved in research for the development of foolproof systems.

Canada is at the threshold of a communications revolution, which will impact severely on employment and society at large. Whether the impact will be felt positively or negatively will depend on whether accommodative and adjustment mechanisms are in place and functioning efficiently in the transition from the manual/mechanical/electromechanical processes in existence heretofore, to the electronic. The transition should not be difficult, and should not cause hardships. Over the past thirty years the Canadian economy has shifted dramatically from being a predominantly goods-producing economy, to being predominantly a services-producing economy. Transformation into an electronic/information-communication economy is easier to accomplish from a service economy than from a goods-producing economy. The service economy has a more appropriate organizational structure, more extensive telecommunications system, a more substantial information base, and most significantly, a more appropriate educational/occupational mix in its labour

force.

Furthermore, all signals indicate that the rate of change will not be as rapid as it was thought at the initial phase in the introduction of the technology. Given adequate time for accommodative adjustments to take effect, and given an efficient administrative process to assist with accommodative adjustments, the effect on employment and skills should not be much different from the effect recorded in the transition from a goods-producing economy to a services-producing economy.

Section II: TECHNOLOGICAL CHANGE AND INDUSTRY EMPLOYMENT

Discussions on the employment effects of changes in technology generally tend to emphasize the negative, with only passing reference to the positive. Yet, the development of new technology has significant positive employment implications.

In sections II and III we examine two related sets of information. One set relates to employment by mature companies, such as those in steel and paper production, innovative companies, such as IBM, 3M and Xerox, and of young high technology companies, such as Digital Equipment; and the other set relates to the employment effects of the operation of computers and computer-related systems. The first is presented in Tables 2 and 3; whereas the second is presented in three case studies.

Table 2 contains information on the employment records of three industry groups in the United States: a group of "mature companies," such as Bethlehem Steel and Dupont; a group of "innovative companies," such as IBM and Xerox; and a group of "young high technology companies," such as Data General and Digital Equipment. The mature companies are generally old established, capital intensive companies, using equipment produced by the innovative companies; the innovative companies generally date from the Second World War; and the young high technology companies are generally the electronic systems companies of the 1960's.

The information is very instructive: an examination of the changes in employment over the period 1945-1974 would reveal that the innovative companies taken as a group recorded a substantially higher rate of increase in employment than did the mature companies. Such a comparison is, of course, critical to an understanding of the employment effects of changes in technology. If employment in the mature companies were examined

Table 2

Employment and Technological Development 1945-1974:
Mature Companies, Innovative Companies and
Young High Technology Companies, United States.

Companies	Employment			Changes in Employment		
	1945	1969	1974	1945-1969	1969-1974	1945-1974
Mature Companies	No.	No.	No.	No.	No.	No.
Bethlehem Steel	202,095	130,000	122,000	- 72,095	- 8,000	- 80,095
Dupont	63,939	118,079	136,836	+ 54,140	- 18,757	- 72,897
General Electric	148,233	400,000	404,000	+251,767	+ 4,000	+255,767
General Foods	13,000	42,000	47,000	+ 29,000	+ 5,000	+ 34,000
International Paper	23,414	54,500	52,717	+ 31,086	- 1,785	+ 29,301
Proctor & Gamble	14,800	43,214	49,800	+ 28,414	+ 6,586	+ 35,000
TOTAL	465,481	787,793	812,351	+322,312	+ 24,558	+346,870
Innovative Companies						
IBM	17,500	258,662	292,350	+241,162	+ 33,688	+274,850
3M	6,795	66,260	83,609	+ 59,465	+ 17,349	+ 76,814
Polaroid	1,058	10,506	13,019	+ 9,448	+ 2,513	+ 11,961
Texas Instruments ('53-'74)	2,300	58,974	65,524	+ 56,674	+ 6,550	+ 63,224
Xerox	593	54,882	101,380	+ 54,285	+ 46,498	+100,783
TOTAL	28,246	449,284	555,882	+421,038	+106,598	+527,636
Young High Tech. Coys.						
Data General (1968)	-	170	3,452	-	+ 3,282	
Digital Equipment (1957)	-	4,615	17,600	-	+ 12,985	
Compugraphic (1960)	-	637	1,864	-	+ 1,227	
National Semiconductor (1959)	-	1,710	17,610	-	+ 15,900	
Marjon Lab (1964)	-	465	1,440	-	+ 975	
TOTAL		7,597	41,966		+ 34,369	

Source: U.S. Department of Commerce, The Role of New Technical Enterprises in the U.S. Economy, A Report of the Commerce Technical Advisory Board to the Secretary of Commerce, January 1976, Appendix A.

in isolation of employment in the innovative companies, the conclusion would be reached that the use of automated equipment has slowed down the rate of increase in employment. But, when account is taken of the employment associated with the production of the automated equipment, we find that the slowdown in employment expansion in mature companies has been more than offset by the substantial increase of employment in the innovative companies which produce the automated equipment. Note the employment of the innovative companies in 1945, and note their employment in 1969 and 1974--a twenty-fold increase. The same or similar development can be expected in relation to young high technology companies: these will contribute to a further slowdown of employment expansion in mature companies, but that slowdown will be more than offset by the increase of employment in high technology companies. Note the increase of employment in them between 1969 and 1974, and note the increase of employment in some such Canadian companies (Table 3).

The content of Tables 2 and 3, and the employment involved in the operation of computers and computer-related systems (examined in the three cases following as well as in various other parts of this report), show the true nature of the employment effects of technological changes. Over time, some industries and related employments and occupations decline and gradually disappear, while other industries and related employments and occupations emerge and gradually expand. Investigators who emphasize the first, but disregard or make only passing reference to the second, demonstrate their ignorance of the reality of technological change, economic development and employment relationships.

Table 3

Employment in Canadian High Technology Companies
(1980)

Company	When Established	Employment Initially	Employment Currently
Digital Equipment	1963	2	1,606
Mitel Corporation	1975	30	1,240
Systemhouse Ltd.	1974	20	574
COM DEV Ltd.	1976	25	80
SED Systems Inc.	1972	43	252
Geac Ltd.	1971	2	302
Dynalogic Corp. Ltd.	1973	1	20
Phoenix Ltd.	1975	12	60
Gundalf Data Ltd.	1971	2	594
Neeco Systems Ltd.	1957	8	155
Lumonics Inc.	1971	2	120
Multiple Access Computer Group	N/A	N/A	1,200
IBM	N/A	N/A	11,830
Canada Systems Group	N/A	N/A	1,200
Control Data Canada, Ltd.	N/A	N/A	1,900

Source: The Companies, and The Canadian Data Processing Directory 1980, published by Computer Data.

Section III: COMPUTER AND COMPUTER-RELATED SYSTEMS EMPLOYMENT

The operation and maintenance of computers and computer-related systems have significant positive employment effects. We examine below the nature and extent of such employment in three organizations.

Generally, the number and occupational mix of employees associated with the operation of individual computer and computer-related systems depends upon (a) the type of system in operation, (b) the nature of activity in which the system is put, and (c) whether the organization employing the system develops in-house software or purchases packaged programmes.

Considerable uniformity exists amongst industries in the occupational composition of employment in computer systems (Table 4): managerial/administrative occupations account for 12 to 19% of total employment; systems analysts make up about 12%, except in construction and distribution industries where they represent only around 6%; programmers make up about 20%; computer equipment operators account for 15 to 20%; and data entry clerks around 26%.

It is instructive to note that the high level occupations of managers, systems analysts and programmers constitute between 40 and 60% of employment--39.3% in distribution industries and 60.4% in public utilities. The occupational distribution within the latter is particularly instructive, since public utilities generally are on the forefront of automated electronic systems. They employ larger proportions of systems analysts and programmers, and a lower proportion of data entry clerks than any other industry group. This may be interpreted to suggest that as electronic processes become increasingly more integrated we should expect demand for systems analysts

Table 4

Percentage Breakdown of Data Processing Employment by Occupation in Selected Canadian Industries, 1980

	Primary.	Construction.	Manufacturing.	Transportation.	Public Utility.	Communication.	Distribution.	Financial.
Managerial/Administrative	17.4	18.7	12.5	13.3	13.8	12.7	16.1	11.7
Systems Analysts	14.6	6.2	11.0	10.5	15.5	11.6	6.8	14.5
Programmers	21.7	20.6	17.0	26.0	28.8	20.0	16.1	17.0
Professional specialists (engineers, operations research specialists)	0.6	-	2.2	0.5	2.3	1.3	0.3	0.3
Subtotal: Managerial & Professional	54.3	45.5	42.7	50.3	60.4	45.6	39.3	43.5
Computer & equipment operators	15.7	20.6	15.5	14.5	15.5	19.6	19.0	15.6
Data Control Clerks	4.8	5.7	5.8	4.3	5.2	6.2	6.7	6.8
Data Entry Clerks	24.7	28.2	25.3	26.4	18.6	25.9	34.6	32.7
Other	0.4	-	10.7	4.6	0.6	2.8	0.4	1.5
TOTAL	99.9	100.0	100.0	100.1	100.0	100.1	100.0	100.1

Compiled from, Canadian Information Processing Society, Canadian Salary Review, Toronto; CIPS.

and programmers to increase and that for data entry clerks to fall.

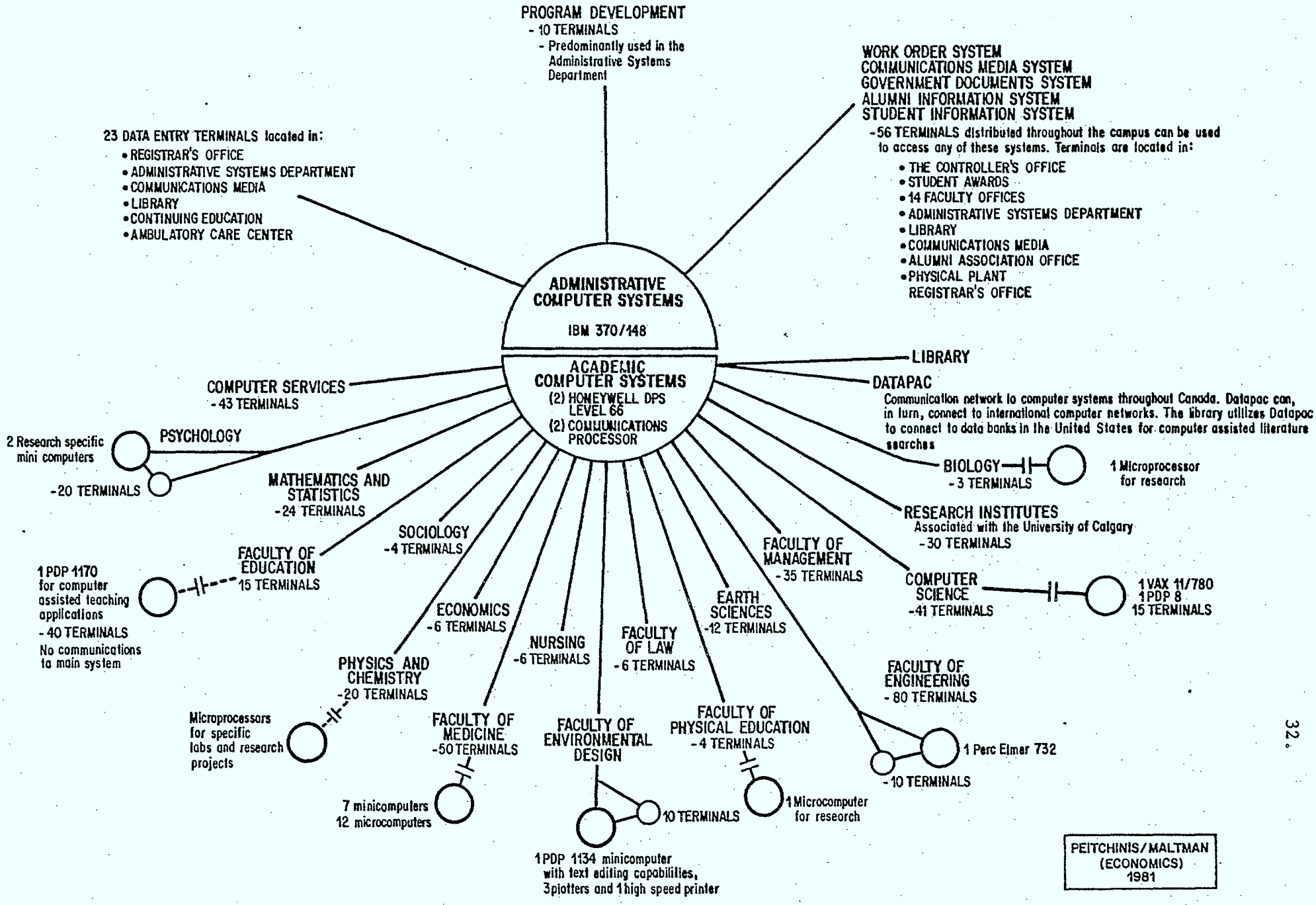
In this section, employment at three computer systems is examined: at a university, at a large petroleum company, and at a large food processor/wholesale/distributor.

Case 1: The University of Calgary Computer Services System

Figure 1 shows the existing computerized information network at The University of Calgary. There are two major computer systems--one serving the academic needs of faculty and students, and the other serving the administrative requirements of the university. In addition, there are minicomputer systems and microprocessor units devoted to specific research activities distributed among faculties and departments throughout the campus. In excess of 400 terminals located throughout the university and associated research institutes are currently linked to the main academic system.

Employment directly associated with the operation of the academic system is very atypical of most main frame computer installations. Only 36 persons are employed in positions directly associated with the system, 28 of whom are programmer-analysts, 5 computer operators, one operations supervisor, and one data entry clerk. But, these numbers are deceptively small. They fail to capture the many professors and researchers whose activities are directly related to the system. We have made no effort to determine the proportions of time allocated by such individuals to computer and computer-related activities, but it is common knowledge that many professors in engineering, mathematics and statistics, economics, psychology, etc. allocate substantial proportions of their time to such activities. In addition, there are 16 computer science professors, who although not related directly to the operation of the university's system, owe their employment to the advent of the computer. Hundreds of computer courses have been introduced by academic institutions and vendors of hardware, which created thousands of

COMPUTER SYSTEMS
THE UNIVERSITY OF CALGARY



PEITCHINIS/MALTMAN
(ECONOMICS)
1981

employment opportunities. When the final count is taken, these should not be forgotten.[8]

The employment structure of the administrative computer system is more typical of the occupational breakdown in computer installations of business organizations. Employment directly related to the computer's operation includes: 21 programmer analysts, 4 production analysts, 6 data entry personnel, and 5 computer operations staff. Activities are divided into 3 functions: programme development activities, information systems activities and data entry activities. Programme development activities involve designing, developing and implementing new administrative applications; whereas information systems activities involve operational computerized information networks including a student information system, alumni information system, a work order system, communications media system, and a government documents system. All these functions involve the recording, manipulation and communication of very large amounts of information.

Prior to the introduction of the information systems, activities such as student registration and student records were performed manually by clerical staff. The increase in numbers of students and courses, increased the numbers of clerical staff and the frustrations of both administrators and

---

[8] A survey of Computer Science and Process Control courses offered in Canadian universities and colleges found 490 undergraduate courses, 322 graduate courses, 78 evening extension courses, 46 short (summer) courses, and 15 off-campus courses in videotape, cassette or correspondence form. The development and presentation of those courses involves considerable employment. See: Canadian Pulp and Paper Association, Process Control Committee, A Survey and Tabulation of Computer Science and Process Control Courses offered in Canadian Universities, Montreal, 1979.

students. The production of official registration records took a long time; the processing of changes in course registration was long delayed; errors multiplied; and delays in the production and mailing of final year grades were creating difficulties in the planning of summer school sessions.

The introduction of computer systems did not reduce the employment of clerical staff. Rather, it reduced the time period involved in the production of information, reduced the number of errors, and increased substantially the amount of information.

The volume and nature of employment associated with the operation of the system are given in Table 5: 93 persons are employed directly and fully in positions related to the operation of the system. There are scores, of course, who are involved indirectly in inputting the system, analysing outputs and adjusting programmes, particularly amongst students and professors.

A number of significant indicators should be noted: one is the evidence that once a computer infrastructure is in place and the requisite manpower complement is employed on it, the system can be expanded into an extensive network with only minimal increments in manpower. For example, between 1973 and 1981 The University of Calgary network more than doubled, yet employment increased by only 13 positions (16%). The second notable indicator is the change in occupational mix. While total employment may remain relatively stable as a system expands, its composition undergoes significant changes: a notable shift is in evidence towards higher level professional and managerial/administrative classifications. In 1981 more than three-quarters of all personnel employed in the operation of the system were in such classifications. The third indicator is the decrease of employment in low level operational

Table 5

Computer Related Employment by Occupation - The University of Calgary
1968-1981

	1968		1973		1978		1981	
	No.	%	No.	%	No.	%	No.	%
Administrative	14	29.2	19	23.75	20	23.0	21	22.6
Systems Design & Programming:								
- Programmer Analyst I	3	6.3	6	7.5	6	6.9	4	4.3
II	4	8.3	12	15.0	3	3.4	15	16.1
III	1	2.1	7	8.75	18	20.7	7	7.5
IV	1	2.1	8	10.0	12	13.8	16	17.2
V	1	2.1	2	2.5	4	4.6	6	6.4
Production Analyst	0	0	1	1.25	2	2.3	2	2.2
Production Analyst (trainee)	0	0	0	0	2	2.3	2	2.2
Operations:								
- Data Control Supervisor	1	2.1	1	1.25	1	1.1	1	1.1
Internal Operations Supervisor	1	2.1	1	1.25	2	2.3	2	2.2
External Operations Supervisor	0	0	1	1.25	1	1.1	-	
Computer Operator I	4	8.3	5	6.25	4	4.6	5	5.4
II	1	2.1	4	5.0	3	3.4	5	5.4
Data Entry Supervisor	1	2.1	1	1.25	1	1.1	1	1.1
Data Entry Clerks	10	20.8	9	11.25	8	9.2	6	6.7
Unclassified	6	12.5	3	3.75				
TOTALS	48	100.1	80	100.1	87		93	100.1
Managerial & Professional	24	50.0	55	68.75	67	77.0	73	78.5
Operations & Data Entry	24	50.0	25	31.25	20	23.0	20	21.5

activities, such as data entry. A switch from batch to interactive systems facilitated VDT data entry directly from offices, thereby eliminating the need for the "assembly line" operational activities performed by keypunch operators. This is a common outcome of the introduction of on-line systems: the input process becomes part of other clerical activities performed within the office.

In summary, the very substantial extension of the computer network over the period 1973-1981 resulted in (a) moderate increase of employment, (b) significant increase in the proportion of professional and managerial/administrative personnel, and (c) an absolute decrease in the number of lower level employment activities. With the introduction of on-line systems, input functions which involved the employment of keypunch operators and data entry clerks are becoming part of general clerical activities.

A breakdown of employment by sex is given in Table 6: characteristically, women occupy most of the low level positions, and men most of the professional positions. Most of the 21 administrative positions are occupied by men, and men occupy 36 of the 48 programmer/analyst positions. Women occupy 12 of the programmer/analyst positions, and of these seven are in junior level classifications. Perhaps this reflects the more recent entry by women into the profession. Since seniority is related to employment experience, increasing numbers of them can be expected in senior level classifications over time.

Table 6

Computer Related Employment by Occupation and Sex - The University of Calgary, 1981.

	Total		Male		Female	
	No.	% of Total	No.	% of Total	No.	% of Total
Programmer-Analyst I	4	5.6	2	4.3	2	8.0
II	15	21.1	10	21.7	5	20.0
III	7	9.9	5	10.9	2	8.0
IV	16	22.5	14	30.4	2	8.0
V	6	8.5	5	10.9	1	4.0
Total - Programmer Analysts	48	67.6	36	78.2	12	48.0
Production Analyst	2	2.8	1	2.2	1	4.0
Production Analyst (trainee)	2	2.8	2	4.3	-	-
Operations Supervisors	2	2.8	2	4.3	-	-
Computer Operator I	5	7.0	1	2.2	4	16.0
II	5	7.0	4	8.7	1	4.0
Data Entry Supervisor	1	1.4	-	-	1	4.0
Data Entry Operators	6	8.5	-	-	6	24.0
Non-professional positions	23	32.3	10	21.7	13	52.0
TOTAL	71	99.9	46	99.9	25	100.0

Case 2: The Information Systems Department of a Large Petroleum Company

Employment in the petroleum industry is largely information-related employment. Only about 30% of employees are classified as production workers. The other 70% are managers, engineers, geologists, geophysicists, secretaries, and such other "non-production" workers. Hence, it is to be expected that the petroleum industry will be on the forefront in the application of computer technology.

The petroleum company whose Information Systems Department is examined here, is a major Canadian company, which has grown very rapidly in recent years. Total employment has more than doubled in the past five years. Hence, when the employment effect of the computer system is being considered, the question is not one of how negative the effect has been, but rather, how much the increase in employment may have been retarded by the application of computer technology. There is no way, of course, by which we can determine that, unless perhaps we were to make some unrealistic assumptions, such as for example, that the company would have expanded at the rate it did, without the utilization of computers and other electronic technology.

We do know, however, that the introduction of computer technology resulted in considerable employment in the company: new employment positions for managers, systems analysts, programmers, computer operators, data control clerks, data entry operators, and scores of other positions related to the application of the computer processes--a total of 109 positions in the most recent count, representing about 6% of the company's total employment at Head Office.

Table 7 contains the occupational distribution of employees in the Information Systems Department. It is a distribution typical of

Table 7

Occupational Mix by Sex of the Information Systems Department of a Large Oil Company.

	Total employment		Male employment		Female employment	
	No.	% of Total	No.	% of Total	No.	% of Total
Manager of data processing	1	0.9	1	0.9	0	0.0
Manager of computer resources	1	0.9	1	0.9	0	0.0
Manager - Administration	1	0.9	1	0.9	0	0.0
Manager - Systems Analysis	1	0.9	1	0.9	0	0.0
- Senior Computer Analysts	13	11.9	12	11.0	1	0.9
- Junior Computer Analysts	7	6.4	4	3.7	2	1.8
Manager - Programming	1	0.9	1	0.9	0	0.0
- Senior Programmers	11	10.1	7	6.4	4	3.7
- Junior Programmers	19	17.4	12	11.0	8	7.3
Manager - Data Base Administration	1	0.9	1	0.9	0	0.0
- Data Base Analysts	6	5.5	5	4.6	1	0.9
Manager - Computer Operations	1	0.9	1	0.9	0	0.0
- Tape Librarians	6	5.5	0	0.0	6	5.5
- Data Control Clerks	4	3.7	3	2.8	1	0.9
- Computer Operators	13	11.9	8	7.3	5	4.6
- Scheduling Clerk	1	0.9	0	0.0	1	0.9
- Data Entry Operators	13	11.9	0	0.0	13	11.9
Systems Security Specialist	1	0.9	1	0.9	0	0.0
Hardware Planner	1	0.9	1	0.9	0	0.0
Secretaries	7	6.4	0	0.0	7	6.4
TOTAL	109	99.7	60	54.9	49	44.8
Totals						
- Managerial	7	6.4	7	11.7	0	0.0
- Professional	58	53.2	42	70.0	16	32.7
- Other	44	40.4	11	18.3	33	67.3
GRAND TOTAL	109	100.00	60	100.0	49	100.0

information systems departments--heavy on the side of managerial and professional occupations, which constitute almost 60% of the total employment. Whether so many managerial positions are necessary for the efficient utilization of the system, or whether such positions are dictated by the tight market for persons knowledgeable in systems operations and the resultant need to pay salaries that are associated with managerial positions, cannot be determined at this time.

Two further comments are warranted: one is, the employment of only seven secretaries in a department of 109, which manifests capital substitution in the handling of information; and the other is, the predominance of men in managerial and professional positions. Apologists will undoubtedly rationalize that women have not yet entered the professional field in adequate numbers, and those who have entered have not had adequate experience for the managerial positions. Also, they will point to the positive evidence of three out of twenty computer analysts, and twelve out of thirty programmers--relatively small numbers, but evidence of penetration into a field of employment activity that is expanding very rapidly. This evidence indicates perhaps a trend in female employment away from secretarial/clerical and towards professional and semi-professional occupations.

Case 3: A Food Processor/Wholesaler/Distributor

The Information Resources Department of this company had a manpower complement of 108, distributed amongst six divisions and thirteen occupational groups. Table 8 contains the distribution amongst divisions, and the work-functions assigned to various occupational categories within each division; and Table 9 contains the occupational distribution, identified by sex, to the limited extent to which the information was available.

The divisional distribution provides perhaps an indication of the nature of activities that are involved in a comprehensive information system, and the occupational groups that are involved within individual activity areas. Thus, the Information Systems Division is involved in the determination of the information requirements of the organization, and the development, implementation and maintenance of systems for the attainment of the determined requirements. These are high level activities, and that is reflected in the occupational composition of personnel involved in them: the entire complement is constituted of managers and professionals. The Information Facilities Division is the operational division: it directs planning and technical support of computer and telecommunications facilities, provides computer services, and it is generally responsible for the maintenance of an operational infrastructure which will fulfill the organization's requirements. The Division's manpower complement reflects an operational system: computer operators, data entry control clerks, data entry operators--predominantly non-professional occupational groups.

Those are the two main divisions. There are then the Data Base Administration Division, involved in data base design, problem solving, access control, and training programme coordination; the Management Sciences

Table 8

Information Resources Department of a Food Processor/Wholesaler/Distributor

Division	Manpower	Functions
Information Resources	1 Director	
- Financial Control	1 Analyst	Co-ordinates and controls financial activities in the Information Resources Department.
- Administrative Support	1 Administrative Secretary 1 Secretary	Provides administrative support to management and professionals in the Information Resources Department.
Information Systems	1 Manager	Directs the planning and implementation of management information systems.
- Business Systems	2 Managers	Determine systems requirements of the organization.
- Systems Development	1 Manager 4 Project Managers 6 Analysts 11 Programmers	Design, implement and assess business information systems.
- Systems Maintenance and Control	1 Manager 3 Coordinators 11 Analysts	Provide maintenance support and quality control on new and operating systems.
Information Facilities	1 Manager 1 Secretary	Directs planning and technical support of computer and telecommunications facilities.
- Computer Services	1 Manager 1 Supervisor 2 Operations Analysts 3 Planners 5 Computer Operators 4 Data Control Clerks 4 Data Entry Operators	Provide computer services and technical support for computer facilities.

Division	Manpower	Functions
Information Facilities cont'd		
- Technical Services and Support	1 Manager 4 Analysts	Control activities relating to the operating system and provide software package support and maintenance.
- Telecommunications	1 Manager 1 Console Attendant	Plans, monitors and controls telecommunications.
- Facilities Planning and Control	1 Manager	Plans the aquisition of computer hardware and telecommunications equipment.
Data Base Administration	1 Manager 3 Analysts	Data definition, standards and access authority.
- Technology	1 Specialist 1 Analyst	Senior consultation for problem solving.
- Education	1 Coordinator	Coordinates training programmes.
Management Science	1 Manager 3 Specialists 2 Analysts	Mathematical and Statistical Modelling and Operations Research.
Record Management	1 Manager 1 Technician	Plans designs and administers records and forms
	2 Administrators 3 Analysts	Coordinate information retrieval, security and computer output on microforms and systems Produce policy and procedure manuals.
Office Systems	1 Manager 1 Analyst	Plan and develop automated office systems
	11 W.P. Operators	Provide text editing, TWX, Telex and voice communications services.

Division, involved in mathematical and statistical modelling and operations research; the Records Management Division, involved in the design of forms, policy and procedure manuals, and the coordination of information retrieval and security; and the Office Systems Division, involved in planning and development of automated office systems, and in secretarial (text editing, TWX, telex) services.

The occupational distribution of the manpower complement (Table 9) reflects the specialized nature of computer system activities, and the state of the market for systems specialists: of the total manpower complement of 108, almost three-quarters are systems analysts; and of them 18 are managers, reflecting the extreme tightness of the market.

It is instructive to note (Table 8) that the entire department is served by only three secretaries, one of whom is the department's Administrative Secretary, who also employs one of the other two secretaries. But, there are word processing operators, data control clerks, data entry operators, and a console attendant, all of whom are former clerks and secretaries. Hence, what we are witnessing is an adjustment to technological change, not much different from the adjustments that have been recorded through history. Work functions change and with the change in work functions job titles, job classifications and job descriptions will change. Some secretaries will become "assistants," some will become "word processing operators," some will become "specialists," and others "advisors," "counsellors," and so on. It is not possible to determine at present the nature of occupational concentrations that will emerge from the on-going changes in computer and telecommunications technology. The electronic infrastructure is still in the very early phase of development. What will

Table 9

Occupational Breakdown of the Information Resources Department of a Food Processor/Wholesaler/Distributor.

Occupation	Male	Female	TOTAL	% of total employment
Managers	17	1	18	16.7
Coordinators/Supervisors/ Administrators	5	3	8	6.5
Analysts	N/A	N/A	34	31.5
Programmers	N/A	N/A	11	10.2
Specialists (Management Science and Technology)	5	0	5	4.6
Planners	3	0	3	2.8
Subtotal - Professional and Managerial employment			78	72.3
Computer Operators	N/A	N/A	5	4.6
Data Control Clerks	N/A	N/A	4	3.7
Data Entry Operators	N/A	N/A	4	3.7
Word Processing Operators	N/A	N/A	11	10.2
Technicians	N/A	N/A	1	0.9
Console Attendant	N/A	N/A	1	0.9
Secretaries	0	3	3	3.7
TOTALS			108	100.0

ultimately emerge, and what manpower complements and occupational groupings will be required for its efficient functioning, is anybody's guess.

The occupational breakdown by sex was made available for senior positions only--managers, coordinators, planners, supervisors, administrators and professional specialists (other than analysts and programmers). The total number of such positions was 34, of which four were occupied by women. Assuming women occupy most of the non-professional positions, such as data control clerks, data entry operators, word processing operators, and computer operators, then it can be concluded that women continue to predominate in low-level employment positions. But, then, this would be a natural outcome of the failure of women to enter into programmes which produce computer and systems-related specialists. Considering the general shortage of systems analysts and programmers, and considering further that most senior positions in systems departments are occupied by such specialists and by other persons knowledgeable in computer systems, the absence of greater female representation must be attributed to inadequate numbers.

Concluding Remarks

The information contained in this section provides a reasonably good indication of the nature of occupational specializations and occupational complements that are required for the operation of computer and computer-related systems. Generally, the manpower mix appears to be 50% managerial and professional and 50% non-professional.

It would have been most instructive from the standpoint of employment and manpower planning implications if we could have determined the effects on total employment within the respective organizations. But,

aside from the fact that we did not have access to the required personnel information, most changes in the number and nature of activities introduced as a result of the implementation of computer systems are generally regarded as the first step, the initial phase, of a continuously changing infrastructure. No one, not even the most knowledgeable, could say what level of employment and occupational mix will emerge when full integration of electronic systems is attained. We know that the systems in operation currently have contributed to substantial increases in efficiency in records management, text editing activities, and high volume clerical activities. We also know that the computer increased manyfold the production and manipulation of data. Scores of activities are now being performed which could not have been performed in the absence of computers and computer-related systems. The critical issue is what are the employment implications of the flow of this additional information through the organization, and what are the manpower implications of these extra activities which could not have been performed in the absence of computers and computer-related systems. This we have not been able to determine.

Employment data suggest that the introduction of computer systems created considerable related employment: new enterprises have sprung-up to provide consultative services; new professional and semi-professional occupations have been created; and a score of operative employment positions have been established.

The effect on the overall employment of establishments utilizing computer systems depends on the rate of increase in their activities. Establishments which recorded rapid increases in activity, recorded increases in overall employment; which suggests that the increase in productivity associated with the computer systems was offset, in whole or in part, by the increase in

activity. Furthermore, the evidence suggests that in addition to more information of the kind produced prior to the introduction of the computer systems, in all cases the computer systems produce different kinds of information--the kinds which could not have been produced by convential processes. The deployment of computer systems in the production of such additional information does not have a direct labour substitution effect; unless it is assumed of course, that ways would have been found to produce that additional information with manual or manual/mechanical processes, and that more employment would have been created in the process than was created by the introduction of the computer system. But, such an analysis is highly speculative, and serves no practical purposes.

Finally, it is instructive to note the similarity in employment in the three computer systems examined above--The University of Calgary, the Petroleum Company and the Food Processor/Wholesaler/Distributor. They are different systems, processing different kinds of information, yet they employ roughly the same numbers of people and the same occupational mixes.

It is equally instructive to emphasize again the evident stabilization in system-employment ratio. It would appear that once a system is established and an appropriate manpower complement is employed on it, the capacity of the system can be expanded very substantially with only minimal additions to system related employment.

Section IV: TECHNOLOGICAL TRENDS AND EMPLOYMENT IMPACTS IN THE TELECOMMUNICATIONS INDUSTRY

The telecommunications industry introduced many technological changes over the past several decades. Table 10 contains a fairly detailed summary of the changes that have taken place, the nature of certain pending changes, and the effects on employment, occupations and skills in the industry. The information relates to the experience of two telephone companies.

Special attention is given in the discussion to five innovations whose effects on employment and the occupational structure have been significant, and which are expected to continue to have significant effects over the next two decades. The innovations are: electronic switching systems, digital transmission systems, computerized toll switchboards, on-line computer communications systems, and fibre optics technology.

Electronic Switching Systems

Technological innovations in switching systems are computer based. The change reflects a movement from electromechanical systems to programme controlled electronic systems.

The electronic systems have the capacity to perform self-diagnostic functions, fault detection and location, equipment testing, and traffic flow monitoring--functions that are not feasible under the electro-mechanical systems. Other advantages are found in the substantial increase in system capacity, the greater reliability of electronic components, the ability to duplicate critical components, and the ability to automatically re-route calls around faulty or overloaded modules in the system.

Employment Effects

Introduction of the electronic switching systems affected the employment of a number of occupational groups: most affected were craftsmen involved in the installation, repair and maintenance of the electromechanical systems. The greater reliability of the electronic components, the increased use of modular components with plug-in connections, and the increased capacity of the electronic systems, reduced the need for installation, repair, and equipment maintenance services. Secondly, the technical complexity of the system dictated increasing reliance on systems and equipment specialists for installation and maintenance. This had a dual effect: it increased demand for such specialists, and it decreased the involvement of management in the technical side of operations. Reports indicate a pronounced shift in management functions, from technical activities to general administrative and operational activities. Budgeting, staff development, productivity assessment and product development have assumed increasing prominence in the allocation of management time. Thirdly, the use of "turn-key" systems, whereby engineering and installation are performed by manufacturers, reduced the demand for engineers. Finally, a few positions were created for instructors, and a small number of highly skilled individuals were employed to deal with the more complex technical problems associated with such systems.

The general effect on skill requirements are difficult to assess: the use of plug-in components has made some jobs simpler; on the other hand, the technological complexity of the system increased the requirements for knowledge in computer logic and electronic circuitry.

Table 10

TECHNOLOGICAL TRENDS AND EMPLOYMENT IMPACTS IN THE TELECOMMUNICATIONS INDUSTRY

Technology	Employment Groups Affected	Impacts on Knowledge and Skill Requirements		Impacts on Employment	
		Positive	Negative	Positive	Negative
SWITCHING DEVELOPMENTS - Electronic switching systems - local and long distance	- Central office installation and repair crafts	- increased requirements for electronics and programming knowledge.	-reduced requirements for mechanical skills.	A few positions are created for high skill computer and electronics specialists to deal with involved problems. These individuals generally operate out of centralized locations.	Repair and maintenance activities are greatly reduced, therefore labour requirements are reduced.
	- Equipment maintenance forces	- increased requirements for computer and electronics knowledge.	-generally a reduced level of training is required because most maintenance is merely replacing circuit cards based on machine diagnostics.		
	- Operator forces	-	-		The increased service capabilities of the system will reduce requirements for operators.
	- Engineering application forces	-	-		Because the applications engineering activities are generally transferred to the manufacturers of the more compact electronic switching systems requirements for engineering applications forces and reduced.

Table 10 cont'd

Technology	Employment Groups Affected	Impacts on Knowledge and Skill Requirements		Impacts on Employment	
		Positive	Negative	Positive	Negative
TRANSMISSION DEVELOPMENTS					
- Fibre optics systems	- Line and cable crafts - Central office crafts	- increased requirements for electronics skills.	- reduced requirements for mechanical skills.	Small number of positions for high skill technical positions.	The increased capacity of the systems reduce labour requirements.
- Satellites	- Line and cable crafts	"	"	"	By removing dependence on land lines, satellites result in decreased requirements for labour.
- Cellular Mobile Communications	- Operator forces	-	-	-	The use of electronic switching systems greatly increases mobil calling capacity, thereby reducing the need for mobil service operators.
- Digital Transmission	- Line and cable crafts - Central office crafts - Equipment maintenance forces.	"	"	"	Increased capacity of the digital systems result in reduced requirements for labour. In addition increased reliability of electronic components and the use of plug-in modules reduced the demand for equipment maintenance forces.
- Loop electronics, loop switching system	- Line and cable crafts - Central office crafts		"	"	Increased capacity and reduced line installation results in reduced labour requirements.

Table 10 cont'd

Technology	Employment Groups Affected	Impacts on Knowledge and Skill Requirements		Impacts on Employment	
		Positive	Negative	Positive	Negative
COMPUTERIZATION DEVELOPMENTS					
Maintenance - Trunk line tests - Crossbar switch tests - Wiring Assignments - Remote office line tests - Line status verifier - Mechanized loop test - Alarm surveillance and control systems - Switching Control Centre - Automated repair Service.	- Central office installation and repair crafts - Line and cable crafts - Station installation and repair crafts - Engineering and programming forces.	- increased electronic and technical skills. - requires familiarity with computers and programming skills.	- reduced mechanical skills required.	Results in the creation of a very few positions for highly trained electronics and computer experts.	Electronic switching systems and stored programme control tend to result in a consolidation and centralization of repair and maintenance services. Most testing is performed automatically so that labour requirements are generally reduced.
Operations - Traffic service position - Auto intercept - Auto directory assistance - Automatic coin telephone - Rural trunk arrangement - Automatic message accounting - Computer assisted toll switchboards.	- Operator forces - Clerical forces	- some personnel with computer knowledge required.	- eliminated most paper handling activities and operator-customer interaction.	Very small number of computer related positions.	These computerized operations systems tend to consolidate operations and speed the handling of operator-assisted calls thereby reducing the requirements for operators and clerical personnel.

Table 10 cont'd

Technology	Employment Groups Affected	Impacts on Knowledge and Skill Requirements		Impacts on Employment	
		Positive	Negative	Positive	Negative
Computerization Developments cont'd					
Recordkeeping - On-line business information systems - Facilities assignment and control - Loop maintenance operations system.	- Clerical forces in all departments.	-some personnel with computer knowledge required.	- eliminates many traditional clerical activities and paper handling duties.	A small number of computer related positions.	The recording of all information in a computerized data base system eliminates paper handling and consolidates functions, resulting in a reduction in the number of low level clerical positions.
MICROELECTRONICS - Very large scale integration - Minicomputers - Microprocessors - Charge coupled devices - Bubble memories.	- Potentially effects all activities.	-some computer related knowledge required.		Developments in microelectronics which greatly reduce the size and cost of equipment create possibilities to perform functions which were not feasible with prior technologies. This includes the possibility of developing in-house microprocessor based control and surveillance systems.	To the extent that developments in microelectronic technology result in improvements in the efficiency of existing activities, labour requirements will be reduced.

Digital Transmission Systems

Until recently, telephone service tended to be divided between subscriber facilities and central office switching systems. Under such systems, subscriber telephone service is provided using paired copper cables which connect each telephone to a central office switching system. The central office contains all the electronic equipment for transmission over the copper cable as well as the switching logic and equipment to connect subscribers with other switching centres. This results in a natural division of employees into "field" and "central office," since the skill requirements to lay cables and splice wires are significantly different from those required to maintain and adjust the central offices electronic equipment.

The integration of digital carrier equipment with central office digital switching is expected to impact significantly on employment, job functions, educational and skill requirements. As more electronic equipment is introduced in the field, more technically trained personnel will be needed to maintain and adjust the equipment. However, because of the increased capacity and reliability of the electronic equipment, the demand for craftsmen is expected to decrease.

Furthermore, the integration of digital transmission and switching systems will use more pre-engineered modular plug-in system packages. This will result in a considerable simplification in engineering work, a reduction in installation workloads, and a shift in job functions from line and cable craftsmen to systems testing. This, too, will have a negative effect on the employment of craftsmen.

Since testing of the system will be carried out automatically, and since fault location will be carried out by computers, such a shift in

functions is not expected to have significant positive employment effects.

The overall employment effect of the digital transmission systems is expected to be negative: demand for installation, repair and maintenance services is expected to decline, which means a decrease in employment of craftsmen. In addition, the advent of modular plug-in systems is expected to have a diluting effect on craftsmen's knowledge and a deskilling effect on their technical expertise. Although an increase is expected in demand for manpower with knowledge of electronic circuitry and computer logic concepts, that is not expected to be of a magnitude that would offset the decrease in demand for craftsmen. Therefore, on balance, the effect is expected to be negative.

Computer Assisted Toll Switchboards

Computer assisted toll switchboards have had a significantly negative effect on the employment by telephone operators. Before their introduction, most toll calls had to be made through an operator. The operator recorded the number being called and the calling number, and made the connection manually. Having made the connection, the operator then monitored and recorded the length of the call.

With computer assisted toll switchboards most toll calls can be made without operator intervention. Calls requiring operator assistance are indicated by a special dialing sequence, and are automatically routed to a central computer which records the calling number and the number being called, then the operator is automatically brought on line to determine the type of call that is being made. The information is keyed into the computer and the operator stays on the line only until the call is connected, after which the computer takes over, noting the disconnect time and routing relevant information to the computerized accounting system.

There are no estimates of the resultant increase in efficiency and the magnitude of negative effect on the employment of operators. It is well known that the effect was significantly negative. Not only did most of the traffic by-pass the operator totally, but instances in which operator intervention was necessary, the intervention time was reduced by 25 to 45%!

Operation of the computer assisted toll switchboards did not involve the acquisition of any significant amount of new knowledge. A training period of about six days was provided, whose purpose appears to have been to accustom operators to the change rather than to teach them the operation.

Nevertheless, operators did experience a significant change in work-activity: the computer spread the call traffic more evenly amongst operators; but, it took away from operators control over the number of calls each handled, and thereby forced them to pay more attention to the demands of the computer system than to callers. Those amongst them who had become accustomed to the old system, found the new one too impersonal.

On-Line (Interactive) Computer Communications Systems

The on-line computer communication systems include a traffic data collection system, service order system, automated accounting systems, and other data-base business information systems. Previous systems were basically manual with a few mechanized functions. The transmission of information between departments was paper-based and required multiple documents. Errors were frequent and corrections and changes were time consuming. Even in activities such as billing, which were partially computerized, the interface with the central computer was on a batch basis, requiring large amounts of coding, keypunching and other manual activities

before the information was in the form required by the computer system. Information for special internal studies was for the most part manually compiled.

Under the interactive data base systems most of the manual activities involved in the ordering system, billing system and traffic data collection system are eliminated. Forms are now stored in the computer's memory, and can be completed via remote terminal facilities. Corrections are more easily made, and transmission of information to other departments is done automatically by the computer. Information on billing is automatically entered into a data base in the computer's memory. Information for special studies can be easily accessed, sorted and manipulated by the computer.

The on-line systems affected the employment and job functions of many classifications of employees. Within the managerial classification, personnel in accounting, financial and other business information activities had to acquire new knowledge and become accustomed to new processes and procedures; the number and proportion of technically qualified personnel increased substantially; and management personnel who did not have a technical orientation, became increasingly involved in purely administrative activities, such as, staff development, budgeting, and inter-departmental coordinating activities. Some of these activities acquired increasing importance with the introduction of inter-connected on-line systems, since cross-departmental effects can result in inter-departmental conflicts, and dissipate the potential efficiency of the new systems.

Within the secretarial and clerical classifications both numbers and job functions changed significantly: most routine, high volume manual clerical activities, such as recording, filing, retrieving

and compiling information, and most paper handling activities disappeared; work flows became more formally structured; and for those who retained their positions and became accustomed to the new environment, work generally became more interesting. But their numbers fell, despite a very substantial increase in demand for services.

Within the technical and operational classifications employment increased: additional positions were created for systems analysts, system designers, software specialists and programmers. But, scarcity of such specializations precluded the increase in employment by the number of additional employment positions that were created.

On the other hand, it is said that shortages of specialized manpower have held back the rate of system implementation and the full utilization of the existing system. The question arises how much short term manpower displacement would have taken place if the specialized manpower were available and the system were utilized to its full potential. The results indicate a negative effect on balance, although it is difficult to estimate the magnitude.

Fibre Optics

The use of fibre optics in transmissions systems is expected to have significant negative effects on both employment and skills.

The transmission technology currently used in the telephone system requires the installation of amplifiers every half mile to maintain the quality of conversation. Optical fibres can carry information up to 50 miles, and are virtually immune to outside interference. In addition, they are very flexible and unbreakable, which makes their installation easier than copper wires. Therefore, their introduction is expected to

reduce significantly the installation and maintenance workforce, and the skill required of installation and maintenance craftsmen. The laying of fibre optic transmission systems merely involves the plugging-in of connectors.

Finally, optical fibres significantly increase the capacity of transmission systems, which is expected to reduce requirements for equipment maintenance forces, and line and cable craftsmen.

Summary and Conclusions

The application of computer, microelectronic and other technologies in the telecommunications industry has had widespread effects on employment in the industry: the introduction of automatic testing of lines, the increase in reliability of electronic components, and the use of plug-in modular component systems reduced the requirements for line and cable craftsmen and equipment repair employees; the increasing use of "turn key" systems, in which applications engineering work is done by the manufacturer, reduced the requirements for in-house engineering manpower; introduction of computer assisted toll switchboards, reduced the requirements for operators; and computer logging of calls, calculating charges, posting and billing reduced requirements for clerical personnel.

But, the employment effect has not been all negative: although on balance it was significantly negative, a substantial number of new positions were created for computer related operational, technical and professional occupations.

It is relevant to record that notwithstanding the notable technological changes in the industry, and the evident negative effects on employment and skills, there is no evidence of significant resistance from adversely affected employees. The explanation for this will be found in two concurrent developments: one is the gradual conversion to electronic technology--in many parts of the system electronic and electromechanical processes functioned parallel to one another over prolonged periods of time--which enabled the industry to retrain, upgrade and transfer employees to alternative employments; and the other is the coincident rapid growth in telephone and telecommunications traffic. The industry was able to provide assurances to most employees that their employment was secure.

Section V: THE EMPLOYMENT IMPACT OF AN ON-LINE DATA BASE SYSTEM IN THE INSURANCE INDUSTRY

Most activities in the insurance industry, from the actuarial work of determining product pricing to the sale and processing of insurance policies and claims, revolves around the recording, manipulation and transmission of information. Because the industry is highly information intensive its activities are particularly amenable to microelectronic-telecommunications based information systems. This has resulted in predictions of job losses in the 30% range as a consequence of the introduction of computer/telecommunications technology in the industry.

The company to which reference is made in this report has employed computer technology for quite some time. But, the most significant changes in occupational mix, employment and job functions have resulted from the recent implementation of an on-line data base computer information system which links the head office with regional offices. The system replaced a partially automated batch computer system where a central computer located at the head office performed a small number of activities.

Under the batch system, the information stored in the computer's memory could only be altered or accessed through the inputting of punched cards at the head office. Requests for information or changes to policies from regional offices were forwarded via telephone or mail to head office where they were coded and punched. Periodic computer runs were made to input changes in the permanent files on computer tape, or to access the requested information. Output from the system for the regional offices was then distributed by mail or courier. Because considerable time elapsed between the request for information and its subsequent receipt, the regional offices maintained

duplicate paper-based filing systems on policies and claims.

Under the on-line system, video display terminals in all of the company's offices are in direct communication with a central computer and data bank, so that information on policies and clients can be directly accessed, and changes to information in the data bank can be made directly.

The decision to implement the new technology was prompted by a number of factors, including the ability to eliminate the duplicate paper-based filing systems at the regional and head offices; the ability of the system to generate improvements in service delivery time; and the quest for greater efficiency in the sale and processing of insurance policies and claims.

The system had a number of effects on activities at the head office and the regional offices: the ability of regional offices to interface directly with the centralized data bank meant that the need to maintain duplicate paper-based filing systems was eliminated, as was the need to phone or write head office to obtain information from their files. These activities could now be performed directly via the V.D.T.'s. At head office, the time required to access information decreased from hours, and in some instances days, to mere seconds; the system's inter-active capability eliminated the need to keypunch coded information changes and information requests; the use of the same data base by everyone in the Company, ensured greater accuracy and consistency in policies and claims processing; and the availability of large amounts of data--incoming continuously, stored and manipulated--facilitated a more efficient analysis of the impact of various factors on product pricing.

Impact on Employment

The overall impact on employment was negative: 234 employment positions were eliminated, and 13 new positions were created. Although data on total employment were not made available, verbal comments placed the reduction at around 20%.

The most severe negative impact was recorded in clerical positions whose activities involved the manual recording, filing, retrieval, compilation and dissemination of information (Table 11). Equally, the processing of most transactions directly via VDTs reduced significantly the employment of keypunch operators; and reductions in the order of 33% were recorded in secretarial positions generally.

Company officers expressed the view that the negative effect on overall employment was only temporary. The increase in efficiency, which was estimated at around 27%, was expected to increase demand for services and thereby increase employment. When demand catches up and eventually exceeds the increase in productivity, overall employment will be restored to and even exceed previous levels.

The negative effect on employment at the clerical and secretarial categories was offset in part by positive effects on computer and systems related employments. Thirteen additional positions were created for systems design and programming specialists, and for technical support workers knowledgeable in computer and telecommunications technology. Total employment in the systems department of the company increased from 101 to 114.

The increase in employment was very modest for such a major extension in the computer/telecommunications network of the company. But

Table 11
Work Functions and Employment Groups Affected by the Introduction of On-Line Data Base Systems in the Insurance Industry.

Activity	Work functions prior to the introduction of the on-line computer system	Work functions after the introduction of the on-line system	Number of Employees Before	Number of Employees After	Percentage Change Employment
System for processing major changes to insurance policies. e.g. Plan, amount etc.	- Prior to the introduction of the system all changes were done manually. Changes in premiums and cash values were manually calculated, coded and subsequently keypunched to alter the tape file on existing policies.	-With the on-line system the cash surrender value, premiums and reserves are immediately accessible via V.D.Ts. The appropriate adjustments to the tape files can now be directly accomplished with the V.D.T's.	57	37	↓35%
Requesting and processing of dividend and loan cheques.	- A form was completed at the regional office and mailed to the Head Office, where the cheque was manually typed. The accounting department's record of the cheque was then keypunched to adjust the tape files.	-Now, the cheque request is submitted via VDT from the regional office and the computer automatically issues the cheque.	Reduction of 9 positions for typists, cheque approvers and correspondents.		Not available
Obtaining a history of the transactions on a specific policy.	- Manually reviewed the file on tape and sent a hard copy of the information to the individual requesting information.	-Now, information about any policy can be accessed via VDT. In most cases no hard copy is necessary.	12	1½	↓87.5%
Changes of beneficiary, name and ownership.	- Changes of this type required the original application from the file. The appropriate changes were made, coded and keypunched to adjust the records.	-Most changes can be made from the regional offices via VDTs.	24	16	↓33.3%

Table 11 cont'd

Activity	Work functions prior to the introduction of the on-line computer system	Work functions after the introduction of the on-line system	Number of Employees Before	Number of Employees After	Percentage Change Employment
Changes of Address.	- Forms were completed manually and sent to head office where they were coded and keypunched to adjust the tape file.	-Address changes are made from the regional offices via VDTs.	14	9	↓ 35.7%
Date entry.	- Most changes to existing files were made by keypunching manually coded change forms.	-With the on-line system most transactions are processed via VDTs.	Keypunch operators 78	22	↓ 71.8%
Regional office employment.	- In almost all work activities there was a large clerical component.	-With the new system much of the number crunching, filing and paper handling activities have been reduced or eliminated.	Reduction in low-level clerical positions for file clerks, stenos and individuals involved in paper handling. 831	693	↓ 16.7%
Comuter Systems Department.	- The computer personnel associated with the previous system were oriented towards batch data processing. Since there were no communications linkages between offices no personnel with communications expertise were required.	-With the introduction of the on-line data base system there was an increased need for technical support programmers and analysts with a knowledge of both computer and telecommunications equipment to develop, implement, maintain and operate the new system.	Computer Operators 24 Technical Support 12 Analysts and Programmers 65 Data Communications Controller 0	24 16 73 1	↑ 12.9%
TOTAL			1,126	892 - 234	20.8%

reference was made earlier to a similar outcome from a major network extension, which confirms perhaps the conclusion reached in relation to that case. It suggests that the technical capacity of computer systems, and the technical and operational capacities of the manpower mix employed in their operations, are such that their services can be expanded widely with only a minimal increment in central hardware and specialized manpower. Here we have the conversion of a partially automated batch computer system with a central computer located at head office, into an on-line data base computer information system linking head office with all regional offices, yet the increment in manpower involved in its operation is only 13 persons--one with knowledge of computer and telecommunications networks, 4 telecommunication technical support programmers, 6 systems analysts and programmers with knowledge of interactive computer systems, and 2 technician/programmers with knowledge of telecommunications network facilities and hardware/software monitoring and tuning communications systems.

Impact on Work Functions

The impact on work functions is said to have been positive: work activities are less repetitive, more interesting, and generally more satisfying. A company spokesman wrote: "... data processing has allowed us to transfer a number of mundane tasks to the computer and, as a result, we are in a position to design jobs that are more satisfying to the individual because we are able to consolidate a number of functional tasks that were necessarily designed on an assembly line basis under prior technologies. This, therefore, allows us to create jobs where an individual has the ability to do a total job ... rather than just being one step in a total process." It was generally expected that the negative employment effect on lower level positions would continue, but the new jobs that will emerge will be more challenging and more satisfying.

Section VI: THE ELECTRONIC OFFICE - ITS NATURE AND IMPLICATIONS FOR EMPLOYMENT

Introduction

The electronic office is an integrated electronic system which links together in an interactive whole computers, word-processors, intelligent copiers, information bases, fascimile transmitters, teleprinters and video conferencing equipment. Such complete integration does not yet exist; but, partially integrated systems have been installed.

The stimulus to office automation emanates from three sources: the availability of office equipment at prices which make it accessible to a wide range of enterprises; the relatively low productivity of office operations and the concomitant high and rising operating costs; and the widely prevailing notion that standard, largely labour intensive, office processes, have been a barrier to the expansion of activity.

Heretofore, capital investment in office processes has been relatively low: estimates indicate a capital investment per office worker of between $2,500 and $3,000. By comparison, the average capital investment per worker in manufacturing is estimated at between $25,000 and $30,000 or ten times the average per office worker. This very substantial difference in capital investment is regarded a major causal variable in productivity differences, and in differences of operating costs.

Although prices and costs are commonly emphasized in justifications for investment in office equipment, equal emphasis is now put on the capacity of the equipment to perform tasks which cannot be performed with standard processes. A common response to the question of advantages is that computers and computer-related systems perform work functions which

were not even thought of prior to their introduction, and that they facilitated the provision of services which could not have been provided without the electronic systems.

Adjustment problems indicate a slow rate of introduction: this is not a mere piece of equipment to be installed in an office, nor is it just a computer which has significant implications for the work process, but effects directly only a few. It is a system of communication, with implications for entire organizational structures, introducing entirely different methods of communication than those to which people have been accustomed: people want to verbalize, face to face or over the telephone, they want to visit, to ask questions and to get answers from people not from inanimate objects, and people want to be in contact with other people in the work process. Even where only partial integration has been introduced, the work environment has become eerie--a graveyard of silence: telephones do not ring, people do not talk, typewriters do not clang. The silence is so intense and overpowering, the unaccustomed tend to either want to scream or to whisper.

Upon examination of all variables that bear on the subject, we have concluded that the integrated office will not become commonplace as long as the equipment continues to create an alien working environment. As a recent article in The Economist stated: "secretaries, and executives are not (nor do they want to be) programmers and systems analysts. Equipment manufacturers have not yet got the message."[9]

Another problem, this one of a technical nature, is the

---

[9]December 27, 1980, p. 56.

integration of the numerous pieces of equipment into an effective system. Individuals knowledgeable of the technology concede that it will take a long time, and very considerable developmental and operational costs, before integrated systems become operationally efficient. At the present stage of the technology, the computer and the peripheral parts are more efficient individually than as an integrated whole.

A further problem is the difficult problem of software. Unlike the manually operated mechanical technology of the distant past, and unlike the electrically operated and labour attended mechanical technology currently in use, electronic technology has to be instructed to perform. The language of instruction is very difficult, and the more complex the process the more difficult it becomes. Communication is a very complex process. There is general consensus that the software will hold back the rate of implementation and the rate of efficient utilization of electronic systems.

Nevertheless, electronic equipment has invaded the office, and the evidence indicates an increase in productivity at the level of the work process where it has been introduced. It is relevant to note in this regard, that the office is a multifaceted operation: the increase in productivity at one level of its operation does not necessarily mean a general increase in productivity. The secretarial level of operation may increase its output, but that may be offset by inefficiencies at the managerial level. Indeed, it was suggested to us that perhaps the electronic equipment is being installed at the wrong level of office operations. The focus should have been at higher levels--the streamlining of managerial processes, particularly the processes at middle management levels.

The employment implications derive from the increase in efficiency, and the broadening of the individual employee's work functions that the equipment facilitates. For example, the operator of a word-processor, whose activities formerly may have been limited to typing, can now compose, type, file, calculate, chart, and effectively carry out the entire range of activities that is within the programmed capacity of the equipment. The volume of work activity will have to increase very substantially to offset the increase in efficiency and the broadening of work functions of individual workers.

This is in effect the explanation for the apparent absence of negative effects on employment in the offices of petroleum companies which have installed electronic equipment. Their volume of work has increased so much in recent years, that it more than offset the increase in efficiency. This suggests that instances in which negative employment effects have been recorded should perhaps be attributed to inadequate increase in demand and output, and not to the electronic technology and associated increases in efficiency.

The Rate of Diffusion

Notwithstanding the very considerable publicity about on-going and pending office automation, estimates of the diffusion of micro-electronic-telecommunications based office technology indicate that the rate of market penetration is still relatively low.

A number of economic, institutional and social factors are acting to slow the rate of diffusion:

1) The high costs of switching to electronic office systems. Despite price declines, a switch to micro-electronic/telecommunications based office technology is expensive, compared to traditional office equipment. While a word processor can be purchased for $10,000 to $20,000 depending upon the software, a conventional electric typewriter can be purchased for $1,000. Computer facilities, facsimilie machines, intelligent copiers and other microelectronic based equipment increase the costs even further. Furthermore, the cost of equipment, is only part of the total capital outlay: the cost of installation, the cost of linking devices, the cost of running parallel manual systems while the inevitable "bugs" are worked out of the electronic system, and the total costs of switching to electronic technology, add substantially to conversion costs.

Thus, even though much has been written about the declining cost of microelectronic office technology, a

substantial initial capital outlay is required to switch from electro-mechanical processes to individual units of electronic equipment, and ultimately to the fully integrated electronic office system. In a sector where investment per worker has traditionally been low, it becomes especially difficult to justify a switch to technology which is expensive relative to the current office technology, and essentially unproven in actual office environments.

2) The continuing uncertainty about the legal status, security and privacy of information stored and transmitted by electronic systems. As long as the uncertainty remains, applications will be limited to in-house operations, which means that communications capabilities will find limited use.

3) The continuing shortage of software specialists. The functioning of microprocessor based hardware depends upon the development of software packages. But, the writing of software is a highly specialized labour intensive process. The worldwide shortage of such specialists has been a serious retarding factor in the development and application of microelectronic networks.

4) Shortages of systems analysts and programmers are often mentioned as a possible delaying factor, but it

is uncertain whether that is the case or continuing developmental problems with the science and technology itself. If the problem is in the latter, the shortages would remain regardless of how much supply of programmers and systems analysts is increased, for they will be misutilized in processes.

5) The resistance of office workers. Computer-based office technology can potentially have a large impact on the way the office is organized, on the work functions performed, on the flow of information in the office, and on the overall office environment. Fears, uncertainties and a reluctance to move away from familiar organizational structures and work methods, generate resistance to the technology at all levels of employment.

6) Limited evidence of increases in overall office productivity. One of the major problems in discussing the effects of office automation is to separate the potential effects of the technology from the effects in actual applications. The literature on the "automated office" focuses almost exclusively on the technology itself. But, while the technological potential to implement electronic office systems is a necessary condition for the achievement of greater efficiency in the handling of information flows, it is not a sufficient condition to ensure that efficiencies will be achieved in real world applications. In many instances, gaps exist between the technological potential of

the system, and the actual productivity increases experienced in real office settings.

The failure of automated systems to attain their potential efficiency relates to a number of factors, amongst which there are the following:

a) Most other office activities are ill-defined, cannot be standardized, and are not amenable to traditional data processing approaches. In the past, the automation of office activities worked best when applied to high volume, repetitive, standardized activities such as inventory control, accounts payable, accounts receivable and invoicing. Although ultimately increasing numbers of work functions will be either automated or eliminated, efforts to-date have not been crowned with the anticipated success. The large number of diverse office activities require complicated software, which have proven difficult to write.

b) Limited integration of micro-electronic devices in actual office settings. Decisions to invest in the technology are made on a device basis with little or no consideration given to the linking of the equipment. Apparently difficulties have been encountered with hardware compatability. The successful linking of separate pieces of electronic equipment into an integrated system depends on the

ability of the pieces to "speak the same language." This condition is often not met. Intense competition amongst large numbers of vendors manifests itself in the use of different communications protocols to 'lock out' the competition.[10] The prevailing opinion in industry is that this condition will continue as long as competition remains at the present level. The fully integrated office will await the establishment of common communications standards by the multitude of manufacturers, or the emergence of one or a few manufacturers, each of whom will produce all equipment and devices that will constitute the integrated office.

c) Employee apprehension. Inadequate knowledge about the technology, reinforced by rumours of mass displacement, create apprehension, which manifests itself in uncertain and cautious approaches to the utilization of electronic equipment. In addition, the prospect of direct interaction with the machines is found demeaning, and the disruption of familiar work methods, work flows and functional relationships, rather disturbing.

d) Failure to automate managerial activities. There is increasing recognition that productivity in the office will not increase significantly until automation streamlines the functional activities of managerial and professional personnel. It is well known that inefficiencies at clerical and secretarial work levels are often

---

[10] Howard Anderson, "The Office of Tomorrow," Canadian Futures, Vol. 1 (1), 1979, p. 19.

> primarily the result of inefficiencies on the part of those whose instructions clerks and secretaries carry out. Furthermore, clerical and secretarial functions account for less than 30% of office expense.[11]

The foregoing suggest that the "office of the future" is still in the future. In the meantime, a variety of electronic devices will be installed, some of them dummy peripherals linked to computers and word processors, and some with limited intelligence contained in imbedded micro chips.

The employment implications of this are positive: the relatively slow rate of transformation to the integrated electronic office means that overall office productivity will not increase at rates that will exceed substantially the rate of increase in demand for services, and the numbers of employees affected adversely will not be too large for successful accommodation to alternative work activities. To emphasize once again, the critical issue in relation to employment is not the technology and the promised increase in productivity. It is rather the rate of increase in general economic activity.

The Nature of Office Technologies

Before we proceed with an examination of the employment and other implications of office automation, we thought it desirable to outline briefly the nature of office technologies that are being implemented. We will touch upon six technologies: data processing, word processing, data storage and retrieval, reprographics, conferencing, and telecommunications.

---

[11] Peter Vanderlee, "Beware the Technology Trap," Focus on Computers Supplement to Canadian Business, December 10, 1980, p. 4.

(a) Evolution of Data Processing

Data processing involves the manipulation of numerical information by computers. It is the most widely known form of office technology, and it is the form which has been generally accepted as a permanent part of the office infrastructure.

The development of data processing has been influenced by three major factors: the high cost of the technology; the physical size and large capacity of individual units; and the technical limitations in the application of the technology. For a long period, the introduction of data processing was limited to relatively large organizations. The high cost precluded direct investment in equipment by small enterprises, and its relatively large capacity made such investment by individual enterprises uneconomical. The problem was resolved with the evolution of data processing services. Even large organizations which invested in the equipment, found it possible to share the capacity of their systems. But, it took time to convince potential users that the data would remain confidential to themselves.

Technical limitations continue to hold back the spread of data processing: even though the science and technology appear to have been mastered, problems continue to exist in both the hardware and the software. Whether the problems emanate from unknowns in the applications of the science and technology itself or from inadequate supply of specialized manpower, remains to be determined. To-date, both of these have impacted significantly on the rate of application and utilization of data processing systems.

Some of the factors that have held back the application and utilization of data processing systems over the past twenty-five years are in

process of being resolved: the advent of microprocessors facilitated changes in the design of computers, and reduced the cost of hardware; improvements in software, facilitated more widespread use of computer systems; and the combination of reduced costs and simplified use, facilitated the application of computer technology on a smaller scale, which initiated a trend towards decentralization of computer facilities.

However, the trend towards decentralization will depend on developments in computer software. While hardware costs have been decreasing rapidly, the costs of computer software, which is a highly specialized labour intensive product, have remained relatively high. Experts in the field contend that this impediment to decentralization can be reduced significantly by a movement towards standardized as opposed to customized software packages. Given such a development, the hardware will become accessible to non-professional users, and volume sales of standardized packages will reduce the cost of software. The effect will be to move data processing closer to the ultimate user.

This is the trend, but the process will take time. Data processing professionals can be expected to make an effort to safeguard their pre-eminent role in system operations, and the large amounts of capital currently embodied in centralized systems will itself be a retarding factor.

(b) Word Processing

The concept of word processing generally became known after 1964 when IBM introduced the Magnetic Tape Selectric Typewriter. This was essentially a typewriter connected to a kind of tape recorder that electronically remembered keystrokes. It enabled one to make changes and corrections in typed materials without retyping the entire text. Typed copy could be printed on the typewriter, error-free, at 150 words per minute.

But the system created a filing problem: pages were stored in sequence on the tape, and it was often difficult to locate them. To alleviate the problem, a Selectric was introduced by IBM that recorded on plastic cards coated with magnetic powder. Each card could record up to one and one-half pages of text, compared to one hundred pages for a tape cassette, but the cards could be easily catalogued and located.

By the mid 1970's Lexitron, Vydex, and Linolex in the U.S., and AES Data Ltd., in Canada introduced stand-alone display machines which showed the typing process on cathode-ray screens, instead of on a sheet of paper. The machines used microcomputers to expand text-editing capabilities, and small flexible magnetic disks, called floppy disks, as memory storage devices. Floppy disks hold some 130 pages of text, and are easily filed, handled, and mailed.

The stand-alone display machines demonstrated numerous advantages over the memory typewriters. Typists were able to work more quickly with video-display screens since they could see the words clearly, could arrange paragraphs instantly, and did not have to stop typing to change paper. When a page was completed, the typist simply pushed a button to transfer the image on the screen to a document printer which typed out the page automatically. Materials stored on memory diskettes could be easily called up into the video screen for editing, or for inserting or merging with other material.

Initially, developmental costs and perhaps monopolistic market structures kept prices high and demand relatively low. But, with the entry of new models on the market, and the increase in competition, prices decreased rapidly, and by 1977 the number of units sold in the United States

exceeded the sales of mechanical memory typewriters. Although memory typewriters continue to dominate office processes, it is generally expected that video-display units will become the dominant office equipment within the current decade.

Demand is being stimulated by a continuous expansion in the capabilities of individual units, functioning independently and in conjunction with other equipment. Manufacturers now emphasize such features as:[12]

(i) Communications: the ability of word processors to communicate with each other and with computer terminals, which provides a capacity for an electronic mailing system.

(ii) Records or information processing: the ability to store data on records, and to sort records (or data extracted from records) in a variety of ways.

(iii) Numeric processing: the ability to total rows and columns, or to perform mathematical manipulations (usually arithmetic) on keyed data, and store the results in a particular position.

(iv) Data entry and data access: the availability of a communications function which facilitates their use as data processing terminals, and gives access to, as well as input into, the memory banks of larger computer systems.

---

[12] Amy Wohl, "A Review of Office Automation," Datamation, February, 1980, p. 118.

(v) Data processing: some vendors offer their customers the ability to write their own programmes, although this capacity is not common.

But, no sooner were these functions incorporated into stand-alone systems than "shared logic systems" and "shared resource systems" made their debut on the market. The shared logic systems have a mini-computer with disk drive memory (capacity 1500 pages or more) and a cluster of "dumb" terminals sharing the logic of the mini-computer; whereas in shared resource systems terminals, storage systems, and even printers are being equipped with microprocessors, which means that intelligence is spread throughout the system.

The advantage of shared resource systems is that certain resources, typically disk storage and peripherals such as printers, photo-composition output systems, OCR scanners, and other less frequently used components may be shared among a number of work stations. Failure of one component of a shared resource system does not render the entire system un-operational even though, depending on the operational significance of the component within the system, it may limit the operational efficiency of the system. This overcomes a major disadvantage of the shared logic system whose operation depends entirely on the functioning of the mini-computer. When it is "down" the entire system comes to a standstill.

An innovation which is expected to improve significantly the productivity of word processors is the Optical Character Reader (OCR). Introduction to this device is based on the premise that for initial input typing, word processors are not much more efficient than regular electric typewriters. Their superior efficiency is found in their correcting and text editing capabilities. Since most typing is still being typed and

retyped by secretaries on office typewriters, before it is sent to the word processing centres for final drafting, productivity has not improved to the extent that was originally expected. Indeed, word processors are still being used largely as substitutes for typewriters; and as long as this continues, they will remain very expensive substitutes.

The Optical Character Reader presents a possible solution to the problem: its capability to scan typed copy from any standard typewriter and to store the information on magnetic cards or floppy disks, to be displayed on the word processor's screen, whenever required, will eliminate the practice of keying in characters a number of times. With this device, every company typewriter can potentially have the ability to input into the word processor.

The benefit of using the OCR is that the input typing function is transferred from a text editing machine, costing $7,000 to $20,000, to an office typewriter costing approximately $800. This will allow the costlier machine to be used more efficiently, since the time spent using it for input typing will be available for editing.

In an effort to increase the efficiency of word processing systems, manufacturers have developed new kinds of high-speed printers. Two such types are the ink-jet printer and the daisy-wheel. The ink-jet printer, introduced in 1976 by IBM, sprays tiny droplets onto paper, forming up to 92 characters per second or 1100 words per minute, without even coming into direct contact with the paper. However, the print quality is lower than that of normal impact printers. The daisy-wheel avoids this problem. It consists of a spinning disk, with protruding spokes, which stops and starts quickly, tapping out up to 55 characters per second.

(c) Data Storage and Retrieval

In the area of data storage and retrieval, the most significant impact of electronic office technologies has been the development of techniques which substitute a screen image for paper documents. Electronic technology makes feasible the storage of information in binary code on magnetic media, and can be used to improve the efficiency of microform systems of data storage and retrieval.

For microform storage, documents are photographically reduced and stored on film. The predominant media for film storage are roll microfilm, and 4x6 inch cards of film called microfiche. The information contained on these microforms can be viewed with the aid of a microform reader which displays a magnified image of the document on an illuminated screen.

Microform based records systems have numerous advantages over paper based systems: they generate substantial space savings; reduce the costs of distributing large amounts of information; and permit more rapid access to stored information than do paper based records systems.

The advent of COM technology[13] contributed significantly to the efficiency of microform based records systems. Output from COM equipment can be generated more rapidly, and reproduced and distributed more readily, than comparable hard copy material generated by conventional computer printers.

The integration of COM technology and computer technology broughtabout the computer aided retrieval (CAR) systems. The system generates

---

[13]COM refers to technology which permits computer generated output to be directly recorded on microforms, bypassing the need for printing hard copies of the information.

an index of the location of information stored on microforms, and stores it in the computer as a subfunction of the COM output. When access to specific pieces of information is required, the computer is instructed to scan the index and retrieve the address of the information desired. Once the address is determined, the record can be retrieved automatically by an automated retrieval system or manually from the addressed microforms. The ability of the computer to scan rapidly through the index, decreases the time required to access information.

Magnetic storage refers to the use of magnetic tapes, disks or disketts to store information in digital form. Computers, word processors and memory typewriters all employ some form of magnetic storage. Information retained in magnetic storage can be printed or viewed on CRT screens.

Magnetic storage systems present advantages over paper based systems that are similar to those of microform storage: reduction in space required for records storage; significant reduction in the time required to access information; and a potential for significant reduction in paper usage, facilitated by the linking of electronic devices and the elimination of physical distribution systems. But magnetic storage has a number of advantages over microform storage systems: access to information is virtually instantaneous; and information can be manipulated and transmitted between locations.

These are important advantages; but they have been offset somewhat by relatively high costs, and issues of security and legality. Although developments in microelectronic technology appear to be resolving the cost problem, the problem of security, and questions about the legal status of electronic records resist rapid solution. In addition, as

indicated above, there is some evidence of employee resistance to the electronic office. The "paperless office" is not as imminent as the peddlers of hardware would wish us to believe.

(d) Reprographics

Heretofore, the production of multiple copy printed materials, such as letters to shareholders, information bulletins or company newsletters has been the responsibility of printing establishments. The advent of photocopying transferred some functions from printing establishments to the office, but the two remained largely separate. Now, that is changing rapidly. Improvements in the communication capacities of office equipment have brought about the integration of reprographic and office technologies.

Two major developments have been responsible for the increasing integration. First, the communication of word processing equipment with photocomposition equipment, allows the text to be keyed and edited initially on word processors, and then transmitted via communications links to photocomposition equipment, thereby eliminating the need to re-key the material to be printed. Second, the development of intelligent copiers which can communicate with computers and word processors, enables data stored or generated by computers or word processors to be transmitted to the copiers, bypassing the conventional photocomposition process. These communications links from computers and word processors to photocomposition equipment and intelligent copiers can potentially reduce the paper generated in the stages prior to the printing process, and improve office productivity by eliminating the need to re-key texts submitted for printing.

(e) Teleconferencing

Typically, teleconferencing is an electronic network which facilitates audio-visual meetings of people separated in physical space. The development of such audio-visual communications linkages is expected to have a most profound effect upon the nature of communication in the future.

It is possible, of course, to "participate" in a teleconference without the use of audio or audio-visual equipment. The computer and computer-related systems facilitate computer conferencing. Since the computer stores all the questions, responses and other inputs of the participants, and can itself be made to answer questions and provide responses, it is not necessary that all individuals participate simultaneously in the interchange. Given the inputs of conference participants, the computers communicate amongst themselves.

But, this process is not regarded with favour at present. The direct human interaction component of conference situations is lost; and since the spontaneity of human interaction is often an important component of meetings, it seems unlikely that computer conferencing will become a complete substitute for audio-visual conferencing. Indeed, the loss of direct human contact associated with any of the teleconferencing technologies will probably tend to limit the substitutability of teleconferencing for more traditional face-to-face meeting situations. But, then, attitudes change and methods of communication change; it is quite conceivable that the technology will improve so much that effective interaction will evolve without "direct human contact."

(f) Telecommunications

A revolution has been taking place in telecommunications technology, with significant impacts on efficiency, employment, costs, and the structure of the communications industry. The newest developments promise the creation of communications networks which will facilitate the transmission of information,

in greater quantities than heretofore, more efficiently, over greater distances, and at lower cost. It is generally expected that new satellite technology, fibre optics, and the use of computers for data switching and data concentration in communication transmission systems, will result in significant cost reductions. One estimate has the cost of data transmission at between one-third and one-tenth of current costs.

Amongst major innovations in telecommunications technology there are the following:

(i) Computerized Switchboards. Computerized switchboards involve the use of electronic switches with capability to automatically manage a variety of network facilities and services involving both voice and data applications. Many computerized switchboards currently in use automatically select the best transmission facility to use, based on a pre-stored route selection table. They also have the ability to interface directly with different communications networks, and with the development of digital voice networks they will serve as the interface link.

(ii) Packet Switching. Over the past ten to fifteen years the common carriers in Canada (the Trans Canada Telephone System and CN/CP) have introduced services which enable users to link their computers and terminals together into "dedicated" transmission networks. Although this increased the efficiency of the communications system, serious limitations continued to exist, particularly in relation to the 'one-user per line' technical constraint. A possible solution to this has been the introduction of automatic physical switching systems. But, such systems involve large numbers of mechanical components which entail high maintenance costs. The answer is found in 'packet switching.'

'Packet switching' is the electronic switching of messages. The terminals and computers of all users of a packet switching system are

hooked into a single dedicated network. The traffic on this network is controlled by computers operated by the common carrier. To send a message a terminal or a computer formats its message into individual packets of data each containing a header with the address of the intended receiver and a trailer indicating the end of the packet. Each packet is sent into the network of the nearest common carrier's computers. The computer reads the header address on the packet, and routes it on to successive "modes" or control computers in the network which finally deliver the packet to its destination. In this way, a single set of physical links can connect terminals and computers of a series of different users. Hence packet switching technology can be used to make more efficient use of lines where traffic from any single user is light and data communications from other users are available to be passed over the same line.

(iii) Fibre Optics.[14] Fibre optics technology is based on the concept of communication by the medium of light instead of electricity, and on the capacity of thin optical fibres to convey light from one point to another. A photocell serves as a receiver, detecting the presence and intensity of light. Optical fibres provide the means for transmitting light, operating on the principle of total internal reflection. Physically, a fibre is a hair thin flexible strand of glass or plastic which can be bent, coiled, or handled.

Optical fibres have several advantages over electric wires. First, they have a much greater capacity. Up to 10,000 times more information can be put into a light signal than into an electric signal. Second,

---

[14] David Vaskevitch, "Fibre Optics Technology will Revolutionize Communications," Computerdata, April 1979, pp. 47-48 and "Fibre Optics: Vanguard of Future Communications," Computerdata, May, 1979, pp. 32-33.

optical fibres can carry information as far as 50 miles, whereas copper wire is usually limited to about half a mile. Third, optical fibres are virtually immune to outside interference, whereas electric wires are sensitive to magnetic fields. Fourth, optical fibres provide much better security, since they cannot be tapped without physically breaking the fibre.

A major limitation in computer communication at present is the speed with which information can be sent to and received from a terminal. This limitation disappears when terminals are directly connected to a computer through optical fibres instead of going through telephone networks. Such a development would mean immunity to noise, high information transfer rates, and excellent security. Typically, computer systems require large numbers of massive cables which are expensive, space consuming and subject to interference. The cables can be replaced by a single optical fibre, costing very little and only millimeters thick.

The information network currently in operation developed as a function of the carrying capacity of electrical signals, and bears the limitations imposed by thattechnology. For example, the telephone is restricted to voice and some data communications; cables are used to transmit television signals using special wire (coaxial), which offers relatively high noise immunity, but at a high cost; and terminal networks are used to connect terminals to computers over long distances. All these are based on packet switching, and use minicomputers as nodes interconnected by telephone lines.

An optical network eliminates such interconnections: all information entering an establishment will be directed to a computer based switching system (as described earlier) for routing: every work-station in

the building will have a single port into the building's information system; connected to the port will be telephones, television, computer terminals, monitoring equipment (e.g. thermostats), and any other devices that work with information. The key to the system is that a single optical fibre running to each work place has enough capacity to handle virtually all present and projected information requirements.

These developments in telecommunications technology suggest that the traditional division of telecommunications into the distinct functional areas of telephone, administrative message systems and data processing is coming to an end. The technological imperative is the organization of telecommunications as an integrated process, which will encompass voice, audio, visual and data communication.

Integration of the Office Technologies

The application of telecommunications technology in office settings can be summarized by two words: interconnection and interface. The office of the late 1980's and early 1990's will be characterized by the interconnection of technologies through telecommunications. The trend is already much in evidence today; some word processors can communicate with each other and with computers, photocomposers and copiers; microforms and paper can be transmitted over telecommunications networks; teleconferencing is telecommunications based, as are all forms of electronic mail. All these interconnections will be made cheaper and faster as development and innovations continue. It is expected that over time virtually every office machine will be interconnected to telecommunications networks, so that information entering the network through any one machine can be moved and made available to any other machine without re-entry.

Furthermore, technologies are increasingly enabled to interface with each other through intermediaries such as computerized switchboards: for example, computing and micrographic technologies interface through COM and CAR equipment; word processing reprographic technologies interface through photocomposition; and micrographics and telecommunications technologies interface in facsimile transmission.

Interconnection and interfacing are becoming practical realities in many environments, and offer the potential for great changes in the structure and organization of the traditional business office. The advent of the microprocessor will facilitate the spread of intelligence throughout the organizational systems, and enable system units to function independently and interdependently--the failure of individual system units may impair efficiency, but will not immobilize the system in the way it happens with systems in which intelligence is concentrated in a central computer.

What are the implications of all this for employment in the office? As we indicated elsewhere in this report, it is not possible to know precisely what will happen to the level of employment and to the nature of the occupational structure. The technology is still in the very early phases of development, and its effects to-date are transitory. We know that the work functions of clerks will disappear, and we know also that during the transition period typists will become word processor operators and data entry clerks. We do not know what will happen with the non-typing secretarial work-functions, and what work functions will emerge with the utilization of the new systems. Incidental information indicates that the secretary/typist occupation is being split into five occupations: word processor operator, text editor, data entry clerk, administrative assistant, and personal secretary.

Section VII: CASE STUDIES ON OFFICE AUTOMATION AND EMPLOYMENT EFFECTS

The case studies presented in the following pages are not in-depth case studies, based on analysis and testing of hard data. They are based rather on interviews with office employees and office supervisors, which means on information deduced from observation, opinion and experience.

All companies are Calgary based, and were selected on the basis of their differing experiences with office automation. Only one of them has in operation what is regarded as an advanced integrated electronic office system.

Generally, the interviews were rather disappointing: many questions were left unanswered, either because of company confidentiality, or because company personnel were unwilling to spend the time required to provide the necessary information. Nevertheless, the effort was not without benefits. It became evident that many firms purchase expensive office equipment with little or no study into its effects on productivity, although the declared purpose is "to do much more with the same number of people or with only a small increase in the number of people"; and secondly, that labour scarcity rather than relative costs is the major impetus to office automation.

A number of problems are inherent in the case study approach to the employment effects of office automation. Office automation is most prevalent in firms with growing work loads. It is therefore, difficult to disaggregate the effects of changing conditions of demand upon employment in the office and the effects of the new technology on employment. While this problem exists, to some extent, in all studies on the effects of technological change on employment, it is especially pronounced in studies

of office employment because of the inability to define any standard unit of "office output."

Secondly, the effects of office automation on employment, on the occupational structure, and on job functions are different at different stages of the automation process. During the period of system development and implementation, systems design and programming experts are hired, to develop, introduce and "debug" the electronic system, while parallel manual systems are maintained with existing personnel. When the automation procedure is complete, a different number and mix of personnel will be associated with the operation of the system. In addition, changes in the functions performed by the system usually occur during the automation process, which, too, effect employment. Currently, office automation is still at the development and implementation stage.

Finally, it is difficult to disaggregate the effects on employment caused by the technology, and those caused by changing business activities and changes in the nature of information flows. Detailed data which allow these effects to be disentangled do not seem to exist. Under such conditions, the most fruitful approach to the study of employment effects appears to be the impressions of individuals who have been, and are, involved in the development, implementation and application of automated information systems. This approach was by necessity taken in our studies of office automation. While some specific employment data were obtained from some of the firms, most were unable or unwilling to provide detailed breakdowns of employment, occupational mix, work functions and output levels before, during, and after the process of automation.

Cases Examined

Seven office situations were examined: four offices in the oil industry, the regional sales office of a large office equipment company, a legal firm, and the oil and gas accounts of a financial institution. The oil industry offices studied encompass the head office of a small drilling and exploration company, the head office of a large Canadian oil company, the Canadian head office of a large multi-national oil company, and a regional Canadian office of a large multi-national oil company. The oil companies were chosen on the basis of similarity in their activities and the different stages in their implementation of office automation.

All case studies lead to the following tentative conclusions regarding the application of microelectronic-telecommunications technology in offices:

1) In all cases the decision to automate was not based on any intent to reduce staff. Rather, it was dictated by shortages in secretarial staff, and the incapacity of manual systems to keep pace with the demand for the compilation and processing of information.

2) Productivity increases resulting from the technology were not translated into job losses. A number of factors account for this:

First, all offices studied were experiencing periods of rapid growth. Work time freed by the implementation of the new technology was easily absorbed into other activities.

Second, office jobs, in general, encompass a multitude of work activities. The elimination of one activity does not eliminate them all. For example, word processors may increase the productivity of the typing function, but typing is only one of a number of activities performed by secretaries. It has been estimated that typing requires on the average, only 20% of a secretary's time. Thus, even a 100% increase in typing productivity translates into a total increase in secretarial productivity of 10%. Because secretarial positions are widely distributed throughout most companies, the elimination of individual positions is difficult.

Third, all companies indicated that their computers and computer-related systems brought about substantial increases in the volume of work performed--documents, reports, data configurations, etc. The work involved in the examination, separation and allocation of this "flood" of output from the electronic systems appears to have more than offset the anticipated labour-saving effects. For example, firms using word processors indicated an increase in the number and length of reports, and an increase in the number of revisions requested. Such an increase in the amount of information processes creates work not only for those involved in the production

and interpretation of the information, but also for those responsible for records management in the firm. This is especially true in organizations where the electronic equipment is not linked, so that paper remains the basis of the record system.

3) In all cases there is indicated recognition that a necessary condition for the successful implementation of electronic office equipment is its acceptance by office employees. Resistance was encountered, and it was attributed to lack of adequate knowledge about the effect on employment generally, and on the work environment in particular. Concerns were expressed about the loss of employment, and about "dehumanizing" the work environment. The resistance was largely manifested in what was interpreted to be failure to use the equipment to the full extent of its capability. Hence, it was alleged that anticipated productivity increases were not always realized.

4) There appears to be a significant learning-by-doing effect associated with microelectronic technology. When the technology is initially introduced, uncertainty about its potential generally results in the under-utilization of the equipment. As the capabilities of the equipment become more familiar to potential end users, the number of work functions which are automated in the office are generally increased. The work functions include activities which previously were manually performed, and functions which were not feasible under manual systems.

5) At the time of the investigation, only 3 of the 7 firms had taken advantage of the ability of electronic equipment to communicate. The three that did so indicated significant benefits from the ability to bypass the postal system, and thereby improve the reliability and speed with which information was transmitted.

6) The major reasons cited for delays in the introduction of integrated electronic office systems were: the high cost of the technology; uncertainties about the legality and security of the systems; and uncertainties about the potential of available systems, in the face of the limited diffusion of the technology into actual office environments. The companies have adopted a "wait-and-see" attitude towards electronic office technology. They do not wish to make the large capital outlays necessary for the establishment of electronic information networks, without some evidence that the potential of the systems can be realized in actual office settings.

Office Automation in the Petroleum Industry - Four Cases

The Firms

The firms studied have all experienced periods of rapid growth over the past decade, a fact cited by all of them as an important factor in the decision to employ electronic office technology.

All firms are engaged in exploration and drilling for petroleum and natural gas. Two of them are subsidiaries of multinational oil companies, and the other two are Canadian companies, with activities concentrated largely in Canada. Their total employments range from 90 to more than 1000 employees.

The three larger firms (cases II, III and IV) have all employed main frame computer technology in the processing of information for more than 10 years. High volume of repetitive numerical activities, involving well information systems, financial control, land management, lease records, accounting systems and complex geological, geophysical and engineering applications, have been transferred to the computer departments. This entailed a decrease in the amount of clerical and manual/mechanical computational work activities in some departments, and a concurrent increase in work activities and staff related to the operation of the computers. Employment opportunities opened up for coders, data entry operators, computer operators, programmers, systems analysts, and a score of system supervisors, managers and general system specialists.

General Employment Effects

All companies reported continuous shortages in all classifications of computer and computer-related occupations. Particularly critical have been shortages of personnel for positions which in addition to knowledge of computer operations require some knowledge of the disciplines

to which computer applications are made, such as accounting, geophysics, engineering, and other.

They reported also that scarcity of specialized computer manpower caused postponements in the implementation of additions to system operations. This has important employment implications. The scarcity of specialized manpower caused postponement in planned computer systems expansion, which means the postponement of employment that would have been created for the operation of the system.

This is a classic manifestation of the consequences of occupational imbalances: scarcity in occupations critical to the operation of production processes precluding the commencement of operations, and thereby causing the sacrifice of potential employment. This relationship contains a lesson for the analysis of vacancy data. Whereas some occupations are supportive in production processes and some stand alone, there are many that have a multiplier effect. Vacancies in such occupations should be viewed not in themselves alone, but in relation to the employment opportunities that are not created because of their scarcity.

It can be argued, of course, that failure to expand the computer systems saved some jobs. For while computers and computer-related systems create some employment, they also eliminate some employment. The companies did not provide data on this matter, but their personnel officers expressed the opinion that more jobs were created than were destroyed.

This outcome was attributed to the specialized nature of the information processed by the systems. Raw data require preparation before they can be entered into the system. As a result, although some clerical duties and actual calculations were eliminated, staff familiar with the processes were still needed to prepare the data, deal with inconsistencies and special cases and analyze the output.

Furthermore, the ability of the computer to quickly search the data, sort by different parameters, and output data in specific configurations meant that the number of reports produced and the physical distribution of these reports increased significantly. In the accounting departments, less time was spent recording entries and balancing ledgers, but more time was spent analyzing costs, revenues, cash positions and budget over-runs. Better financial control, rather than savings in labour became the touted benefits of the systems. In geological and geophysical work, the objective was more sophisticated analysis and superior assessments of properties, rather than labour-saving. The payoff was in better investment decisions, not in the reduction of labour costs.

The Nature of Office Automation

Office automation in the four oil companies studied commenced in the latter half of the 1970's. In all but one, the office systems are entirely separate from the data processing systems.

In all companies, the process of office automation commenced with the introduction of non-communicating word processors. Shortages of trained secretarial personnel, the desire to speed the production of typed documents, and the inability of more conventional methods to keep pace with the growth in demand for information, are the common factors cited in decisions to commence investment in automated office systems.

Today the four companies are at substantially different stages of office automation. Those designated as Cases I and II have continued with stand-alone word processing systems, and have no plans to extend the automation process beyond that stage. The company designated as Case III, has moved beyond that stage and is currently engaged in the

implementation of the second stage of automation--switching from non-communicating to communicating word processing equipment. Its goal is to create an integrated electronic information network with intelligence distributed throughout the peripheral devices. Communications linkages between devices will make it possible to access information stored in memory banks from any physical location in the company. It is envisaged that all levels of personnel from clerks to management, will interact directly with the system. The plan has a 5 to 10 year horizon.

The company designated as Case IV has in operation the most sophisticated office system. The stage of system development has moved beyond the clerical and secretarial level, to the managerial and professional. The system links all levels of personnel to a large central computer bank. Electronic mailing capabilities exist within the Calgary office, and between the Calgary office and the parent company's offices in the United States.

Case I: A Small Oil and Gas Company

This company was established five years ago with three employees. It currently employs over ninety. It is engaged in exploration and drilling for oil and gas in Western Canada.

The Implementation of Electronic Office Equipment

In 1978, the company introduced four non-communicating word processors, with simple arithmetic capabilities. The decision to allocate badly needed capital to office equipment was based on two considerations: one was the sustained rapid growth of the company and the concomitant need for more efficient methods of information handling than manual methods provided, and the second was the serious shortages of trained secretarial

and clerical personnel. The implicit substitution of labour with capital was substitution caused by scarcity of manpower. In essence, the company sought a process which facilitated the handling of increasing flows of information without increasing significantly the growth of secretarial and clerical personnel. Undoubtedly, the scarcity and resultant cost of space also bore on the decision to invest in the word processors.

The Employment Effects

The introduction of word processors in this office has had remarkably little effect on occupational mix, employment, job functions and organizational structure. The word processors are distributed among departments in the company, with several secretaries sharing each machine. In addition, each secretary is equipped with a conventional electric typewriter. Shorter documents such as memos and non-standard correspondence are still typed on electric typewriters. The word processors are used for standard correspondence, lengthy reports and documents. In addition, one of the word processors is used to maintain documentation on wells and leases.

The users of the word processors estimated that the typing of repetitive documents, and documents requiring substantial revisions, takes one-third of the time it takes to do the job on electric typewriters. But, they hastened to emphasize that this increase in productivity did not result in any reduction of secretarial staff. It resulted rather in an increase in the quantity of work done by each secretary, and in improvements in the detail of records and documents. The documentation on wells and leases became more extensive, more accurate and easier to update than was possible under the previous manual system; weekly and monthly drilling and

exploration reports improved in terms of the amount of detail that is included; and updates of reports became easier, more accurate and faster. For example, since the exploration reports are entered into the word processor's memory, it is relatively easy to recall any file and update it as new information flows in.

The attitude of the office staff was positive, and indeed, enthusiastic. They were enabled to produce more, and the quality of their work improved significantly. Prior to the introduction of the word processors their work was increasing rapidly, and they were under continuous pressure. The word processors relieved some of that pressure.

Furthermore, the word processors were introduced as complementary instruments in the existing manpower-capital office infrastructure. The secretaries retained the freedom to use either the word processors or the more conventional electric typewriters, whichever appeared more convenient and appropriate. There was no job reclassification or restructuring of job functions; all secretaries were trained in the operation of the word processors in a 3 day course offered by the vendor; and all of them continued to perform other activities, in addition to typing. The entire office staff indicated an increase in job satisfaction--their work became more challenging, more interesting, and of better quality.

There was no intention at the time of the investigation to expand office automation beyong the use of non-communicating word processors. Other electronic office equipment, and electronic office systems were thought to be too expensive to be cost justified.

Case II: A Large Canadian Oil and Gas Company

The Calgary head office of this company has about 850 employees. The company has experienced very rapid growth in activity over the past 10 years.

The Implementation of Electronic Office Equipment

The decision to automate parts of the information flow was dictated by the growth of the company. The manual methods of information handling could not keep pace with the growth in demand for information, and shortages of trained secretaries made the manual methods inappropriate and an obstacle to efficiency and expansion.

Attention was focused initially on secretarial functions--typing, filing, retrieving information--and word processing equipment was introduced. The equipment was organized in clusters, with groups of word processors, operators and proof readers arranged in several centres throughout the company. Potential inputters were directed to send all financial and technical information for report typing, statistical typing, standard format forms and letters, multicopy "original" letters and lengthy documents to designated word processing centres. Only shorter communications, such as letters and memos were to be typed by secretarial staff with conventional electric typewriters.

No structural reorganizations occurred during the introduction to word processors. The word processing clusters simply replaced typing pools. Senior management personnel continued to be provided with private secretaries, while junior and middle management continued to share secretarial staff.

The system of centralized pools proved less satisfactory than anticipated, and at the time of the investigation a re-organization was being introduced, leading towards decentralization--word processors and operators were being distributed among various department.

Four major benefits were expected from decentralization to a departmental basis: first, operators would become familiar with departmental technical jargons and preferences as to style; second, concentration within departments would ensure greater confidentiality; third, the work functions of operators would not be limited to word processor operation; and fourth, individual departments would become familiar with the capabilities of the equipment, and hopefully, use it to capacity.

It was recognized that some of these benefits would be at the cost of efficiency, but the state of technology was such at the time that the company could not maintain security and confidentiality with a centralized system, and could not risk the alienation of secretarial staff in a very tight labour market.

The Employment Effects

The introduction of word processors resulted in higher quality work, faster turnaround of typed documents, and "a significant" increase in the amount of work done by the same number of typists. In addition, a number of new employment positions were created: coordinators were appointed to the three processing centres, whose work functions were to liaise between departments and the centres, to input the centres, to allocate work amongst operators, and to assign priorities; a number of "proof reader" positions were created, on the premise that it would not be efficient for typists to verify their own work; and a supervisor was

appointed to oversee the entire word processing operation--problems and complaints from inputters and word processor operators, evaluation of performance, training of word processor operators, development of programmes designed to demonstrate the capabilities of the word processors to potential inputters so that optimal use is made of the equipment, and such other.

There were no plans to expand office automation beyond the acquisition of more word processors and operators. The benefits of more extensive automated information systems are not seen as outweighing the initial implementation snags and costs, and the problems associated with the reorganization necessary to accommodate more extensive electronic office systems.

Case III: The Regional Office of a Large Multinational Oil Company

This company has several offices in Canada and the United States. At the time of the investigation, its Calgary offices were located in eight different buildings throughout the city.

The Implementation of Electronic Office Equipment

In July 1978 the company introduced the first word processing equipment. Four non-communicating word processors were acquired and organized into a central word processing pool. Within two years their number increased to 28 units, organized in a centralized/decentralized mode--a central hub of word processors and eight satellite centres located in eight different departments which provide text editing services for any document of two or more pages.

The central word processing department is equipped with sophisticated software, and handles more complex applications including math verification, graphic design, communications, records processing, and major volume text editing.

Personal secretaries continue to be employed throughout the company, but their typing is limited to documents and correspondence of two pages or less, and perform varying kinds of administrative and research work functions.

At the time of the investigation the company was in process of planning expansion into third generation word processors, which allow for communications links amongst all the company's Canadian offices. The communicating word processors are seen as the building blocks of a fully integrated electronic office system which will link all information flows in the company into an electronic network. The system is envisaged as

locating remote intelligent terminals on the managers' and secretaries' desks, so that data retrieval and manipulation can be performed from any location in the company. It was expected that the system would be operative within 5-10 years.

The Employment Effects

The introduction of the word processors has not had any negative effects on the employment of secretarial staff, despite the fact that each word processor-operator combination produced an estimated output equal to that of four to five typists using electric typewriters. This outcome was attributed to a number of factors, amongst which the more important were the following:

1. Expansion in company activities resulted in rapid expansion in the volume of office work generally;
2. The utilization of the word processors was largely limited to the typing function. Typing is but one of a number of duties performed by secretarial staff. While a certain amount of the secretaries' time may be freed by the introduction of the word processors, secretarial jobs are spread widely through the company and secretarial functions are not easily definable.
3. The decision to invest in word processing technology was dictated by the inability of manual methods to keep pace with the demand for information within the company. When the word processors were introduced, there was already a backlog of demand for information that was not being produced.

4. A serious shortage existed of well trained secretarial staff, and market signals indicated increasing shortages over the near future.

Indeed, introduction of the word processors resulted in the creation of thirty new positions in the company--supervisors, unit leaders, training personnel, applications analysts, service and maintenance personnel. In addition, as a result of communications hook ups between the Calgary office and other Canadian offices, a number of positions of communications technicians were created.

Considering the very rapid expansion in the company's operations, it could be argued that employment would have increased more in the absence of the electronic office equipment. On the other hand, it could also be argued that in the absence of that equipment, the company's operations would not have expanded as much, and less employment would have been created.

There was virtually no employee resistance to the new technology. Work flows and organizational structures were not altered to any significant degree; secretaries continued to perform some typing functions--short documents, memos and confidential correspondence; and assignment to word processor operation was on a voluntary basis.

Case IV: The Canadian Head Office of a Large Multinational Oil Company.

Over the past 20 years this company experienced very significant growth: in 1960 the Calgary office employed approximately 400 persons; by 1970 employment increased to about 740; and in January 1980 it stood at 1,100.

The Implementation of Electronic Office Equipment

The increase in work load, quest for greater office efficiency, and a shortage of trained secretarial personnel, were the major factors cited for the introduction of electronic office technology.

The company introduced stand alone word processing equipment eight years ago. The original plan was to concentrate most of the company's typing activities in word processing pools. The resultant release of secretarial time was to be allocated to administrative support activities. The office was to be restructured gradually, with clusters of secretaries serving the administrative needs of several managers.

In practise the word processing system did not proceed as planned: in some cases administrative secretaries resisted the transference of their typing duties to the word processing pool; in other cases, confidentiality or the need for rapid turn-around dictated that documents be typed by administrative secretaries. As a result, the word processing pools typed only 40% of the total volume, instead of the 80% that was originally planned. In addition, the reorganization of administrative secretaries into clusters for group use did not work. Managers preferred to have a secretary working in close proximity, not in a cluster down the hall; and the secretaries found that physical separation of their work area from the managers meant that they were often not informed of the manager's activities and, therefore, were unable to perform all of their

functions effectively. The large floor area and traditional design of the existing office space were not conducive to the concept of clusters of administrative secretaries.[15] This outcome resulted in a gradual drift back to more traditional organizational forms. Clusters of administrative secretaries have disappeared, in favour of more one-to-one relationships between managers and secretaries.

There is a message in this experience, and it is that the availability of equipment is not a sufficient condition for efficiency. The physical setting, the organization of the work, the nature of the work, inter-occupational work relationships, all bear on the work process, and on the efficiency with which work is performed.

The utilization of word processing equipment improved the productivity of the typing function, but the overall productivity of the office did not improve significantly. The stand alone, non-communicating word processors did little to influence the work of the managerial and professional staff, who accounted for the largest proportion of office expense and activity. Therefore, it was decided that future approaches to office automation should be directed at improving the productivity of professional and managerial personnel.

In 1978 the company initiated the introduction of an integrated electronic office system designed to improve overall office productivity. The new system has about 400-500 video display terminals (VDT) distributed

---

[15] The cluster arrangement functioned satisfactorily at one of the parent company's offices in the United States. Its less than satisfactory functioning here was attricuted to the different physical setting of the office layout.

throughout the organization, which access a central computer. The computer has word processing software, which means that the VDT's have replaced the stand alone machines in the word processing centres. All keystrokes are captured in large scale centralized computer memory banks and can be stored there indefinitely. Once created, these electronic files can be retrieved from any terminal. All levels of personnel use the terminals. Special codes and passwords are used to restrict access to confidential information.

The system also has the capacity for electronic mail within the Calgary offices and between the Calgary office, field offices, and offices of the parent company in the United States. The electronic mail system overcomes the problems of time zones since the message can be sent at any time and will be waiting for the receiver when the office opens the following day.

The Employment Effects

The company has undertaken studies to evaluate the effects of the system on productivity and on personnel attitudes, but the findings are confidential. Similar studies at one of the company's U.S. based offices has indicated moderate increases in productivity--7% for professional and managerial personnel, and 20% for secretarial staff. No negative effects on employment were recorded. The increase in productivity was more than offset by the increase in office activity.

Indeed, the system created new employment positions: a coordinator was hired with responsibility to implement and oversee the system; six liaison positions were created, with responsibility to train users of the system, and to deal with problems and grievances; and since administrative secretaries were discouraged from the performance of typing

functions, some secretary-typists were hired for the typing of memoranda, confidential letters, and such other.

But, there was an implicit suggestion that the company retained some back-up staff, because intelligence is not distributed among the peripheral devices. This dictates the maintenance of manpower reserves in key areas of activity so that processes can revert to manual operation when the central computer fails to perform.

There was no overt resistance from employees to the introduction of the system, except for the frustrations inherent in changes of such magnitude. A deliberate effort was made to keep changes in inter-occupational relationships to a minimum; an effective grievance procedure was instituted for employees and departments not satisfied with the system; and users of the system were assured that their jobs would not be in jeopardy.

Cases V, VI and VII

These three case studies include a law office, an office equipment sales office, and the oil and gas accounts office of a large Canadian financial institution. These are relatively small offices, with office activities much less diverse than those performed in the oil companies studied.

Case V: A Legal Firm

This company is a medium sized law office with approximately 20 lawyers and 50 para-legal assistants and secretaries. The company employed an office manager with considerable experience in electronic office systems, to design and implement its automation programme. At the time of the interview the system was still in the early stages of development--the word processor stage.

Investment in the word processors was in anticipation of a rapid increase in the volume of work. The firm concluded that its rate of growth would be arrested unless it developed the capacity to handle a significant increase in office work. The alternative to word processors was a substantial increase in the number of office employees; and since such employees were scarce, the decision was not a difficult one to make.

The word processors were used to handle lengthy documents, a large number of lengthy original letters, and an extensive amount of precedent work. Their utilization had not resulted in any new work functions, but created certain conflicts between secretarial staff and para-legal employees.

The Employment Effects

The introduction of the word processors has had a number of effects on the employment structure and job functions in the firm. The

relatively high capital investment involved dictated capacity utilization of the word processors, which in turn dictated that they be concentrated into utilization centres. All standard correspondence and standard contractual work was to be routed to the word processing centre.

But, problems arose with the allocation of time and priority in the performance of work in the centres. Some of the lawyers refused to direct work to the processing centre, preferring instead to have their own secretaries type their documents and correspondence. Rather than establish a system of work allocation and sets of priorities, it was decided to return to the decentralized organizational structure used prior to the introduction of the word processors.

Another problem concerned the relationship between secretaries, legal assistants and para-legal employees. Legal secretaries were placed in a position of having to decide whether they were to be a combination of typists and word processor operators or a sort of legal assistants. But, the work functions of legal secretaries without or with minimal typing responsibilities encroached on those of para-legal employees. It was anticipated that the problem would sort itself out, but the outcome was uncertain. Evidently a new position was evolving of a legal secretary who in addition to non-typing secretarial functions would perform some of the functions performed heretofore by para-legal personnel. In the meantime, some of the legal secretaries who found themselves operating word processors expressed frustration, and concluded that the technology had a dehumanizing effect.

Despite the productivity increase in the typing function, the ratio of secretarial and para-legal staff remained the same. But, there was

some change in the nature of work--more of the routine legal work was delegated to the secretaries and para-legal assistants. As a result, the firm was able to handle a larger case load with the same number of lawyers.

Case VI: Regional Sales Office of an Office Equipment Company

This company is involved in the manufacture and sale of main frame computers, mini and microcomputers and other electronic office equipment. The office is a regional sales office of the company.

The Implementation of Electronic Office Equipment

The experiences of this company with electronic office equipment illustrate the importance of design in automated systems. The company uses word processing technology consisting of electronic memory typewriters: documents are stored on magnetic cards, and hard copy typewriter-like terminals are used for input and revision. A shared high speed printer outputs the documents.

The technology has been employed in the office for slightly more than four years. The decision to automate was prompted by four major factors: 1) shortages of trained secretarial personnel, 2) the ability of the equipment to reduce the time needed to produce standard contracts, proposals and letters, 3) the capacity of the equipment to produce consistently higher quality work, and 4) the inability of manual methods to handle the increasing work load in the office.

Upon introduction of the technology, secretarial jobs were restructured: secretaries were given the option to become administrative assistants or machine operators. Administrative secretaries (assistants) assumed work responsibilities supportive of managerial and sales staff functions, whereas machine operators became strictly typists on the electronic memory typewriters.

Considerable importance was attached to the goal of improving the productivity of secretarial personnel. Therefore, mag card centres were

established to monitor the output of secretarial staff and machine operators, and to determine work flow patterns and bottlenecks in the office. The information collected from the monitoring centres was used to restructure work and information flows, so that maximum efficiency of the equipment could be achieved.

Much of the work performed is related to sales and service contracts. The system is so organized that every activity is recorded automatically--number of inputs, the time necessary to produce the document, output per mag card operator, the number of rush requests from each department, and so on. The information is examined each month, to identify bottlenecks in the system.

The Employment Effects

The major effect of the technology has been the restructuring of secretarial jobs. As indicated above, secretarial activities were reclassified into activities performed by machine operators, and administrative support activities with minimal typing. The change did not result in any reductions of secretarial staff. On the contrary, a new position was created--a supervisor who assigns priorities, allocates work, and does some overflow typing. But, considering the growth of the company since the introduction of the new technology, and assuming that growth would have taken place in the absence of the increase in efficiency in the office, employment would have increased substantially. The critical question is whether such a growth could have been achieved within the period that was achieved without the substantial improvements in office efficiency.

The increase in efficiency, which was quite substantial, was achieved through a process of product standardization and more effective

division of labour. Because the word processor's major advantage lies in the typing of repetitive documents, all contracts, letters, and proposals that could be standardized were standardized and recorded on magnetic cards. As a result, a much larger proportion of typed materials was channelled to the word processing centres. Within a year-and-a-half of implementation of the system, output per operator increased from 500 to 1600 pages per month.

Case VII: The Oil and Gas Accounts Department of a Canadian Financial Institution

This office handles the bank accounts of oil and gas producers. Seventy people are employed in the office, of whom 30 are secretarial personnel and 40 managerial, administrative and support staff. There is a one-to-one ratio of 25 secretaries and managers, while the remaining 15 managerial, administrative and support staff share 6 secretaries.

The Implementation of Electronic Office Equipment

In 1978, the company acquired three stand-alone word processing units, and one word processor with communication capabilities. Three factors influenced the decision to introduce electronic office technology:

1) the inability of conventional methods and equipment to handle the work load,
2) the scarcity of secretarial workers, and
3) perhaps the most important factor, the need for instant and continuous communication with the Company's head office in Toronto.

The stand-alone word processors are used to type repetitive correspondence and longer reports; regular typewriters are employed for shorter documents and non-repetitive correspondence; and the communicating word processor is used to type standard loan applications, which are then transmitted automatically to head office in Toronto for approval.

Prior to the introduction of the word processing equipment all typing was done on electric typewriters, and loan applications were sent via the regular mail service to Toronto for approval. The process took any-

where from two to three-and-a-half weeks. Under the present system, the approval process takes two days. In the highly competitive environment in which the company operates, and the time pressure under which its customers function, such a reduction in approval time is very important.

The Employment Effects

There were no employment effects of consequence: no employment redundancies; no changes in occupational mix; no significant changes in work functions. The number of secretaries remained unchanged; and the secretary to principal ratio remained unchanged.

Conclusions

In summary, the cases we have examined indicate that micro-electronic office technology, at the present phase of its development and implementation, has not had any major effects on office employment--in the numbers employed, in the occupational mix of office employment, or in the job functions of office employees. None of the cases provides support to past predictions of widespread unemployment of secretarial and clerical personnel. It would appear, such predictions have been based on two assumptions neither of which is sustained:

1) The first assumption concerns the rate of introduction of electronic technology. A rate has been assumed which is still unprecedented. Prices of electronic instruments have fallen, as expected; and the productive capabilities of electronic office technology have expanded, also as predicted. But, the introduction of electronic technology still entails a substantial capital investment, which has to compete with other claimants for the available investment funds. In the context of the anticipated increase in overall productivity, and in the context of the role of the office in the operations of most establishments capital investment in the office does not appear to be a high priority consideration.

2) The second assumption concerns the rate of increase in productivity. A rate has been assumed that appears to be highly exaggerated. This seems to have resulted from a confusion between the productivity of clerks and typists, and the productivity of the office. The office is not constituted of clerks and typists, and furthermore, clerks and typists do not make the decisions on what work is to be done, how much work is to be done, and what kind of work is to be done. The electronic technology

provides the decision-makers with more information, faster, but does not do much in relation to their decision-making processes. Furthermore, an increase in productivity relates to the supply side of the equation only; the effect on employment will depend on what happens on the demand side. If demand for office services were to increase at a greater rate than the rate of increase in productivity, employment will increase. This is what happened in the cases that are being examined here. The prognosticators of widespread unemployment appear more and more as crystal-ball gazers, and less and less as professional analysts.

BIBLIOGRAPHY

Ahfeldt, H. "Langerfristige Wirtschafts - und Arbeitsmarktentrwicklung in der Bundesrepublic Deutschland und Baden." Report. Prognos, Basel, 1978.

Reviewed in Zeman.

Anderson, Howard. "The Office of Tomorrow." Canadian Futures, vol. 1(1), 1979, pp. 15-19.

A stress is placed on the evolutionary development of the automated office. The human and technical barriers suggest that it will be a number of years before fully integrated electronic office systems can be implemented. It would appear that in the intervening period, severe dislocations of office personnel will be unlikely because the interim technology, in the form of word processors, tends to create more paper work.

Andrieu, M. and Serafini, S. "Impacts of Electronics and Telecommunications on Production Processes in Canadian Manufacturing," in Group of Experts in Economic Analysis of Information Activities and the Role of Electronics and Telecommunications Technologies, Directorate for Science, Technology and Industry, OECD, Paris, September, 1979.

Arthur D. Little, Inc. Strategic Impact of Intelligent Electronics in U.S. and Western Europe: 1977-1987. London: Arthur D. Little, Inc., 1979.

Reviewed in Zeman.

Association of Professional, Executive, Clerical and Computer Staff (APEX). Office technology: the trade union response. First report of APEX. Word Processing Working Party. APEX, 1979. (68p.)

This report discusses the effects which word processing may be expected to have on employment, job content, job evaluation and health and safety at work. Recommendations for APEX and for the government are presented.

Association of Scientific, Technical and Managerial Staffs. Technological Change and Collective Bargaining. London: ASTMS, 1979.

Reviewed in Zeman.

Barron, Cheryll. "Microelectronics: A Survey." Supplement to The Economist, March 1, 1980.

"The idea of an imminent microelectronics revolution has been oversold. It is true that the 1980's will be a golden age of microelectronics. But the spread of microchips will be slower than many forecasts suggest and their impact will be evolutionary rather than revolutionary."

This statement appears in stark contrast to much of the other literature emanating from Great Britain on the employment implications of the silicon chip. The survey seeks to outline the impediments to the diffusion of microelectronic based technology in the factory, in the office and in consumer goods, and to comment on the potential employment impacts in the perspective of a slower rate of diffusion than is assumed in many other forecasts.

A notable number of authors are predicting future unemployment consequences on the basis of an extremely rapid rate of diffusion of the technology. This report outlines restraints on "chip induced change" which promise to slow the rate of diffusion below that predicted in many forecasts. The restraints arise from a number of different sources: (1) Production of chips has been unable to keep pace with the expanding demand. As a reflection of this shortage, prices for some types of chips rose by 15 to 20 percent in the first half of 1980, interrupting the traditional downward trend in the price of semiconductors, (2) Software costs have continued to climb, reflecting a shortage of skilled programmers and analysts. Estimates indicate that "worldwide capacity to write programs is growing by 18 percent a year which is several percentage points slower than the rate at which computers are being installed." (3)Equipment incompatibilities are hindering applications. (4) Social and institutional barriers such as labor resistance to change from union and non-union sources, conservatism in the business community, problems of the legality and security of information systems and unresolved problems of inconsistent regulatory legislation over telephone, telex and data networks impede rapid diffusion of the technology

CONCLUSIONS

(1) As a consequence of the social, institutional, economic and technical barriers the author predicts that complete automation of information flows in the office are "at least 20 years in the future." Similarily, "the experts are unanimous that it will be a long, slow haul before the bulk of manufacturing industry is affected."

(2) While negative employment effects have been experienced in certain industries, increasing demand and the development of new products have more than offset the negative effects in other industries.

(3) The failure to maintain competitiveness in international markets, as a result of slow adoption of

microchip-based technologies, will have at least as significant negative employment effects as will the technology itself.

(4) "The other obvious generalization is that a growing economy will more easily absorb redundant labor than one that is stagnating."

(5) The policy approach of shortening the work week and promoting job sharing is the least promising. Negotiating such changes internationally is not feasible and the isolated adoption of such policies in individual countries would serve to undermine international competitiveness.

(6) The most effective policy is to initiate training programs for the required skills. "High unemployment in Western Europe conceals shortages of many skilled categories."

Barron, Iann and Curnow, Ray. The Future with Microelectronics: Forecasting the Effects of Information Technology. London: Frances Pinter Ltd., 1979.

Reviewed in Zeman.

Battelle. "Technological Development and its Impact on Work Place in Machine Manufacturing and Precision Engineering." Report. Batelle Institute e.v., 1978.

Reviewed in Zeman.

Beach, Earl F. "Technological Unemployment: A Failure in Theorizing." Industrial Relations-Relations Industrielles. Vol. 31(1), 1976, pp. 122-132.

Bell, Daniel. "Thinking Ahead: An Information Revolution Presents New Opportunities and New Problems for Business and Society." Harvard Business Review, May/June, 1979.

Bell, Daniel. "Post-Industrial Society, the myth of the service economy." Futures, vol. 9(April, 1977), pp. 1-3, 114.

Benn, A. "Eight in Ten Secretaries will Lose Jobs." Presentation to the Labour Women's Conference in Felixstowe, U.K., 17-19 June, 1979.

Reviewed in Zeman.

Birenbaum, Rhonda. "Hospitals turn to computers as the paperwork piles up." ComputerData, October, 1980, pp. 50-54.

The author estimates that hospitals spend 30 percent of their time in information handling activities. For this reason hospitals have become a major target for the automation of information flows. This is but one of a number of articles about York Central Hospital in Richmond Hill,

Ontario, Canada's pioneer hospital in the area of on-line data base patient information systems. Advantages to the communications linked microprocessor system in the hospital are experienced because of improvements in the speed of response to test results, greater accuracy, a reduction in clerical work and an ability to perform functions such as drug interaction checks. The system, however, has done little to change the cumbersome nature of the medical record, and York Central's director feels that "it may be some time before administrators do away with the present hard copy medical record. No specific data are provided about the effect of the system on total employment in the hospital.

Bounine, J. and Lussato, B. Telematique...ou Privatique? Questions a Simon Nora et Alain Minc. Editions d'Informatique, Paris, 1979.

Reviewed in Zeman.

Braun, E. Technological Change and Employment. Technology Policy Unit, University of Aston.

Brauscomb, L.M. The Electronics Revolution: Micro Circuits and Macro Challenges. Paper presented by Vice-President IBM at the U.S. Embassy London, 15 January 1979.

Briefs, Ulrich. "The Effects of Computerization on Human Work - New Directions for Computer Use in the Work Place." Paper presented at the Second International Federation of Information Processing (IFIP) Conference "Human Choice and Computers," Baden, Austria, 4-8 June 1979.

Reviewed in Zeman.

British Association for the Advancement of Science (The). Technology and the Future of Work. A one day symposium held by the British Association for the Advancement of Science 22 Novemeber 1978, in London. (113p.)

Papers include:

(1) Maddock Sir Ieuan. "The future of work." (Looks at the forces influencing the pattern and scale of work and discusses their possible effects in the future.) pp. 8-26.

(2) Sadler, Philip. "Technology and the future of employment in Europe." pp. 69-75.

(3) Fyfe, John. "The economic and employment aspects of technical change." pp. 76-95.

Butler, D. "Telecommunications and Society--Key Policy Issues for the Future." Telephony, February 4, 1980.

Canadian Federation of Communications Workers. Employment Trends and Technological Change in Canadian Telecommunications Industry. Toronto, November, 1977.

Carre, D. and LaMoigne, J.L. "Pour un Contre-Rapport Nora." Hebdo, Aix-en-Provence, 1978.

Reviewed in Zeman.

Cleaver, A.B. "The Future of Computers in Financial Institutions." Long Range Planning, June, 1980. pp. 12-20.

The article examines the increased use of computers in financial institutions. Conclusions of the study are: (1) Applications are limited because of the relatively high costs of the technology. (2) Where application is common, in areas such as check clearing, manual methods are unable to cope with increased business volumes. (3) Decreases in the price of the technology in conjunction with increases in the power and complexity of the equipment is eroding the price barrier. (4) Adoption of fully automated banking systems requires a reorganization of the banking system and a redefinition of objectives. These institutional barriers will take a longer time to overcome than the technical and economic factors.

Clutterback, D. "The future of work." International Management, Vol. 34(6), August, 1979, pp.16-19.

The article concentrates on the impact of microelectronics on employment in the manufacturing sector. The author suggests that a reduction in the need for labor in manufacturing will be experienced for both production line workers and for middle management. The suggested policy measure to deal with the reduction in employment opportunities in this sector is an increased emphasis on leisure activities.

Cockroft, D. "Chips with Everything: How New Technology Affects You: Commerce." Personnel Management, Vol. 11(6), June, 1979, p. 32.

As office technology becomes increasingly automated some thought must be given to the effects that this will have on employment. Trade unions should be given some voice in the design and implementation of electronic office systems.

Computer Technology and Employment. Proceedings of an AUEW/TASS conference held on 16 September 1978 in London. Published by the National Computing Centre, London, 1979. (167p.)

Includes:
(1) Booth, Albert. "Technology and society." pp.15-30.
(2) "The view from Western Europe." (German, Italian and French metal workers present their policies and views about the new technology), pp. 37-45.
(3) "Technology and union policy." (Views from a number of different industries are presented.), pp. 47-66.
(4) Benson, Ian. "Notes on the economic and social impacts of computer technology," pp. 79-99.
(5) Labour Research Department. "The Structure of the Electronics Industry." pp. 117-126.

Crean, J.F. "Automation in Canadian Banking." The Canadian Banker and I.C.B. Review, Vol. 85, No. 4,5 and 6 and Vol. 86, No. 1 and 2.

This is a five part series describing automation in the Canadian banking system. It contains little specifically on the employment implications of the new technology. It does, however, deal with some related topics which bear on the employment issue. Major points made in the series of articles can be briefly enumerated: (1) Automation of the check clearing process speeded up the function and resulted in greater efficiency and accuracy. (2) Automation of accounting functions eliminated clerical functions of posting and balancing accounts which generally required tellers to work overtime. (3) As a result of automation banks were able to provide additional services. The most notable of these has been the bank credit cards, which have grown to be a major proportion of the banks business activity. (4) Little progress has been made in the area of electronic funds transfer (EFT) because of unresolved institutional and legal issues and a resistance to change by the public at large. (5) The growing volume of checks written, loans and credit card accounts could not be handled with manual methods of information handling. (6) The automation of information handling in the banking system lags behind the capabilities of the technology. "It has frequently been asserted, for example, that the future will see the implementation of systems in which the consumer's purchanses will be instantaneously debited to his account...while such a scenario is technically possible, it is far more likely that the customer will continue to demand payments systems which allow for the use of credit cards, and provide him with a legally recognized record of his purchases."

Critchlow, Robert V.; and others. Computer Manpower Outlook. Bulletin No. 1826, Bureau of Labor Statistics, Washington, D.C., 1974.

The objectives of this study are: (1) to provide information on the current employment and education and training characteristics of computer occupations, (2) to

explore the impact of advancing computer technology on computer manpower and education, and (3) to project computer occupational requirements and their implications for training. Some of the major findings of the study are: (1) employment in computer occupations is expected to grow more slowly over the 1970-1980 period than during the past decade, and the distribution of workers among computer jobs is expected to change; (2) hardware prices have decreased and are expected to continue to fall over the next decade; and (3) increasing sophistication and complexity of computer personnel functions will require workers with more and better training than in the past.

Critchlow, Robert V. "Technological Change in the Printing and Publishing Industry." Monthly Labor Review, August, 1970, pp. 3-9.

This study examinies the impact of computerized typesetting in the printing industry on specific occupations, skills and employment. The author contends that rising demand for printed material should mitigate the negative employment effects in the industry. Displacement will, however, be experienced in certain occupational groups.

_____. "Technology and labor in automobile production." Monthly Labor Review, October, 1977, pp. 32-35.

"Computers, automatic assembly lines and other labor saving innovations will create jobs for many specialists, but slow demand for semi-skilled workers." By 1985 technical and other changes will alter occupational structure in industry, with employment increasing in 3 occupational categories: managers and other officials, sales workers and operatives; and decreasing in all others: professional and technical, clerical, craft, service and laborers. Discussion in the article includes the types of changes that are expected to occur, expected rates of diffusion, potential productivity increases and labor adjustments.

Crook, W.J. and Syrett, D. "Computerized Admissions Mean Automatic Efficiency." Dimensions in Health Service. September, 1975, pp. 26-29, and Crook, W.J. "Computerized Admissions Revisited." Dimensions in Health Service, December, 1977, pp.17-18.

A two part examination of the experience of Wellesley Hospital in Toronto with the automation of the admitting, discharge and transfer function. Computerization of this function had a number of effects on work functions and employment in the hospital: (1) eliminated repetitive compilation of data for administrative reports and allowed the transfer of 2 clerical workers to another department in the

hospital. (2) Allowed the compilation of new daily reports of patient lists, bed inventory and patient registers which produce more information and (3) provides a data base for future computerization of other information flows in the hospital.

Dickson, K. and Marsh, J. The microelectronics revolution: a brief assessment of the industrial impact with a selected bibliography. Technology Policy Unit, University of Aston, Birmingham, 1978. (87p.)

Considers the impact of applications of microelectronics in the manufacturing industry. Non-technological factors influencing these applications are also discussed.

Dooley, Ann. "Survey Finds DPers at Top of Most Wanted Workers." Computerworld, Vol. 12(29), July 17, 1978, pp. 1-6.

Discusses the growth in demand for data processing specialists. Notes that there has been an average growth rate of 21.7 percent for data processing professionals with the major areas of growth experienced for: (1) systems analysts, (2) telecommunications specialists, (3) programmers, (4) accountants with computer backgrounds, and (5) data processing managers. Shortages of trained personnel in all these areas have resulted in rapidly rising salaries for qualified personnel.

Dostal, Werner. Microprocessors, Technological Development and Impact on Employment. (in German). Report 1A - IAB, Nuremburg, 1978.

Dostal, W. and Ulrich, E. et al. "Impacts of Technological Change on Labor." IAB, Nuremburg, 1977.

Reviewed in Zeman.

Dymmel, Michael D. "Technology and Telecommunications: Its Effect on Labor and Skills." Monthly Labor Review, January, 1979, pp. 13-19.

Reviewed in Zeman.

Elling, Karl A. "Co-determination by decree is not a panacea." Labor Gazette, Vol. 76(10), October, 1976, pp. 533-534.

Reviewed in Zeman.

Engberg, Ole. "Who Will Lead the Way to the "Infor- mation Society'?" Impact of Science on Society (UNESCO), Vol. 28(3), July-September, 1978, pp. 283-295.

Reviewed in Zeman.

Erlander, B. Effects of Computerization on Employment and Working Environment. Dir. 1978: 76. Decision at Cabinet Meeting July 20, 1978, Stockholm.

Reviewed in Zeman.

Finn, E. "The Labor Perspective." CIPS Review, Vol. 4(1), January/ February, 1980, pp. 24-26.

The Canadian labor view of the possibilities of microelectronic induced unemployment is presented. The article discusses the possible policy responses to the problem of technological unemployment.

Freedman, A. "Office automation in the insurance industry." Monthly Labor Review, November, 1965, pp. 1313-1319.

Freeman, C. "The Kontratiev Long Waves, Technical Change and Unemployment." Paper. University of Sussex, U.K., January, 1979.

Reviewed in Zeman.

Freeman, C. Technical Change and Future Employment Prospects in Industrialized Societies. Paper presented at the "Workshop on the Relationship between Technical Development and Employment, Six Nations Programme on Aspects of Government Policies towards Technical Innovation in Industry." Paris: 13-14 November, 1978.

Freeman, C. Technical Change and Employment. Paper presented at the conference on "Science Technology and Public Policy: An International Perspective," University of New South Wales, 1-2 December 1977.

Reviewed in Zeman.

Friederichs, G. "Microelectronics - A New Dimension of Technological Change and Automation." Paper, Club of Rome Conference on The Coming Decade of Danger and Opportunity, Berlin, October, 1979.

Reviewed in Zeman.

Gotlieb, C.C. and Borodin, A. Social Issues in Computing. Chapter 9, Computers and Employment, pp. 164-191, New York: Academic Press, Inc., 1973.

The effects of computers on employment in the industrialized countries is discussed. The authors conclude that the evidence to date suggests that computers have not had a major unsettling effect on employment. The effects have been essentially the same as any other major technological change. Changes in the composition of the work force have occurred, and productivity has increased but these changes have been gradual. Aggregate demand has kept pace with productivity increases so that employment has remained relatively stable. Skill requirements within industries have both increased and decreased. Eventually the accumulated effects of continued applications of the new technology may have a profound impact on the nature and meaning of work.

Gottheimer, D. "Business Systems: 1979 Overview." Dun's Review, Vol. 113(3). March, 1979, pp. 15-16.

Discusses the possible impacts of current office equipment on productivity growth and employment of middle management personnel in offices.

Great Britain. Cabinet Office. Advisory Council for Applied Research and Development. The applications of semi- conductor technology.. London: HMSO, 1978. (32p.)

This is the report of the working party set up to consider the effect of developments in semi-conductor technology on U.K. industries, identifying those particularly affected. Opportunities and possible threats which these developments present are outlined and it is recommended that industry's awareness of the new technology and its potential should be increased.

Great Britain. Central Policy Review Staff, Cabinet Office. Social and Employment Implications of Microelectronics. November, 1978. (24p.)

This is a progress report on the work of the CPRS on the employment and social effects of microelectronics. CPRS do not foresee massive unemployment providing the U.K. remains internationally competitive in the sectors which will be most affected. Changes in society as a result of new microelectronic applications are considered.

Great Britain. Department of Industry. Microelectronics: an annotated bibliography. August, 1979.

The bibliography is divided into three major sections:
(1) Employment and Social Implications of Microelectronics.
(2) Microprocessor technology.
(3) Microprocessor applications.

Great Britain. Department of Industry. London and South East Regional Office. Chips with Everything: microprocessor technology - its applications and implications. 1978. (80p.)

A collection of papers presented at a seminar sponsored by the U.K. Department of Industry on microprocessor technology and its applications in British industry.

Halina, Jos. W. Communications and Communities - A North American Perspective. Prepared for the International Commission for the study of Communications Problems, UNESCO. Ottawa: October, 1978.

Harman, Willis W. "Chronic Unemployment: An Emerging Problem in Post Industrial Society." The Futurist, August, 1978, pp. 209-214.

Reviewed in Zeman.

_____. Chronic Unemployment and Underemployment. Research Report CSSP 4676-14, Center for the study of Social Policy, SRI International. Menlo Park, California, February, 1978.

Reviewed in Zeman.

Harvey, David. "When the Robots Take Over -- What's Left?" Chief Executive Monthly, December, 1979, pp. 43-47.

By the end of the 1980s, industrial robots will be in widespread use. Both skilled and unskilled employment could be affected. Some forecasters predict that the concept of jobs as essential ingredients of life will vanish as a result of advances in microelectronic technology. These negative impacts on employment are already being experienced in some areas. The changes may take place against a background of slow economic growth and an increasing number of people coming into the labor market. Union agreements and government policies regarding the displacement of jobs by technology ease the adjustment process.

Haslam, J. "An appraisal of microelectronic technology." National Westminister Bank Quarterly Review, May, 1979, pp. 54-64.

This article discusses the development of the microelectronics industry in the U.K. Government support and the effects of the technology on employment and productivity in Great Britain are discussed.

Hayman, C. "Social and Employment Implications of Microelectronics." Paper. Central Policy Review Staff, London: November, 1978.

_____. If There is a Problem, Do the Services Industries Offer the Solution? U.K. Symposium for the Press, Sperry Univac International Executive Centre, Saint Paul-de-Vence, France, 27-30 September 1978.

Herman, A.S. "Manpower Implications of Computer Control in Manufacturing." Monthly Labor Review, October, 1970, pp. 3-8.

A six industry survey of the effects of computer control of industrial processes. The industries surveyed were: (1) chemical plants, (2) steel mills, (3) petroleum refineries, (4) electric power plants, (5) paper plants, and (6) chemical plants. The survey finds that expanded use of computer control in these manufacturing activities has created new jobs requiring retraining but has not displaced many workers.

Hines, Colin. The Chips Are Down: The Future Impact of Microprocessors and Computers on Employment in Britain. London: Earth Resources Research Limited, April, 1978.

Reviewed in Zeman.

Hyman, Joan. "Banks Intensifying On-line Efforts, but Some Not Ready to Take Plunge." Bank Systems and Equipment, Vol. 16(5), May, 1979, pp. 66-70.

Research conducted by Bank Systems and Equipment indicates that in the U.S. approximately 47 percent of commercial banks are using or will use on-line teller terminals within 12 months, but 30 percent of banks have no intention of implementing on-line systems in the next 2 years. The survey also determined that the majority of transactions are demand deposit transactions and some feel that these transactions are more time consuming on-line than when handled manually. Cost of the equipment was cited as the major reason for delaying installation. Increased teller productivity was cited as the major benefit of the innovation. In general, commercial banks are progressing towards electronic tellers but the changeover will be slow.

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

Reviewed in Zeman.

ISI. "Impacts of Microelectronics on the Bavarian Economy." ISI, Karlsruhe, 1978.

Reviewed in Zeman.

Jaffe, Maxine O. "Banks See On-Line Terminals as Hedge Against Soaring Labor Costs." Bank Systems and Equipment, Vol. 16(5), May, 1979, pp. 72-78.

With labor costs constantly rising an increasing number of commercial banks are automating the teller function. Of banks using on-line systems, increased teller productivity and upgrading of services to customers are the most cited benefits of the systems. Most banks indicate that the systems are making a difference in staff needs by reducing teller and backroom personnel. A few banks indicate that transaction times increase rather than decrease after the systems are installed.

Japan Computer Usage Development Institute (JACUDI). Social and Economic Effects of Information Oriented Investment. Tokyo: Japan Computer Usage Development Institute, March, 1974.

Reviewed in Zeman.

Jenkins, Clive and Sherman, Barrie. The Collapse of Work. London: Eyre Methuen Ltd., 1979.

Reviewed in Zeman.

Jenness, R.A. Manpower and Employment: Problems and Prospects. Paris: OECD, 1978.

Reviewed in Zeman.

Jeud, D. "Chips With Everything: How the New Technology Affects You: Shop." Personnel Management, Vol. 11(6), June, 1979, p. 36.

This article concentrates on the effects of developments in microelectronics on employment in retailing. The author concludes that retailing will not greatly alter in response to the new technology. However, it is suggested that planning ahead for labor displacement will ease the transition.

Kaufmann, Felix. "The Jobs That Nobody Wants: Economic Challenges of the 1980s." The Futurist, August 29, 1979, pp. 209-214.

Kerr, C and Rostow, J. (eds.). Work In America: The Decade Ahead. New York: Van Nostrand Reinhold, Spring, 1979.

Kettle, John. "Automation: It Does Work." Executive, June, 1980, pp. 12-13.

The author argues that automation does create unemployment. The reasons that we have not as yet experienced rapidly rising levels of unemployment in industrialized nations is a result of the absorption of displaced labor in non-productive types of jobs. In order to ease the transition unions have insisted on reduction of labor by attrition rather than layoffs, companies have created fictitious jobs, some people, discouraged by the lack of work, have ceased job hunting. The current developments in microelectronics, coupled with rising wage rates and the falling costs of the technology threaten massive unemployment. The problem of how to distribute income will become a major issue in a society where productive activities are largely automated.

Kirchner, Jake. "Micros Seen Moving too Quickly." Computerworld, Vol. 13(37), September 10, 1979, pp.7-8.

In the opinion of William Davidow of Intel Corporation, the rapid development of microprocessor technology is far outpacing the ability of end users to apply the technology. Most end users do not require microprocessors which are more advanced than the present generation. What is required is that problems with the current generation of microprocessors be resolved.

Lamberton, D. Mcl. Social Costs of Change, Employment, Professional Skills and Curricula. Discussion Paper , Group of Experts on Economic Analysis of Information and the Role of Electronics and Telecommunications Technologies. Paris: Organization for Economic Cooperation and Development (OECD), 30 November 1978.

Reviewed in Zeman.

Lamborghini, B. "The Diffusion of Microelectronics in Industrial Companies." Olivetti, Torino, 1979.

Reviewed in Zeman.

Lea, D.E. et al. Employment and Technology. 1979.

Reviewed in Zeman.

Lemoine, Philippe. Informatisation and Economic Development. Discussion Paper, Group of Experts on Economic Analysis of Information Activities and the Role of Electronics and Telecommunications Technologies. Paris: OECD, 12 April 1978.

Reviewed in Zeman.

Leontieff, Wassily. "Observations on Some Worldwide Economic Issues of the Coming Years." Challenge. March/April, 1978, pp. 22-30.

Reviewed in Zeman.

_____. "Is Technological Unemployment Inevitable?" Challenge. September/ October, 1979.

Reviewed in Zeman.

Lindley, R. (ed.). Britain's Medium Term Employment Prospects. University of Warwick, 1978.

Lund, R.T. et al. Industrialization Automation - Its Nature, Effects and Management: Critical Issues Report. Report, Center for Policy Alternatives. Cambridge: MIT, 1978.

Reviewed in Zeman.

Lund, R.T. Microprocessor Applications: Cases and Observations. Report, Center for Policy Alternatives. Cambridge: MIT, 1979.

Reviewed in Zeman.

_____. "Microelectronics and Productivity: Cashing in Our Chips." Technology Review, January, 1981, pp. 32-36, 38, 44.

"Microprocessors can have dramatic effects on worker's job content, location and employment levels in all aspects of product manufacture and use." In manufacturing activities micreelectronic technology is seen to result in expanded requirements for light electronic assembly and reduced requirements in the production of mechanical parts. There is a deskilling effect in production and service jobs and an increase in skill requirements for professional, technical and supervisory jobs.

In the firms studied by the author, employment in the short run tended to expand, "probably because of increases in the market share or general market expansion." The longer term employment effects of the technology, however, were not as clear. "It seems likely that the more important employment effects will involve firms that retain conventional technlogy. These firms may experience a reduction in employment or a curtailment in growth as their competitors' microprocessor-based products capture larger shares of the market." On the positive side microelectronic technology is seen as creating a large number of programming jobs.

Machlup, Fritz, Bitros, George, and Leason, Kenneth W. Effects of Innovations on Demand for Earnings of Productive Factors--Volume 1, Executive Summary and Analytical Report. Prepared for the National Science Foundation. Springfield, Va., 1974.

Reviewed in Zeman.

Macut, J.J. et al. Technical Change and Manpower Trends in Major American Industries. Bureau of Labor Statistics, U.S. Department of Labor, Washington, D.C., 1974-1979.

Reviewed in Zeman.

Magnusson, B. Electronic Data Processing and Manpower Report. Stockholm: National Central Bureau of Statistics, 1977.

Reviewed in Zeman.

Management Institut Hohenstein. Inquiry into the Third Technological Revolution.

Reviewed in Zeman.

Mark, J.A. "Impact of Technical Change on Labor." Paper. National Conference on the Impact of Technological Change on the Work Place, St. Louis, MO., June, 1979.

Reviewed in Zeman.

Mather, B. "Computerization and Employment: A Labor View." Canadian Federation of Telecommunications Workers, Ottawa, January, 1980.

McIntosh, T. "Union Agreement Could Hearld Electronic Office." Electronic Times, June 7, 1979.

Reviewed in Zeman.

McLean, J. Michael. The Impact of the Microelectronics Industry on the Structure of the Canadian Economy. Occasional Paper No. 8. Montreal: Institute for Research on Public Policy, March, 1979.

McLean, J.M. and Rush, H. J. The impact of Microelectronics on the U.K.: a suggested classification and illustrative case studies. Science Policy Research Unit Occasional Paper Series No. 7, University of Sussex, 1978. (51p.)

Provides a classification of microprocessor applications and considers their impact on the materials handling, textile and automotive industries. Word processing technology is also discussed. Employment effects in all these areas are particularly studied.

McNair, Malcolm P. and May, Eleanor G. "The Next Revolution of the Retailing Wheel." Harvard Business Review, September/October, 1979, pp. 81-91.

Michael, Donald M. Cybernation: The Silent Conquest. Santa Monica, California: Center for the Study of Democratic Institutions, 1962.

Miller, Frederick W. "WP Salary and Equipment Survey: Users Say What They Pay, What They Use." Infosystems, Vol. 27(6), June, 1980, pp. 56-57.

Less than 50 percent of the business that use word processors have centralized word processing departments, indicating that it is a function performed by a few workers among a group of users. The heaviest users are government agencies, publishing firms, public utilities and insurance companies. The majority of users do not employ units with remote communications capabilities, so that electronic mail, document transmission and remote job entry to computers are not commonly found uses of the technology.

Morgenbrod, H. and Schwartzel, H. "How New Office Technology Promotes Changing Work Methods." Management Review, Vol. 68(7), July, 1979, pp. 42-45.

Office automation is predicted to proceed at an extremely rapid rate. It is predicted that this will lead to a major restructuring of the work environment in the office but will not be damaging to personnel.

Newhouse, Joseph P. "Technological Change in Banking." in Employment Impact of Technological Change, Appendix II, U.S. Commission on Technology, Automation and Economic Progress, Washington, D.C., 1966.

Niles, Jack M. "Opportunities and Threats from the Personal Computer." Futures, Vol. 11(2), April, 1979, pp. 172-176.

Reviewed in Zeman.

Nora, Simon and Minc, Alain. L'Informatization de la Society. Paris: La Documentation Francaise, January, 1978.

Reviewed in Zeman.

Norman, Colin. Microelectronics at work: productivity and jobs in world economy. Worldwatch Paper No. 39, Washington: Worldwatch Institute, October, 1980. (63p.)

The paper discusses the anticipated impact of microelectronics in the office and the factory and the international dimensions of the microelectronic revolution.

"The new microelctronic technology has brought within reach a vast rnage of products and processes that would have been unattainable just ten years ago..."

"An attempt to assess their (microelectronic based innovations) impact is akin to forecasting the effect of the automobile on society as the first Model T rolled off the assembly line."

"Microelectronics will affect both the number and types of jobs available but more jobs will be lost in countries which lose their competitive advantage as a consequence of the failure to adapt."

Norman, Colin. "International Stakes in Microelectronics." Technology Review, January, 1981, pp. 40, 41, 43.

This article contains little on the employment implications of microelectronic technology. Rather, it focuses on the policies of governments toward the microelectronic industry and the extent of development of the industry in different countries. The author notes that, while the U.S. still dominates the world market for integrated circuits, Japanese companies are beginning to provide some stiff competition. The European community lags well behind the U.S. and Japan in terms of the development of a microelectronic industry. The author contends that the efficiency gains made possible by microelectronics will mean that countries which fail to adopt the technology will lose their share of the world market and hence will experience more severe employment effects than will countries adopting the technology.

Organization for Economic Cooperation and Development (OECD). Technical Change and Economic Policy: Science and Technology in the New Economic Context. Paris, 1980.

Oman, Ray. "Cost/Productivity of Automatic/ Coventional Typewriters." Journal of Systems Management, Vol. 29(7), July, 1978, pp. 10-14.

The purposes of this study were to examine the comparitive productivity and labor costs of word processing equipment and conventional electric typewriters. The data for the study were obtained from actual office environments. The results indicated that the cost of producing a document on a word processor was significantly higher than on a conventional typewriter. This finding is in direct contrast to the claims of vendors and some users of automatic typewriters who contend that efficiency is greatly enhanced by a switch to the more sophisticated equipment.

Pavitt, Keith. "Technical Change: The Prospects for Manufacturing Industry." Futures, August, 1978, pp. 283-292.

Conclusions of the analysis of the study can be summarized: (1) The overall question of the net employment impact is difficult to answer, "although it may be possible now to assess the effects over the next 10 to 20 years of the dampening factors, it is much more difficult to assess the growth stimulating factors." (2) Negative employment effects of microelectromic technology will eliminate jobs in electronic assembly, precision engineering and routine office work. (3)There may be some positive effects in the manufacture of new consumer goods based upon the technology. (4) Trends in manufacturing towards more sophisticated production methods depends upon increasing the supply of certain kinds of skilled manpower. Problems of structural unemployment "could become more accute, unless increased resources are devoted to manpower training and retraining." (5) Some countries, because of the "quality and quantity of technical skills and R and D activities are in a better position to take advantage of the opportunities presented by the new technology." These countries include Germany, Japan, the Netherlands, Sweeden and Switzerland. Weaker OECD member countries are identified as the United Kingdom and countries of Southern Europe.

The article is based upon, what the author refers to as, speculation about the future direction of technical change and its policy implications. The analysis and conclusions are, therefore, very subjective.

Peitchinis, Stephen G. The Attitude of Trade Unions Towards Technological Changes. Research Report, Technology Branch, Department of Industry, Trade and Commerce, Ottawa: April, 1980.

_____. The Effect of Technological Changes on Educational and Skill Requirements in Industry. Research Report, Technology Branch, Department of Industry Trade and Commerce, Ottawa: April, 1978. (272p.)

Reviewed in Zeman.

_____. "The Impact of Technology." CIPS Review. Vol. 4(1), January / February, 1980, pp. 18-21.

_____. The Introduction of Computer- Aided Design CAD /Computer-Aided Manufacturing CAM Systems and Their Employment Implications. Research Report, Technology Branch, Department of Industry Trade and Commerce, Ottawa: September, 1980.

This report discusses the factors influencing the adoption of CAD/CAM technologies in Canadian industry and the potential employment implications of the technology. The conclusions with respect to employment as summarized in the report are: (1) The introduction of varying phases of Computer -Aided Design/Computer Aided Manufacturing Systems is expected to accelerate over the current decade. (2) Fragmentary evidence suggests widespread impacts on employment, skills and job contents. (3) The effect on production 'blue-collar' workers is generally expected to be negative. (4) The effect on non-production workers--management, production planners, systems analysts and other scientific professional and technical workers - is generally expected to be positive.

_____. Technological Changes and the Demand for Skilled Manpower in Canada. Research Report, Department of Industry, Trade and Commerce, Ottawa: October, 1980.

_____. "Technological Changes and the Sectoral Distribution of Employment." Paper presented atthe 1979 Annual Meeting of the Western Economic Association in Las Vegas, Nevada, 21 June 1979.

Reviewed in Ze man.

_____. Technological Changes and Employment. Research Report, Technology Branch, Department of Industry Trade and Commerce, Ottawa: February, 1980. (29p.)

Phillips, Glen. Technology - Employment - Education. Selected Bibliography from the Southern Science and Technology Forum held at the University of Southampton, 9 October 1979. (7p.)

A partially annotated bibliography.

Porat, Marc U. The Information Economy. Palo Alto, California: Stanford Center for Interdisciplinary Research, 1976.

Post News. Electronics in Supermarkets. Report Sommerset, U.K., 1979.

Reviewed in Zeman.

Prentis, M.R. The Information Revolution - Some Policy Perceptions. Ottawa: Telecommunications Economics Branch, Department of Communications, May, 1979.

Rabeau, Yves. Tele-informatics, Productivity and Employment: An Economic Interpretation. GAMMA Information Society Project: Phase II, April, 1980.

Rada, Juan F. The impact of microelectronics: A Tentative Appraisal of Information Technology Geneva: ILO, 1980. (109p.)

The unpublished version is reviewed in Zeman.

Renowden, J. "Chips With Everything: How New Technology Affects You: Commerce." Personnel Management, Vol. 11(6), June, 1979, p. 32.

Labor in industry will be affected as microelectronics takes over the functions of information handling and control. The implementation of these new systems will require the hiring of staff with different types of skills or the retraining of existing personnel.

Robinson, L.A. "Office Automation: Stimulus or Deterrent to Clerical Growth." Personnel Journal November, 1971, pp. 846-855.

By office automation the author is referring to the conversion of information systems to computer based systems. An attempt is made to compare clerical employment to productivity, as measured by gross sales, in 61 firms. Conclusions of the analysis can be summarized: (1) Computers have assisted in checking but not reversing the clerical growth in firms with several years experience with EDP methods. (2) Use of computers has give related clerical functions a high degree of stability so that they are less sensitive to fluctuations in the general level of business activity. (3) There is a decline in total clerical costs as a proportion of gross sales when computerized methods of information handling are employed. This decline appears to be in direct proportion to the length of experience with computerization of information flows implying a considerable "learning-by-doing" phenomenon. (4) This labor substitution effect which arises after experience with the technology does not imply a reduction in total clerical personnel unless clerical growth is greater than the rate of growth in demand for services.

Rogers, Thersa F. and Nathalie S. Friedman. Printers Face Automation: The Impact of Technology on Work and Refinement Among Skilled Craftsmen. Lexington, Mass: D.C. Heath and Co., 1980.

Rosen, A. "Percentage of the Labor Force in Manufacturing in the Year 2000." Personal Note, Stanford Research International, California, May 15, 1979.

Reviewed in Zeman.

Rosenburg, Ronald and Conuel, Tom. "Computer Jobs: The Sky's the Limit." Mini-Micro Systems, Vol. 2(9), September, 1978, pp. 29-35.

The article examines the growth in the computer industry and the resultant growth in demand for all aspects of employment in the computer field. Great shortages of trained labor exist in all areas. The shortages are seen to be particularly severe for engineers with experience with mini and micro systems and for systems analysts. Ten jobs exist for every applicant. These shortages have led to intense competition between companies for skilled labor and have resulted in rapidly rising salaries for data processing personnel.

Ross, David P. "Unemployment in the Industrialized World." Perception, Vol. 1(4), March/April, 1978, pp. 7-10.

Reviewed in Zeman.

Rothberg, Herman J. "A Study of the Impact of Office Automation in the I.R.S." Monthly Labor Review, October, 1969.

A case study of the employment implications of computerization of the processing of income tax returns in the Internal Revenue Service in the U.S. This is a detailed study of the effects of office automation on work functions, total employment and occupational structure. Conclusions: (1) Reductions in clerical staff were not experienced as a result of automation because of an increase in the number of returns processed and the undertaking of more extensive examination and verification of the returns. (2) Under the manual system previously employed it is estimated that 15,000 extra employees would have been required to handle the same work load. (3) A general upgrading of skill requirements was experienced, with more than 7 percent of the total positions being computer related. (4) Administrative positions as a proportion of the total work force increased but clerical positions such as posting, checking and record keeping declined.

Rothwell, Roy and Zegveld, Walter. Technical Change and Employment. Report prepared for the "Six Countries Programme on

Government Policies toward Technological Innovation in Industry." held in Paris, November, 1978; June, 1979. (159p.)

Includes examinations of the impact of microelectronics in the watchmaking industry, the office, the printing industry, the telecommunications industry, the textile industry, manufacturing and the self-service sector.

Rowland, Tom. "Technology's Threatening Promise." Management Today, March, 1979, pp. 94-97, 158-163.

The author examines the proposition that microelectronic technology has been responsible for the decline in employment in the manufacturing sector in Great Britain. The analysis of the British economic system indicates that it has been the decline in the competitiveness of British industry which has been responsible for the decline of employment in manufacturing. The author contends that microelectronics has long run benefits for labor and society. Microelectronics improves productvity, allowing goods and services to be produced at lower costs. It opens up new opportunities for the creation of new jobs through the development of new products and services. Finally it allows low skilled workers to perform complicated tasks.

Russel, Robert A. The Electronic Briefcase: The Office of The Future. Occasional Paper No. 3. Montreal: Institute for Research on Public Policy, September, 1978.

Sandberg, Ake (ed.). Computers Dividing Work and Man: Recent Scandinavian Research on Planning and Computers from a Trade Union Perspective. Demos Project Report, NO. 13. Stockholm: Sweedish Center for Working Life, March, 1979.

Schafer, Joachim. "The West German Perspective." CIPS Review. Vol. 4(1), January/February, 1980, pp. 26-29.

A review article of West German experiences with microelectronic technology. Some specific estimates of the consequences of the effects of the technology on employment in the office, banks and insurance companies are provided.

Scrimgeour, J.H.C. CAD/CAM and its Impact on the Manufacturing Industry. Paper presented at the Canadian Conference on Automatic Control, McGill University, Montreal: 23-25 May 1979.

Serafini, S. et al. "Post Industrial Canada and the New Information Technology." Canadian Futures, Vol. 1(1), 1979, pp. 81-91.

A brief overview of the debate on the possibility of technological unemployment as a result of the application of microelectronic technology to information processing activities. The article outlines the empirical evidence to date on the relationships between information and non-information labor and capital in the Canadian economy.

Sherman, B. et al. "Technological Change, Employment and the Need for Collective Bargaining." ASTM, London, 1979.

Reviewed in Zeman.

Sherman, B. "How do we cope with the microcomputer age?" Industrial Management, October, 1978, pp. 21-22.

An examination into the changes in work practise and attitudes needed to avert labor resistance to the microelectronic revolution.

Shaiken, Harley. "Microprocessors and Labor: Whose Bargaining Chips." Technology Review, January, 1981, p. 37.

Microelectronics can potentially reduce employment and change the job skills required in virtually every sector of the economy. Because of its potentially large impact on labor the microelectronics revolution has generated increasing concern by unions about decisions "shaping the design, deployment and use of technology. In fact, bargaining over technology may become a prominent feature of labor management relations in the coming decade."

Siemens, A.G. "Burro 1990." Unpublished report by the Siemens Company as reported in New York Times, July 5, 1978, p. D1.

Reviewed in Zeman.

Six Countries Programme on Aspects of Government Policies toward Technological Innovation in Industry. Workshop on the Relationship between Technological Development and Employment. Papers presented in Paris, 13-14 November 1978.

Papers include:
(1) Gershuny, J.I. "The Service Sector and Employment: Some Speculations on the Future Structural Changes in the Developed World." pp. 127-148.
(2) Lamberton, D.M. "Information Technology and Employment."
(3) Meriaux, B. and Vigezzi, M. "Automation, Structures and Volume of Employment: A critical analysis of the report Nora-Minc."
(4)Bechmann, G. and Vahrenkamp, R. "The Industrialization of the Service Sector--The Case of Computer- Aided Design (CAD)."

Steiner, Carl L. Automation and Technological Change in Banking. Bureau of Employment Security, Department of Labor, Washington, D.C., 1966.

The purposes of this study were to determine the personnel change directly resulting from the installation of electronic data processing in one of the large commercial banks in Baltimore, to describe the processes and job duties involved and to indicate how changes have affected employment and what may be expected in the future. The use of the equipment resulted in some shifiting and retraining of personnel but no unemployment. Actually more workers were added to care for the increased volume of business. Only 48 jobs were abolished while 58 were created and 40 more were increased. Although the outlook is for continued growth in the industry, bankers do not agree on the amount of employment expansion likely to take place. Banks have been able to fill the executive ranks with higher starting salaries, training programs and rapid promotion but have been forced to use part time workers to meet peak seasonal demands. However, most are using electronic data processing now to meet growing shortages of clerical personnel. So far high speed machines are tools for coping with shortages rather than replacing employees. They are being used to make possible a wider range of services at greater speed. Because of the considerable time required to change to automation and get the system working, the impact of electronic data processing on jobs in banking probably will not be apparent for several years. The Appendix contains job titles and codes, organization charts, and job descriptions for new and

expanded jobs resulting from installation of electronic processing equipment in one large commercial bank.

Stewart, Jon and Markoff, John. "A Peek at the Office of the Future." Journal of Applied Management, Vol. 4(3), May/June, 1979, pp. 30-31.

While the office of the future has so far failed to replace secretaries and clerical workers with video display terminals, the technology to do do exists. Economic incentives promoting office automation include: (1) the high rate of growth of information activities and information workers in industrialized countries, (2) high costs of office overhead, (3) low rates of productivity growth in offices, and (4) falling prices for microelectronic office equipment. Microelectronic automation of offices is likely to bring about an organizational revolution among white-collar workers. This revolution will be marked by the takeover of the tasks of the office support worker by machines. This will increase the efficiency and capabilities of executives and professionals.

Stonier, T. "Technological Change and the Future." Paper, Annual Meeting of the British Association for the Advancement of Science. Edinburgh, September, 1979.

Reviewed in Zeman.

Stoneman, P. "The Effects of Computers on the Demand for Labor in the United Kingdom." Economic Journal, September, 1975, pp. 590-606.

This is an empirical attempt to isolate the effects of computerization on employment in Great Britain. The study concludes that the net impact on employment of computers, to date, has been minor. Up until the middle of the 1960s computer technology created more jobs than it destroyed. Subsequently, the labor displacing effect of the technology became dominant. These negative effects, however, were quite small. By 1978 the labor displacing effect of computer technology was projected to be only one percent of the total labor force.

Strassman, Paul A. "The Office of the Future: Information Management for the New Age." Technology Review, Vol. 82(3), December, 1979/January, 1980, pp. 54-65.

Strassman is vice-president of Xerox Information Products with responsibility for strategic planning of office systems.

SUMMARY

The author presents a comprehensive analysis of the organizational barriers in the office setting which impede the automation of information flows. It is these institutional factors, rather than the technical factors, which will be most important in determining the future development of microelectronic based information technology. Without a concomitant restructuring of office organization the potential productivity improvements of microelectronic/telecommunications technology will not be realized. Interim technologies such as word processing and distributed data processing can not be expected to have major impacts on office employment in the short and medium term. In fact, the author foresees these interim technologies as having much the same effects on clerical and managerial employment as the main frame computers in the sixties. The information generating potential of the equipment will serve to increase information flows, which will require a growing clerical and managerial labor force. Therefore, Strassman predicts continued growth in office employment throughout the 1980's.

Strategies for Change in a Technological Society. Conference report, Bath University, 20 December 1977, University of Bath Science and Technology Education Center, 1978. (41p.)

Papers include:

(1) Stonier, T. "A profile of the post-industrial society." p.4.

(2) Owen, K. "Change in British industry." (Outlines the impact of new technology on various industries), pp. 10-16.

(3) "Adams, K. "Attitudes and ethics in a technological society." pp. 17-22.

(4) Barnett, Colin. "Employment and technological change." (Suggests methods of combating unemployment, such as shorter working weeks, work sharing and policies of job creation), pp. 23-30.

Strauss, Stephen. "Word Processors." The Toronto Globe and Mail, July 17, 1980, p. T1.

This article presents a survey of opinions about the effects of word processing and other microelectronic office technology on employment. Opinions are varied:

"Robert Fabian, a former computing science professor at York University, and now a consultant in the field, says experts estimate there is about a 25 percent increase in typing efficiency with the introduction of word processors that will mean one out of ten secretaries will lose their jobs."

"Adam Osborne, a California computer expert, suggests that half of the white collar managers will be dispalced by 1990."

This sensational second viewpoint is not widely accepted by experts responsible for installation of electronic office equipment or by users of the equipment. Among most experts and users a consensus has arisen that:

(1) Resistance on the part of managers to direct interaction with office equipment will retard application and maitain traditional office organization for quite some time.

(2) Benefits from word processors, in general, do not come from staff reductions but rather from checking the growth of the clerical labor force and speeding up of information flows.

(3) Word processors are often associated with increases in the amount of work: more letters are sent and more revisions are requested.

(4) Problems of incompatibility between equipment is hindering applications. A U.S. based consultant contends that; "Some things just can't be integrated no matter what the vendor tells you...Sometimes you can't communicate with different models of the same machine, or things made by parent companies and subsidiaries can not interface."

The results of these impediments, according to the author, are: "a kind of paralysis of action as companies wait for all the promises of an efficient future to become a somewhat more efficient present--a paralysis which is highlighted by the fact that half of the 100 largest companies in the United States had no intention of installing word processor at all" let alone fully integrated electronic office systems.

Thompson, Gordon B. Memo from Mercury: Information Technology is Different. Occasional Paper No. 10. Montreal: Institute for Research on Public Policy, June, 1979.

Thornton, P. and Wheelock, V. "What Future for Employment." Employee Relations, Vol. 1(1), 1979, pp. 3-6.

A projection of the effects of technological change on employment in Great Britain.

Tolbert, Samuel H. and Pertuz, Alvero E. "Study Shows How Computerization Affects Nursing Activities in ICU." Journal of the American Hospital Association, September, 1977, pp. 79-84.

This study reports the effects of computer based monitoring systems on work functions in a cardiac care unit. The study is unique because the hospital studied has 2 essentially identical units--one which is computerized and one which is not. Work sampling techniques were used to assess the impact of the computerized system. Work functions affected were direct patient care which averaged 17 to 21 percent less on the comuterized units. Time spent charting was also less but repetitive measurement of vital signs was unaffected by the computerized system. This last result was attributed to the fact that some nursing staff preferred manual measurement to automated measurement. The computerization of the monitoring system did not reduce the patient staffing ratio on the computerized unit.

Topfer, P. "Impacts of Technology: Developments in the Workplace in German Watch Industry." Nieder-Roden, 1978.

Reviewed in Zeman.

Trades Union Congress--General Council (TUC). Employment and Technology: A TUC Interim Report. 1979. (50p.)

The report discusses the development, application and impact of microelectronics. A programme of trade union action is presented together with suggestions for manpower policy and union education.

United States. Bureau of Labor Statistics. Department of Labor. Outlook for Technology and Manpower in Printing and Publishing. Final Report, Washington, D.C.: U.S. Government Printing Office, 1973.

The bulletin describes changes in technology in the printing and publishing industry, a major industry employing over 1 million workers. The study focuses on productivity, employment and occupational requirements, and describes methods of adjustment. It includes first hand information on the impact on production and manpower of electronic computers, phototypesetting equipment, web-offset printing, and other innovations at the nine printing firms which participated in the study.

United States Congress. Office of Technology Assessment. An Assessment of National Information Systems and Their Effects on Society. Working Paper No. 1. Washington, D.C.: Telecommunications and Information Systems Group, March, 1979.

United States. Department of Labor. Bureau of Labor Statistics. Manpower Planning for Technological Change - Case Studies of Telephone Operators. Bulletin 1574, 1968.

United States. Department of Labor. Manpower Administration. Technology and Manpower in the Health Industry 1965-1975. Manpower Research Bulletin No. 14, May, 1967. (107p.)

The bulletin provides a review of the expected impact of technology on labor skills, employment and occupational mix in the health field. Included are predictions of the effects of computers on job content, skill requirements and total employment in the areas of diagnosis, patient information systems and patient monitoring.

United States. National Commission on Technology, Automation and Economic Progress. The Outlook for Technological Change and Employment. Washington, D.C., 1966.

Valaskakis, Kimon. The Information Society: The Issue and the Choices. GAMMA Information Society Project: Phase I, March, 1979.

Vyssotsky, Victor A. "Computer Systems: More Evolution Than Revolution." Journal of Systems Management, Vol. 31(2), February, 1980, pp. 21-27.

The computer will affect most clerical, technical, managerial and professional jobs. Productivity in such activities may increase by 50 percent in 20 years, but this change will come about in evolutionary steps. The overall saving in clerical effort as a result of the substitution of electronic information flows for paper based information flows will be in the 20-30 percent range, but for the office as a whole net savings will be less than 15 percent. The speed at which electronic transmission of information will grow is not obvious.

Webb, T. "Jobs in Jeopardy and the Trade Union Response." Personnel Management, Vol. 11(7), July, 1979, pp. 28-31.

The article discusses the job displacing effects of microelectronic technology in the service sector. Shorter working hours, less overtime and early retirement are suggested as policy measures to deal with rising levels of unemployment as a result of the new technology.

Williams, T.J. "Computer Control and Its Effects on Industrial Productivity." The A.I. Johnson Memorial Lecture, Canadian Conference on Automatic Control, McGill University, Montreal, 24 May 1979.

Winkler, Connie. "Office of the Future May Not Work, Poppel Warns." Computerworld, Vol. 13(21), May 21, 1979, p. 12.

A report by an information systems management consultant contends that office organization is well behind office technology, so that the productivity increases that microelectronic / telecommunications technology make possible may not be realized in most office settings. The article reports that in many cases the introduction of the first phase of office automation, in the form of the word processor, increases office productivity by only ten percent.

Young, Howard. Jobs, Technology, and Hours of Labor: The Future of Work in the U.S. Paper presented by the Special Consultant to the President, International Union, United Automobile Workers. Presented at hearings of the Joint Economic Committee's Special Study on Economic Change, Washington, D.C., 14 June 1978.

Reviewed in Zeman.

Zeman, Zavis and Russell, Robert. "The Chip Dole." CIPS Review, Vol. 4(1), January/February, 1980, pp. 10-14.

A brief review of the polarization of the debate over the employment implications of microelectronic/telecommunications technology. The implications of the debate for the Canadian case are especially considered.

Zeman, Zavis et al. The Impacts of Computer / Communications on Employment in Canada: An Overview of Current OECD Debates. Montreal: Institute for Research on Public Policy, November, 1979.

A review of the major literature from OECD countries on the employment implications of microelectronic/telecommunications technology. The review contains extensive excerpts from 42 major works and 10 minor works. In addition, an overview of the debate, a view of the inadequacies of the literature, and suggestions for further research are provided.

Addendum to Bibliography

European Trade Union Institute (ETUI), The Impact of Microelectronics on Employment in Western Europe in the 1980's, Brussels, 1979.

Ford, G. W., "Computers and the Quality of Working Life," Search, August 1974.

Gershuny, Jonathan, After Industrial Society: The Emerging Self-Service Economy, Macmillan, London, 1978.

Haug, M., "Computer Technology and the Obsolescence of the Concept of Profession," Work and Technology, M. Haug and J. Dofny (eds.), London, 1977.

Hines, C., and Graham Searle, Automatic Unemployment (A discussion of the impact of microelectronic technology on U.K. employment and the responses this demands) Earth Resources Research, London, 1979.

Japan, Ministry of International Trade and Industry, Special Committee on the Impacts of Microelectronics on Employment, A Fact-Finding Study on the Impacts of Microelectronics on Employment - Summary, mimeo, 1979.

Lamberton, D. M., "Structure and Growth of the Communication Industry," The Service Sector of the Australian Economy, K. A. Tucker (ed.), Croom Helm, London, 1977.

Martin, J., Future Developments in Telecommunications, Prentice Hall, New Jersey, 1971.

Oikawa, K., and P. Andrieux, Trade Unions and the New Technology of Posts and Telecommunications, Computers and Data Transmission, Report prepared for the 22nd World Congress, Oslo, 1975. (Postal, Telegraph and Telephone International, Geneva).

Tavernier, G., "The Executive's Turn to be Automated," International Management, September 1979.

U.S. Department of Commerce, The Role of New Technical Enterprises in the U.S. Economy, A Report of the Commerce Advisory Board to the U.S. Secretary of Commerce, January 1976.

U.S. Bureau of Labor Statistics, Adjustments to the Introduction of Office Automation, Bulletin No. 1276, U.S. Government Printing Office, Washington, D.C. 1960.