NATIONAL POLICIES
AND THE DEVELOPMENT OF
AUTOMATIC DATA PROCESSING

A report prepared for Data for Development, Marseille, France
March, 1979

by

P. Robinson and L.A. Shackleton

Department of Communications, Canada

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PREFACE

In 1978, Data for Development commissioned reports on trends in national policies for automatic data processing in the following six countries: Canada, West Germany, Hungary, Sweden, the United Kingdom and the United States.

This report attempts to draw together the main points covered in the six separate reports. It does not rely solely on the material in the reports, but draws heavily on discussions among the authors held in Marseilles in October 1978. This report is not a summary in the normal sense, but a synthesis of the ideas and concepts presented by the authors in their reports and in the discussions.

It is important to recognize that the material included in the source reports does not cover developments after September 1978. Only passing reference is therefore made to the significant policy initiatives announced by the Prime Minister of Britain and the President of France on December 6th. These, and other subsequent developments elsewhere, have an important bearing on the topics covered in this report.

EXECUTIVE SUMMARY

This report compares and contrasts the developments that have taken place in the six countries for which individual reports were prepared. The growing use of informatics, and the rapid succession of innovations in computing and communications , are leading to fundamental changes as nations move into the new "information age". Most industrialized and many developing countries are placing increased emphasis on the development of appropriate policies and on an assessment of the economic, social, cultural, legal and political implications.

This is reflected in Part I of this report which summarizes many of the issues with which governments are now having to come to grips. Perhaps the most important - and most sensitive - of these issues relates to national sovereignty: a fear of growing dependence rather than interdependence, and a concern over impacts of foreign legislation on domestic policies. Other issues relate to the vulnerability of the computerized society; social concerns, including privacy; economic issues, particularly impacts on employment; issues related to government operations; and legal aspects.

Part I also comments on the current level of public awareness in the different countries, and on the emerging high level of political interest in some governments. This trend appears to have resulted in a progression in the policy formulation process from issues primarily related to government operations and stimulation of equipment manufacturing, through issues related to invasions of personal privacy, to a more coordinated approach which recognizes a wide range of social, economic and other implications and the inter-relationships among their possible solutions.

Part II of the report provides a brief outline of some principal trends in ADP development, and compares more specifically the environment and characteristics of ADP use in the six countries which participated in this project. Section A emphasizes the similar pattern of development in the six countries, and the fundamental importance of developing indigenous expertise. It reviews the trend of equipment improvement and cost reductions in both computing and communications, and points to some inherent opportunities and dangers. Finally, it sketches the sort of applications under development in the countries most advanced in ADP use: office automation, electronic mail, electronic funds transfer and videotex.

Section B reviews the statistics and estimates available as a basis for comparisons, and attempts to assess the limitations of this information. It is interesting to note that for most countries the required information has been drawn from unofficial sources, and that in many cases it is difficult to compare different units of information relating to a single country. The lack of appropriate standards for such statistics, or even of a common terminology, makes it difficult to obtain a clear understanding of national developments and seriously limits the meaning that can be attributed to international comparisons.

Section C outlines some important differences in the institutional environments of the six countries. It touches on ADP plans and policies, on the development of the hardware, software and service bureau industries, and on the state of ADP training and of data communications. It notes the limited recognition of ADP in present legislation, and mentions the roles of non-government institutions. This review suggests that the development of ADP use does not depend on the presence or absence of ADP plans and policies. The production of ADP hardware and software packages does appear to require a measure of government support, but service bureaus and applications software production seem to develop with or without such encouragement.

Section D considers the general penetration of ADP use in the six countries. It briefly reviews the role of ADP in manufacturing, in commerce and finance, in transportation, in the new area of personal computing and in five types of application which are suitable for use in a number of industries. Two of these (data banks and on-line systems) are in use in all six countries; the other three (electronic mail, office automation, and videotex) are now being introduced. The review suggests that it may be necessary to develop a foundation of administrative applications of ADP to ensure necessary skill development and to make the technology and its manifestations acceptable both to users and to the community at large.

PART I: OVERVIEW

1. Introduction

Policies for automatic data processing cover a wide range of issues, from the relatively narrow operational policies for use of computers in government departments, through a broad range of economic and social impacts on individuals and societal structures, to concerns regarding national sovereignty. The issues therefore transcend the traditional lines of responsibility of individual government departments.

If individual issues are considered in isolation and from the limited perspectives of one government department there is a danger that the full implications, inter-relationships and cross-impacts could be lost. But an investigation of issues in the broad perspective requires a new conceptual approach to policy formulation that many find difficult to accept. The issues appear too broad, too all-encompassing, too diffuse and too complex to permit a lucid policy approach to be developed; there is difficulty in accepting that the issues are different in kind or degree from the types of issues that governments have faced for years; there is only now a growing awareness of the rapid changes taking place and the wide extent of their implications; there is little understanding of the inter-relationships among the issues and among the events taking place in widely different areas of the economy.

Some countries appear to have overcome these initial hurdles, and others appear to be now facing up to them. In most countries special Commissions or Boards have been established to look into various aspects of the broad range of issues. The solutions that have been developed differ, but the basic questions are characterized by important similarities rather than by significant differences.

Part I of this report summarizes very briefly these basic questions. It goes on to consider the implications of public awareness and the need for political debate. It concludes with an assessment of the evolutionary phases in the development of national ADP policies. Such an overview must obviously suffer from the effects of generality and brevity. It is nevertheless felt that

an overview of this kind will help put in perspective the more detailed comparisons of the approaches taken in different countries.

2. The Issues

The issues presented here are not equally applicable to all countries which are the subject of this synthesis report. Even in cases where issues are relevant to a particular country, lack of public and political awareness may lead to an initial impression of lack of relevance. Differences in political and legal systems, in cultural and historical backgrounds, in geographical situation, and in current stages of development and awareness will inevitably lead to significant differences in attitudes and in the priorities attached to a consideration of the issues.

Nevertheless, the authors of the separate reports felt that at least some aspects of most issues had general relevance. They also felt that, even in cases where individual countries or governments could see little relevance to their particular concerns or aspirations, a better understanding of the concerns of others would help in determining their own positions and approaches to the problems.

It is in this light that the following brief description of the issues is presented. Its brevity and its attempts at generality raise the danger of over-simplification. It will be necessary for each country and each government to translate the points raised into terms of more specific relevance to their own situation.

There is also a danger in presenting the issues of over-emphasizing the negative aspects. The benefits that may be derived from the use of the new technologies are widely recognized. Businesses and governments are making increasing use of the new services to improve productivity and to provide a wider range of products and services to consumers. Information is becoming more available and easier to use. Tedious and dangerous jobs are being automated, and there is a potential for greater job satisfaction. The very quality of human life can be improved.

It is these benefits and potential benefits that have led to the rapid changes and developments that are now taking place. And it is against this background of undeniable benefits that the following issues and problems must be considered. In no case is it a matter of merely dealing with a negative impact; policy approaches will need to weigh the advantages against the disadvantages in considering the current situation and will need to weigh the hoped-for positive results of any proposed measures against any negative aspects that might be created, some of which might be even worse than those for which the measures were devised.

2.1 National sovereignty

National sovereignty is defined here as the ability of the nationals (both in and outside government) of a particular country to exercise control over - or, at least, significantly influence - developments within its boundaries. Given this definition, there are a number of aspects of technological and other changes in computing and communications which could have important implications for national sovereignty.

These changes open up a vast new range of opportunities for the entrepreneur, provide new alternatives for management in the operations of business and government, and provide a basis for the development of new services into the home.

Primarily because of developments in telecommunications, it is now possible to provide computer-based services from a systems centre to other widely dispersed locations, regardless of geographic barriers and national boundaries. In a number of cases this has led multinational corporations (and other organizations) to centralize their computing systems resources to obtain greater central control over corporate planning and operations. Governments are only now becoming aware of the broader implications of this trend.

In addition to the economic impacts on the balance of payments and on directly related ADP jobs, this trend could also result in the centralization

of jobs related to financial control, administration, research and development, planning, marketing and other management functions. The resulting transfer of key decision-making functions from the subsidiaries in one country to headquarters in another will reduce the ability of nationals in the first to influence the direction of their own future social and economic development. For example, it is becoming increasingly recognized that while computerization creates new jobs it may also cause significant dislocation in other areas of employment; decisions taken in the central location could tend to ignore such impacts in other countries.

Greater use of, and growing dependence on, foreign computing services would reduce domestic control over breakdowns in service (e.g. strikes), and reduce domestic ability to protect against other events in the foreign country (e.g. sabotage, computer crime, or invasions of personal privacy). The dependence on foreign services could have a multiplier effect in that the lower requirements for domestic expertise would lead to a smaller resource base from which to develop systems specifically geared to domestic requirements.

A further aspect of national sovereignty relates to the inapplicability of domestic laws to data processed and stored in a foreign location, and difficulties in the exercise of domestic jurisdiction over companies and other organizations operating within the country, but which store and process their information abroad.

As videotex-type services become available in the home they may have an important influence on culture and on society as well as on the sale of products and services they advertise. Foreign domination of videotex-provided services may therefore have a growing impact on basic values and concepts as well as perhaps tending to emphasize foreign goods and services. There is also some concern about possible impacts on newspaper and magazine publishing. However, speculation that videotex may replace newspapers is countered by some doubts about early consumer acceptance of the new services.

In considering the points presented here, it must be emphasized that no country can really become self-sufficient in all the information processing services it requires. In particular, for example, there will be a need to

access specialized scientific, industrial, or economic data banks and to obtain, perhaps on a one-time basis, specialized processing services not available domestically. A growing interdependence is inevitable - as indeed it is in many other areas. The concern here is that for some countries there may only be a growing dependence, rather than interdependence.

2.2 The vulnerability of the computerized society

Sweden was the first country to launch a concerted investigation of vulnerability issues. The aspects identified under this term cover a wide range and have been classified into two categories: external and internal.

External vulnerability issues include aspects of national sovereignty (described above) and aspects of national security. These last include the use of computers by defence forces in times of war and peace, as well as the protection (or planned destruction) of information banks that may be of use to an enemy. Other items relating to external vulnerability issues include the dependence on foreign sources for equipment (which might be cut off in times of war); the storage of information abroad that could be used for strategic purposes; and the political stability in neighbouring countries to ensure successful transmission of data to and from foreign computers and terminals.

Internal vulnerability issues relate to computer crime and to computer security. They also relate to an assessment of the growing dependence of society on computer systems: continuing and increasing costs; and the consequences of operational failure or other types of disruption. Vulnerability is also influenced by concentration of computerized systems - both geographical concentration and functional concentration. For example, Sweden has expressed concern that 70% to 80% of its computers are located in a few major urban centres, and in the United States, the National Academy of Sciences is considering the question of whether or not too many files are stored in too few locations.

The vulnerability of society is further influenced by the ability to link data in different files. If this is done, even with seemingly unrelated data, and with data, which, while kept separate, are innocuous, it could lead to conclusions which are personally sensitive, or which uncover confidential

corporate information, or which relate to state security.

Other internal vulnerability issues relate to the impacts of computer use on the labour market and to the inadequate development of domestic capabilities. It has been suggested that these issues relate more to the lack of coordination among government departments and between the private and public sectors and to the failure to integrate new developments into overall national economic planning than to the impacts of computer use per se.

Few countries have yet been able to assess the importance of these vulnerability issues, but concerns are increasing as awareness develops.

2.3 Social concerns

The social concern that has so far received the most widespread attention is that of personal privacy. A number of governments have already passed legislation related to the protection of personal information. In general, this provides for: limitation on the use which may be made of the information collected; disclosure to an individual of data about himself/herself; prohibition of disclosure to unauthorized persons; complaints regarding relevance and accuracy of the information and in some cases rectification.

In dealing with privacy protection there is also need to recognize a somewhat conflicting requirement: "freedom of information". The civil rights movements in many countries are pressing for greater access to information - particularly government information. Pressures in the United States led to the so-called "sunshine laws" of a few years ago.

Other social concerns have not yet been investigated to the same extent and have not led to legislation. Civil rights movements are concerned about the growing potential for massive surveillance and control over the individual, as foreshadowed in Orwell's "1984". To some extent these fears have been reduced by the data protection laws that have been introduced in some countries. There is also some concern regarding the potential of surveillance on a smaller scale - recording, for example, productivity, number of errors, etc. of clerks in

checkouts at supermarkets or of typists in the office-of-the-future. There has, indeed, already been a strike of check-out clerks in Denmark to remove this type of surveillance.

There is potential danger from increased information concentration. The power of the press and the mass media is well recognized. Editors and reporters are aware of this and equally aware, in general, of the responsibility they carry in exercising that power. However, the speed with which news can now be carried, and the fact that reports and articles can be typeset by computers, means that a report can be prepared centrally and rapidly distributed for immediate insertion in newspapers around the world. As the smaller independent newspapers disappear (a trend which has been evident for some time - predating the introduction of computers), greater power is created centrally, providing greater potential for the manipulation of mass emotions by fewer individuals.

Another aspect of social concern relates to the impact of computers on human relations. Many feel that computer systems are de-humanized and de-humanizing: they point to examples of dunning notices for the payment of invalid bills, to the difficulties experienced in getting corrections made, and to the inflexibilities built into the systems. They are concerned about alienation, and the decreased opportunities available for social contact.

At the same time, however, they recognize some of the positive aspects. Some, for example, find it easier to give sensitive medical information to a computer than to a doctor; and it has been shown that some with learning disabilities respond better to computers than to individual coaching by teachers.

A further social concern relates to the mysticism surrounding computers. There is widespread fear of computers - primarily fear of the unknown. There is a need, then, to remove these fears and to make people not only more comfortable in dealing with computers, but to make them more conscious of how they can use computers for their own benefit. There is also fear of job dislocation. Social adaptation has been developing, but perhaps not sufficiently rapidly to avoid

problems. In some individual cases, adapatation is difficult, and in others workers may not be easily trained for other jobs, as their traditional work is computerized.

2.4 Labour-related issues

Of particular and growing concern is the impact of computerization on employment. For example, one reasoned but pessimistic suggestion is that in Britain, unemployment could increase from about 1 million to 5 million in 15 years. In Canada, it has been suggested, as a first rough estimate, that more than 200,000 of the currently unemployed (total of 1 million) might be out of work because of computerization. In an article in the Economic Journal (Sept. 1975) P. Stoneman suggested that about 1% of the U.K. labour force could be unemployed because of computerization by 1978. In Sweden, as just one example, it has been estimated that production in one Volvo plant now employing 1,200 could be maintained by only 18 workers. It has been further estimated that by 1975, some 30,000-60,000 net jobs were lost or failed to materialize in Sweden because of computerization. However this failed to show any marked effect on the total unemployment figures for that year - an indication that net job loss because of ADP may be made up by employment in other areas.

There are still those who argue that the introduction of computers into an organization has created additional jobs and has not resulted in any lay-offs, and that, therefore computerization does not lead to unemployment. The arguments are presented strongly and with conviction, but they ignore the fact that computerization often makes it unnecessary to create new jobs that would be necessary without computers. They also ignore the fact that an undue proportion of the unemployed belong to the younger generation - a fact that would also suggest that the problem is lack of job creation, rather than one of throwing older employees out of work. In the 1980's it may become increasingly difficult to avoid lay-offs of the older employees.

In addition to the impacts of computerization on employment in general, job dislocation also arises from the increased utilization of telecommunications facilities in the operations of computer networks. Jobs in one location may be

replaced by services provided through a terminal. This may lead to regional instability within a country and increased computer concentration (discussed under vulnerability above), or may lead to transfer of jobs to another country if the control centre is abroad.

With dislocations in employment, a greater need is seen for emphasis on education and training - not only to meet the growing requirements for ADP-related jobs, but also for retraining for other jobs where employees are unsuitable for employment in ADP-related functions. In the ADP area, particular emphasis is required on application development rather than on machine-oriented research and design problems. Retraining requirements for other jobs require more attention. In addition, consideration may need to be given to the desirability of increased leisure time (i.e. a shorter working week), or to using non-productive time for further education and training, perhaps in areas not directly related to job content.

Computers can have a positive impact on working conditions. For example, dangerous or tedious jobs can be computerized. On the other hand, however, computerization could result in lower job satisfaction, in eye-strain if working continually with display terminals, or in other negative effects. These have not yet been clearly identified or studied in most countries, but there is growing recognition that further analysis is necessary.

The stresses exerted by computerization on employees, and their growing fears of job-dislocation and unemployment are leading to increasing labour unrest and in some cases to growing militancy. In Europe unions are aware that it is impossible to stem the tide of technological development and have recognized the need for government and industry to take advantage of the opportunities that these afford.

In Sweden and Germany mechanisms exist to help unions exert influence on management decisions. In Britain unions exert a strong influence on government policies. In Canada and the United States there are, in general, no effective formalized mechanisms for union influence on management decisions during the formative stages. This lack and growing militancy on the part of some unions

could lead to growing labour-management confrontation. If this problem is not soon recognized, it is likely to become one of the major political issues.

Even in Europe, where employees have gained rights to greater participation and responsibility in decision-making, some feel that the new information technologies are eroding those rights as decisions are being presented as forced by the new technologies.

A further issue, of concern to management, is the growing power being vested in ADP employees. If they were to strike, they could cause damage to operations out of all proportion to their numbers.

2.5 Other economic issues

The technological developments, the increasingly wide use of computers in various areas of application, and the introduction of new services are resulting in significant changes in the market place. These changes are leading to growing areas of conflict and new areas of competition as goods and services provided by the traditional methods are displaced by new goods and services based on the new technologies. They are also raising serious questions regarding which services might be provided on a traditional monopoly basis and which might be left to competition. For example, until relatively recently, banking, mail, telecommunications and computing bureau services could be regarded as distinct with little opportunity for competition among the organizations offering these services. With the evolution of electronic payment systems, and the growing use of "electronic mail" the separate and distinct nature of the services is being eroded. In addition, in the provision of equipment and the associated software, there is growing confrontation between the computer manufacturers and the telecommunications agencies. More established industries are also threatened by the new technologies; the impact of the introduction of digital watches on the Swiss watch-making industry is well known.

The impacts of computerization on competitiveness create further issues. On the one hand, governments and corporations recognize that if the country or

the firm is to remain competitive it must promote the use of new technology. On the other hand, the introduction of automation in the production line, in office procedures, and in an ever-growing range of other applications, is likely to cause serious dislocation in employment. In addition, the costs of the new technologies and the labour market unrest that accompanies their introduction may force some of the smaller organizations to sell out or into bankruptcy. This would increase the power of the larger organizations - a point already mentioned in regard to the potential for "monopolization" of information supply in the mass media.

Many countries cannot afford the initial capital nor the risks involved in mainframe manufacture, and in the case of data banks, duplication, maintenance and upkeep is often more expensive than paying for the occasional use of the services. Under these circumstances, it is difficult to assess the right balance between imports of goods and services and domestic production, and to ascertain in which areas the greatest benefits are to be derived. With regard to software and other computing services, in Canada and probably in other countries, by far the major part of the imports are by subsidiary companies from corporate headquarters. This type of activity is more difficult to measure and to control than services purchased in the open market.

Concentration of computing activities in major urban centres also has certain economic implications. Questions arise as to whether lowering communications tariffs to provide for inexpensive access to services provided from major centres would have a more beneficial effect on regional economic development (in general, if not in ADP specifically), and as to whether maintenance of tariffs at present levels would result in less concentration (one of the vulnerability issues) and in more beneficial regional development.

Approaches to taxation of equipment (import taxes, depreciation allowances, valuation procedures), of processing services, of data bank services and of software could significantly influence domestic production and development. In particular, software is a totally new concept which does not lend itself to traditional approaches.

2.6 Government operations

A question that has been lurking in the background for some time, is the degree to which coordination among various government departments and agencies is feasible and desirable in dealing with the range of issues outlined above. Concerns have been expressed that conflicting requirements and objectives of different government departments could lead to incompatible policy approaches. On the other hand, many feel that the issues raised by the new technological developments are really no different, in essence, from the problems governments have dealt with for years and see no need for increased coordination and cooperation in policy development.

There appears to be general agreement that government purchasing policies should be used to further domestic industrial developments in this area (services and software as well as equipment). The way this is done, however, could lead to problems regarding different treatment for foreign-owned and domestic companies operating within a country; or it could lead to conflict situations if a government-supported company were felt to be competing unfairly in foreign markets.

Most governments have been concerned about rapid growth of their own expenditures on ADP, and there has been uncertainty about the effectiveness and efficiency with which computers were being used in government service. Governments are looking at these questions more closely and in some cases are putting increased emphasis on systems planning and evaluation as well as on purchase of equipment.

Some governments have also been concerned about the availability of high calibre programmers and systems analysts. In addition to intensifying internal training activities they are also directing attention to increased funding in the public education system for computer-related topics. In this there appears to be a general need for some central initiative to emphasize applications of computing rather than traditional computer science.

2.7 Legal aspects

Legal questions cannot be regarded in the same light as questions related to the basic issues; they are therefore not in that sense issues, but arise in regard to implementing solutions to the issues. They are therefore secondary in nature. This does not mean that they are secondary in importance nor in difficulty and complexity. Lack of recognition of this conceptual difference may lead to confusion in a resolution of the issues.

Privacy is again the area which to date has received the most widespread attention in regard to addressing the legal questions it poses. Data protection laws have been introduced in a number of countries. Some apply only to the public sector, and some to both private and public sectors; some apply only to "natural" persons, others apply also to "legal" persons; administrative provisions vary considerably. In many countries, even some with existing data protection laws, there are questions that still have not been addressed. In addition, there is a major question regarding the "harmonization" of different national laws, and the preparation of mutually acceptable guidelines; the Council of Europe and the OECD are both working on this. There are significant differences between the approaches of the United States and those of most European countries that could make an early solution to these questions difficult.

Harmonization is also a problem in regard to data related to international trade. Questions regarding multiple authentication of documents, the negotiability of certain documents, including bills of lading, and statutory customs requirements need to be resolved in relation to what is electronically feasible, and bearing in mind the need for effective control and security. It has been suggested that unilateral action to deal with these questions could lead to even greater incompatibilities than now exist, and have a counter-productive effect on data transfer required to support international trade.

The situation regarding legal protection of software is unclear. There are inconsistencies in many countries, and approaches of different countries which appear to have clarified the situation internally are radically

different. In most cases, questions regarding the applicability of laws on patents, copyright and trade secrets and regarding the need for new legislation remain unanswered. The totally new concept of software, which is different from anything that has existed before, makes it difficult to rely on precedent, or to argue by analogy. Similar questions arise regarding the legal protection of data banks. It may be possible to deal with both aspects together, or the differences may be sufficient to require different approaches.

A number of questions are beginning to arise in regard to legal liability. For example, as greater use is made of electronic means for funds transfer, there will be increasing potential for problems caused by delays or errors. Problems have already arisen in regard to obtaining satisfaction for faulty merchandise purchased using bank credit cards. Liability for errors in software or for mistakes in services provided by a service bureau has not been examined in any depth. The liabilities and responsibilities of computer professionals cannot seriously be considered without a clear, generally accepted, definition of the term "professional" in this context.

Several countries are beginning to look into the growing potential for "computer crime". It is questioned whether current laws deal adequately with the possibilities, and whether allowable penalties are commensurate with the type of crime possible in major complex systems. There is the further problem of ascertaining under which particular jurisdiction a crime has been committed when international networks are involved.

Questions also arise in regard to what documentation (e.g. computer print-outs, or magnetic tapes) might be admissible as evidence in a court of law, and what constitutes storage of data "on the premises". Answers to this last question could have important implications for transborder data flow.

3. The Political Debate

The answers to most of the questions posed above must be provided by the politicians. They cannot be dictated by the technology; indeed, the technology provides for many different alternative solutions, and it is more a matter of

selecting the criteria on which to base the eventual choice. Nor should the answers be determined solely by government bureaucracies, for there are too many political implications. Nor should they be determined by the technocrats, although it is they who have so far provided most of the answers in the absence of any broader political or public awareness.

It is perhaps surprising that such an awareness has been so long in developing. Some contend that it is because there is a general reluctance on the part of non-computer people to reveal their ignorance of computer matters. Others contend that it is because the way in which data are collected and prepared for publication in national statistical reports tends to conceal rather than reveal the nature of the changes taking place. Yet others suggest that traditional lines of responsibility - in faculties in universities, for example - lead to fragmented attention to isolated facets of the overall problem, and lose sight of the fundamental and widespread impacts.

Whatever the cause - and it may well be a combination of these and other factors - the mysticism surrounding computers has been difficult to overcome, and the development of public awareness has been long delayed in most countries. The structural changes taking place in society appear to have been too diffuse and too complex, and events have moved too rapidly to permit the development of an understanding and a clear definition of issues. Without this recognition it is unlikely that there will be public pressures on politicians to grapple with current and emerging issues.

Until last year, Sweden was the main exception: there, there has been a relatively high level of public and political awareness, and the government has attempted to keep the public informed. Prior to the formulation of policies, and even prior to a clear understanding of the issues, reports - such as the recent interim report on the "Vulnerability of the Computerized Society" - have outlined the questions to promote public debate.

Last year (1978), public awareness of the fundamental changes taking place developed - and developed rapidly - in both Britain and France. In the former, it appears to have been sparked by a BBC television programme entitled "Now the

Chips Are Down", and in the latter by a report on "L'informatisation de la société".

It is clear that as long as the public remains in ignorance of the fundamental nature of the current changes, there is little likelihood of sustained effective government consideration of the range of issues. Political awareness, appreciation of the inter-relationships among the issues, and recognition of the full significance of their implications is essential for effective action.

Once public awareness develops it has been demonstrated that pressures can increase sufficiently quickly to promote concerted high level political interest and action.

4. Trends in Policy Approaches

The evolution of national policies has taken different routes in different countries, because of differences in social and political structures and differences in industrial development. There are, however, a number of similarities.

Initially, in most cases, government policies have centered on the use of computers in the internal operations of government and on support measures for the computing equipment industry.

In the early days, policies related to the internal operations of government were largely limited to administrative procedures, but as expenditures increased more effort was put into developing a cohesive approach to the acquisition of computing equipment. Central control over acquisition intensified, but now an emphasis is developing towards improved methods for planning and for assessing the effectiveness of computer use.

Initially support measures for industry concentrated on the manufacture of computers and computer-related equipment. Specific support programs, government purchasing policies, subsidies, and government sponsored mergers and affiliations have been implemented in some countries. In addition, the impacts

of major national programs (particularly, for example, the space program in the United States) have been significant in certain cases in the development of domestic manufacturing capabilities. More recently there seems to be greater emphasis on support for the development of software and services.

These aspects of national policies might be termed the "technological phase" of policy development. The formulation and implementation of these policies were the responsibilities of departments primarily concerned with government operations, government purchasing, industrial development and departments having a high technology content. In general, there was little inter-relationship among the requirements and among the policies formulated.

The "social phase" of policy development began in the late 1960's and early 1970's, with a growing fear of invasions of personal privacy. Hessen, one of the West German states, was the first to pass a Data Protection Act in 1970. Sweden followed with its legislation in 1973, and since then a number of other countries have passed data protection or privacy laws. The provisions of these laws vary widely and efforts are now being made through international organizations to achieve a greater degree of compatibility.

In the last year or two, there has been a development of awareness of other important impacts - economic, social, political and legal. An increasing emphasis is beginning to be placed on these in the development of national policies. In West Germany, for example, a program to study social and other implications will be started in 1979. In Britain, the Prime Minister has called for a study of the social and economic implications, with particular emphasis on effects on employment.

The growing recognition of the broader implications of technological developments in computers and communications appears to be leading to a third phase in policy development - "the overview phase". Inter-relationships among the issues and the fundamental nature of the changes taking place are beginning to receive some recognition and attention.

Even in the early 1970's some reports (in Canada and Japan, for example) were stressing these inter-relationships and suggesting the need for a more cohesive approach to national policies in this area. A report to the President of the United States in 1976 advocated the need for a "National Information Policy". It pointed out that "To debate whether there should be a national information policy is pointless. There will be such a policy.....It will exist whether or not (it is) arrived at consciously or unconsciously, by commission or omission, carefully or haphazardly, in a comprehensive or in a piece-meal fashion.....The issue, therefore, is whether government will attempt to take a considered and coordinated approach in arriving at (the) answers". In Britain and France coordination - an overview approach - appears to be achieved de facto by interest and intervention at the highest political level.

In Sweden, the general high level of public awareness and the high level of political interest also appear to have resulted in a de facto overview approach. The momentum generated in that country appears to be leading it to a "National Data Policy", encompassing all the important facets of policy requirements in this area.

It is perhaps too early to say whether these factors do in fact indicate a transition into an "overview phase" of policy development or merely a current fad. Certainly government organization in general does not easily lend itself to such an approach on a sustained basis. Some question, in fact, whether such sustained attention is warranted and are skeptical of continuing political interest at a sufficiently high level. This is perhaps a question that governments will need to resolve in the near future.

Another question that governments will need to address, and one closely associated with the first, is whether their approaches should be reactive to past events and existing problems, or whether they should be pro-active and based more on likely future impacts and opportunities. The rapidity with which changes are taking place, and the fundamental and far-reaching nature of those changes, raise serious questions as to whether traditional approaches to policy formulation are still appropriate in this area.

PART II: TRENDS AND COMPARISONS

This Part begins with a discussion of the principal trends in ADP development and applications, based on the six country reports and on current literature about emerging developments. It continues with a more detailed review of those statistics, institutions and applications that were presented in three or more of the country reports. The aim of this review is to illustrate the limits of our knowledge about the present state of ADP development and the causative factors in this development, as well as to draw attention to some common features illustrated by the experience of several countries.

A. TRENDS IN ADP DEVELOPMENT

1. A Brief Backwards Glance

The development of computer use has tended to follow a similar pattern in most countries, in spite of major differences in political, social, cultural and legal systems. There has also been a similar pattern in the application of the new "information technology" which combines advances in computing and communications.

To the extent of these similarities, it is probably correct to view the information revolution as technology-driven. Countries now embarking on an effort to exploit these new technologies more fully, should be aware of the progression of steps illustrated by experience to date. It seems unlikely that many of these steps can be safely avoided, although some may be considerably shortened.

It is of particular importance to create a firm base of indigenous expertise on which to build further growth and development. In virtually all cases, computing activities began in universities. Computing was a challenging field, and applications to other fields of research proved fruitful. University work developed the expertise needed to man subsequent computer installations in government and business.

Computing then spread from the university environment into government, particularly the military and government research establishments. But it was not until it spread into business operations that major growth occurred. The ability of computers to carry out repetitive calculations quickly and accurately was soon recognized. Many customers were blinded by the vast potential, and allowed the latest and largest computer model to become a status symbol. The subsequent disillusionment led to a greater emphasis on software and services and on the people necessary to develop them.

This has in turn led to a more recent re-emphasis on education and training. Many of the more industrialized nations are devoting considerable resources to developing the numbers of skilled personnel required for the continuing rapid expansion of applications. Particular stress is being laid on applications development and operational use, rather than on equipment-oriented computer science courses, which have been subjected to increasing criticism in recent years.

The first commercial applications to be computerized were repetitive clerical jobs in such fields as payroll and accounting; these still appear to be areas where a quick return on investment can be achieved as organizations launch themselves into the new "information age". This computing was originally done locally, with inputs and outputs physically delivered and picked up. The next phase in computer utilization involved remote access from relatively "dumb" terminals to a central computer installation. The technology and costs of communications at first limited the area served by a central facility. But this was short-lived, as it proved to be the catalyst that led to rapid developments in communications technology, or perhaps more correctly, in the application of that technology to information processing. There rapidly followed the development of nation-wide public data communications facilities and services, and the ability to share resources among powerful computers in the network.

Computers have also been used in process control and on the production line. These applications have had less visibility than applications in other areas, perhaps partly because they have represented a relatively small fraction of computer use, and partly because they are more remote from the end consumer.

Computer use in these areas of application is now growing more rapidly and, because of the threat of robotization to employment, greater attention is being paid to their implications for policy development.

2. Current Trends in Technology

Fierce competition in the computer industry has resulted in rapid innovation leading to dramatic increases in computing capability, and equally dramatic decreases in physical size. The first "generation" of computers used electron tubes which require a large amount of space themselves, require additional space for cooling mechanisms, and which have a heavy maintenance load. The second "generation" replaced tubes with semi-conductors, with major savings in cost, space and maintenance requirements. Integrated circuits, culminating in the current "chip" technology, have led to further significant improvements.

This trend towards decreasing size and increasing capability is continuing. Today, the large scientific computer is capable of performing 10 million operations per second. By 1990, this is expected to increase to 300 billion per second, which is still below the limit imposed by the feasible component spacing on chips.

The significant reduction in the cost of computing power - about an order of magnitude every 10 years - has perhaps been the single most important factor in the rapid spread of computer use. Its impact has been markedly increased by the rapid rise in the cost of labour and of other goods and services.

Of particular significance is the current explosion in the use of small computers, brought about by the miniaturization and reduced costs of computer components. These are often called "mini-computers" or "small business computers" (though these marketing terms lack any generally accepted definition). It is not yet entirely clear what the full impact of this explosion will be.

"Minis" can provide the power and flexibility locally that could formerly be obtained only from a larger central installation. It had earlier been expected that this would tend to reverse the trend to centralization and consolidation. But there appear to be no major signs of this. Instead, the "mini" appears to have permitted a major extension of computer use into new areas of application, and to have provided new opportunities in established areas.

They have also permitted a trend to "distributed processing" (a term that is not yet clearly defined nor clearly understood). This usually results both in increased local processing and also in greater consolidation of control and systems design at the central facility.

The microprocessor is another recent major development. This review does not attempt to deal with the microprocessor because it differs from computers in not (usually) being user-programmable. It is, however, becoming increasingly important as a component of computer and communications goods and systems. It is also found in a growing number of consumer products such as pocket calculators, automobile ignition systems and timepieces. Perhaps its most obvious industrial impact to date has been on the traditional watch-making industry, where a considerable proportion of human skills and invested capital was suddenly deprived of its market. There is little doubt that there will be other significant impacts of microprocessor use.

The merging of computer technology with telecommunications technology has been apparent for only a little over ten years, and it is only in the present decade that major developments have occurred in the data communications market. Taken in the context of the telecommunications industry - a monopolistic industry that is more conservative than the computer industry - the developments we are seeing must be regarded as just as significant and revolutionary as those taking place in computers.

Digital technology has led to reduced user costs and significant decreases in transmission error rates. Packet-switched services can further reduce user costs over a wide range of requirements. Fibre optics, with their enormous capacity, and their ability to virtually eliminate noise and interference, are expected to provide further significant decreases in costs and improvements in service. Satellite technology breaks the link between costs and distance, and overcomes physical barriers to providing communications services to remote regions of the world. The use of small, low-cost, roof-top antennae will provide greater flexibility and ease of access to transmission facilities.

These rapid technological developments in computing and communications, and the continuing decline in costs, are opening up new areas of application that were previously uneconomic, and providing new opportunities for the innovator.

3. Trends in Applications

In this brief review it is impossible to do justice to all the dramatic developments now taking place in an increasingly wide range of applications.

One of the most interesting and dynamic areas of development at this time is that of office automation. It is an area of major growth, with average annual increases in equipment purchases forecast to be in the region of 32% over the next five years - almost double the increase expected in general-purpose computers. The functions included will be the preparation, processing, and transmission of correspondence, purchase orders, and invoices (word processing and electronic mail); the storage and retrieval of documents (automated filing); and funds transfer and credit transactions directly through the electronic funds transfer system (EFTS).

It is expected that, early in the eighties, expenditures on stand-alone typewriters in some of the more developed countries will fall to less than one quarter of those for word processing equipment. It is also expected that there will be a growing merger of word processing and data processing functions, although today less than 1% of the equipment installed combines these functions. An increasing number of articles is appearing on the potential for conflict

within organizations as this develops. This blurring of boundaries between heretofore distinct functions, and the potential for conflict - in some cases major conflict, because of the economic stakes involved - is a recurring theme throughout many of the present developments. The merging of computing and communications was merely the forerunner.

Closely associated with office automation are developments in electronic mail. Many organizations already have internal computer message services. Salesmen use casettes to record customer requirements and use acoustic couplers to transmit the information over the telephone system to the company's computer. Some service bureaus are providing an "electronic mail-box" service. Other entrepreneurs are beginning to offer facsimile services to transmit hard copy. Costs of electronic mail are rapidly becoming competitive with those of traditional mail, and delivery is faster. Post Offices in many countries have plans to develop electronic mail services (the initial proposals in the United States are being challenged by private industry).

These developments will have a significant impact on the physical delivery of traditional mail. Again there has been a blurring of the distinct functions of established organizations; in this case those of the telecommunications agencies and the Post Office, complicated by the entry of new contestants into the market. Some of the conflicts likely to arise in this situation may be less apparent in those countries where PTTs provide both postal and telecommunications services on a monopoly basis. However, internal conflicts within the PTTs and conflicts among competing policy objectives are likely.

Cutting across both these areas of application are developments in electronic funds transfer. They will complement and perhaps promote further developments in office automation. They could compete with developments in electronic mail, and will have a significant impact on the volume of traditional mail.

Developments in this area will continue, spurred by the continuing rise in the number of cheques issued and the increasing difficulty of handling the rising volume of paper transfers. There are growing numbers of teller terminals and automatic cash dispensers in bank branches. Automatic payment of pre-authorized accounts is increasing and services for payment authorization by phone are now being offered. Inter-branch banking, where a customer may pay into or withdraw from his account at any of a bank's branches are being introduced. Inter-bank clearing houses have been developed and the international SWIFT money-transfer system is now well known.

The use of plastic bank credit cards is growing and will cut down on the increase in the number of cheques issued. There is some pressure to introduce "debit cards" in which the plastic card is "charged" with a certain value, which is reduced with each purchase. This procedure will further reduce the need for cheques, and could reduce the need for cash and for teller services.

In addition to the developments taking place within the financial community itself, there is a growing use of point-of-sales (POS) terminals in department stores, and automated check-outs in supermarkets. As these become connected to the broader EFT system, direct debiting and crediting will be possible. Whether this is entirely desirable is another matter.

POS terminals are also used in maintaining an effective inventory update system. With appropriate software built into the system, automatic initiation of re-ordering is possible. And, eventually, direct connections to a warehouse, which may itself be automated, will permit full automatic reordering, as well as automatic transfer of funds in payment.

Another area of high interest at this time, is the recent development of videotex services in a number of countries. As the services are developed, a customer will be able to use his television set to browse through the advertising material, select the particular model he requires, select the particular supplier which gives him the best price, order the product, and pay for it, all in one operation from his home. The television set thus becomes an in-home POS terminal. It is perhaps more likely, certainly in the shorter

term, that the telephone will provide the terminal facilities for ordering. This is already possible using a touch-tone telephone to dial directly into a computer in at least one major department store.

Videotex services will also be used in other ways. Some plans include extensive use in education; others include information on local entertainment or dining facilities, news items or special interest articles and reports. Here again, problems of conflict arise. In this case there is some concern about impacts on newspapers and magazines.

Computers have already attained considerable use in the control of continuous flow operations and in some other dangerous or tedious industrial processes. Until recently, however, their size and high cost have tended to limit factory uses. Current developments are making it possible and economic to use industrial robots for an increasing range of factory jobs. The potential impacts of factory automation on employment are causing increased concern.

This brief review of trends has not covered the full breadth of developments. The increasing use of computers in the education system and the spreading use of personal computers will provide a more informed public, and one less likely to be afraid of the mysticism which currently surrounds computers. Developments in the use of computers in highly sophisticated areas such as medical diagnosis will lead to increasing penetration into uncommon and highly specialized areas of application. These will affect work in the office, work in the factory, and leisure at home.

The potential impact of this whole gamut of applications development is enormous. It can create a wealth of new jobs in interesting and exciting areas. But the conflicts between the new and the traditional can also result in a loss of jobs.

For those that are working in the areas of growth and development, there will be many more exciting changes, and even more significant challenges in making the technology work for us.

B. QUANTITATIVE COMPARISONS

If we accept Lord Kelvin's dictum that something is known when it can be measured and expressed in numbers, it might appear that we have considerable knowledge about informatics and its use. There is no shortage of numbers which purport to illustrate various facets of this topic. Unfortunately, few of the available numbers prove on examination to be based on anything that can be accepted as a measurement, and rarely do the numbers representing different aspects of informatics in any country fit together in a consistent pattern. It must be admitted at the outset that our knowledge of informatics and its use is really of a meager and unsatisfactory kind!

Perhaps the best reflection of this problem is that none of the country reports on which this review is based could present all of the quantitative information requested in the form requested. And, except in the case of Hungary, most of the quantitative information was drawn from unofficial sources such as consultant surveys and trade publications, which treat only specific aspects of the topic. Such sources are rarely concerned with whether their study overlaps another or leaves undefined gaps.

The difficulties of making statistical comparisons among countries, even when internally consistent data are available for each country, are well known and were mentioned briefly in the Hungarian report. These difficulties are multiplied when the data are partial, undescribed, and lack common underlying standards or objectives. The comparisons presented in Table I are at best only approximations, and discussion of these comparisons must necessarily focus more on their limitations than on their revelations.

1. General Comparisons

Table I starts with some general statistics for the countries covered by this project, selected from the Statistical Yearbook of the United Nations Statistical Office: population, area and source of gross domestic product. The

six countries differ greatly in size. Their populations range from 8 million (Sweden) to 215 million (United States). Their areas range from 93,000 sq. km. (Hungary) to 10,000,000 mostly frozen sq. km. (Canada). And population density ranges from only 2.3 per sq. km. (Canada) to 247 per sq. km. (Federal Republic of Germany). Such great differences could not fail to have some influence on the relative desirability and feasibility of particular ADP applications in different countries.

There are also considerable differences in the sources from which the six countries obtain their Gross Domestic Product (GDP), although in the case of Hungary these differences are exaggerated by an important difference in statistical systems. Hungary appears to derive a much larger share of GDP from agriculture (16% in 1976), industry (47%) and construction (13%) than any other country, and together these three goods-producing categories appear to account for 76% of GDP, as compared with only 51% for Germany, which ranks second in this respect. However the figures for Hungary (and other planned economies) show Net Material Product, and exclude such important activities as finance, many services, public administration and defence. When this is allowed for, it seems likely that Hungary does obtain the largest proportion from agriculture and construction, but likely ranks second to Germany in the proportion derived from industry, and derives only a slightly greater proportion than Germany from goods production in total.

The other four countries, and especially the United States, derive much higher proportions of their GDP from the range of service activities than do Germany and Hungary. Here again the differences between the United States and the other three are somewhat exaggerated by the fuller allocation of import duties in the United States calculations (the residual percentage not shown in the table is only 3% for the United States, 11% for the other three in this group). In spite of all limitations to statistical comparability, it would appear reasonable to expect the differences in goods/services orientation to have some influence on the nature and extent of computer use.

2. The Computer Population

Successful computer use generally requires experience as well as equipment and training; the length of time that computers have been in use in any country will therefore influence what one can reasonably expect to find in the way of applications. The first fully programmed electronic computer began operation in the United States in 1946; it was not until 1959 that Hungary's first computer was installed. Administrative applications began to develop in the United States at the beginning of the 1950's although computer use did not enter its period of rapid expansion until the latter part of that decade. In Hungary the period of rapid expansion of computer use also appears to have commenced about a decade after its first computer was installed. The Hungarian report states that Hungary still lags some eight to ten years in computer use, but the information available suggests that this difference is diminishing.

All six country reports provided some data on computer installations, but the data appear to differ in quality and coverage. Even the definition of "computer" does not appear to be uniform; in this review "computer" is considered to include only digital machines capable of accepting, processing and supplying data under the control of an internally-stored program which the user can change or modify, and where user input is not restricted to a keyboard device. This definition attempts to exclude analogue computers, microcomputers, special purpose business machines (such as visible record accounting machines) and terminals (even terminals with some limited intelligence). It does cover most or all of the machines commonly known as mainframes or general purpose computers, minicomputers and small business computers (the latter two classes are regarded as marketing distinctions which have no really significant characteristics distinguishing them from medium sized and small sized mainframes).

The figures on computer numbers in part 6 of Table I were selected with this definition in mind, although the information available allowed little

opportunity for adjustments. The data for Hungary appear to be official statistics for the whole computer population, those for Canada and the United States to be unofficial estimates of the whole computer population. The data for the United Kingdom cover the appropriate components from the higher of two alternative series included in the country report. The data for Germany and Sweden may be less complete, judging by the relatively high population/computer ratios which result from their use. The Hungarian ratio of population/computer may look unreasonable, but is actually closely comparable with the ratio for Canada some ten years earlier.

Canada, Hungary and the United States classify computers by "size". The basis of the Hungarian classification is not known; both Canada and the United States classify by monthly rental value. In making comparisons it must be remembered that a given computer will usually cost 20% to 25% more in Canada than in the United States because of differences in taxes (the current foreign exchange difference is additional). Allowing for this factor, the value brackets are sufficiently similar to demonstrate that the United States has a much greater proportion of "very large" computers (7%) than does Canada (1.5% - Canada calls these simply "large"), while Canada appears to have a surprisingly greater proportion in its "very small" category (56%) than does the United States (1/2 to 2/3 of its "small" group would be only 22%-29%). It is possible that the number of very small machines in Canada has been overestimated and/or the number of small machines in the United States underestimated. A recent U.S. government report indicates that some 64% of U.S. government computers are "small", a remarkable difference from the 43% figure for the country estimated by AFIPS.

The information in the report on the United Kingdom permits estimation of a cost-based classification of computers which can be compared with the Canadian and United States data. If these estimates are keyed to the totals appearing in the quasi-official "National Computer Index" (NCI) figures on computer installations, then the United Kingdom probably has 5% of its computers

in the equivalent of the U.S. "very large" category, and about 55% in the U.S. "small" category. This distribution is much closer to that for the United States than to that for Canada. However, if estimates are keyed instead to the Pedder Associates Limited census (PAL), it is likely that the U.K. would show only 1%-1.5% of its computers in the "very large" category, and over 70% in the "small" range, a distribution much closer to that for Canada than to that for the United States. This illustrates how widely an international comparison could be made to vary by the selection of one series rather than another. It again raises the suspicion that the U.S. estimates, like the records of the British NCI, may not make sufficient allowance for small computers.

Figures on the number of computers in the Federal Republic of Germany, Sweden and the United Kingdom are presented by "computer type" (those for the U.K. are from the more comprehensive "PAL" census). The Swedish and German distributions appear similar assuming that the German "process control and mini" group is roughly equivalent to the Swedish "office" plus "mini" groups. The United Kingdom, however, shows a much lower proportion of "mainframes" (if these are equivalent to "universal" and "general"), and a notably higher proportion of "small business" and "mini" computers. If the British NCI series were substituted for the PAL series, the U.K. would show about the same proportion of mainframe/other computers as do the German and Swedish data. It seems likely that small computer numbers are underestimated in the German and Swedish data, just as in the British NCI series.

If we ignore the different distributions of computers by size, with their implications for the real availability of computing power, the United States appears to have one computer per 940 population, Hungary only one per 12,500. These figures are sufficiently different from those for other countries that no likely adjustments would change their rankings as first and sixth in computer availability. The rankings of the other four countries could easily be altered by assumptions about the completeness of the estimates, their meaning in terms of computing power, or even their adjustment to a common reference year. Only the greatest of differences can be viewed with confidence even as indicators of relative computer use.

The compound growth rate figures shown in the table must also be qualified. Data for each of the six countries indicate that the smallest computers are growing most rapidly in number, and by a substantial margin. Therefore, when a growth rate has to be based on figures which clearly undercount the smallest computers (as for the U.K.) or probably undercount the smallest computers (Germany, Sweden and the U.S.), it is likely to be lower than for a country with a probably accurate count (Hungary) or a possible overestimate of the smallest computers (Canada). The impact that this can have can be illustrated from data in the U.K. report, by modifying the NCI time series figure for 1970 in line with the PAL-NCI ratio for 1977. The compound growth rate indicated by this calculation is 20%-21%, rather than the 13% shown in the table! It seems likely that there is little real difference in the rates of growth of computer numbers for the six countries covered by this review, although the rate for Hungary is probably somewhat above those for most other countries, and that for the United Kingdom somewhat below.

The reports also suggest some interesting differences in the distribution of computers by industry. Germany and Hungary appear to have the largest proportions of their computers in goods-producing industries, although in both cases the proportion is lower than is the goods production share of GDP. Most other countries also show a lower proportion of computers in goods-producing industry than of GDP from goods production, the single exception being Sweden. This gives Sweden about the same proportion of computers in goods-producing industry as is the case in Hungary. The five market economies all show much higher proportions of computers in commerce and finance, although there is a wide range from Canada's 17% to the United Kingdom's 45%. If, as in Canada, the commerce and finance sector in the U.K. has larger than average computers, then the U.K. figures for this sector would be exaggerated by the underrepresentation of small computers in this NCI-based comparison. The relatively high Canadian proportion of computers in transport and communications reflects the country's large area and sparse population; these activities have required an unusual proportion of available resources throughout Canada's economic history.

3. The Terminal Population

All reports except that for Hungary presented some data on terminals in use. The Hungarian report noted that terminal use was just getting under way, and extensive terminal use was not likely to be developed until the mid-1980's. The other countries all appear to be making extensive use of terminals, although this use still appears to be in the stage of rapid growth.

Data for the United States indicate an average of 8 terminals per computer reported, and even if the estimate for small computers in the United States were doubled the ratio would still be 5.5.[1] There is little doubt that the United States has a clear lead in terminal use. The German and Canadian data relate to different years; if this is allowed for they suggest about the same level of terminal use per computer reported. However if further allowance is made for the much greater number of small computers in the Canadian figures, the ratio for Canada would be above that for Germany (a reversal of the situation apparently indicated by the table), another illustration of the hazards of making international comparisons with the sort of data now available.

For Sweden and the United Kingdom the data in the reports clearly covered only a part of the terminal population. The Swedish figures relate to only 999 computers rather than the 3,700 indicated in part 6 of Table I; it is unlikely that the other computers could be assumed to have the same terminals/computer ratio. However even this partial total suggests that the Swedish terminals/computer ratio was above 5 in 1975. The United Kingdom figure for "intelligent" terminals may be complete, but that for "others" certainly is not: there are still far more "dumb" than "intelligent" terminals as these terms are usually used.

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1. Using the higher of two alternative estimates for the total terminal population of the United States. This figure appears to be the more consistent with other information used. If the lower estimate of 1,200,000 terminals were used the two values of terminals/computer would be reduced to 5.2 and 3.7. Cf. Note 20 to Table I.

Estimates of the industry distribution of terminals are given for Germany, Sweden and Canada. The German distribution is very similar to the industry distribution of computers, though with a slightly lower percentage of terminals in goods-producing industry and a slightly higher percentage in commerce and finance. For Sweden and Canada the proportion of terminals in goods production is less than half the proportion shown for computers, the proportion (by number) in public administration notably higher (although the Canadian data show that the numeric proportion of terminals in government matches the value proportion for computers). But for Sweden a very high proportion of terminals falls in the "other" category, while for Canada the proportion in commerce and finance is far above that category's share of computers or GDP. In both finance and commerce, Canada likely has a relatively small number of relatively large firms, by comparison with other countries. And in Canada these firms usually operate over a wide geographic area.

4. ADP Staff

All reports except that for Germany presented some information on ADP staff, and the authors of the German report provided an estimate that 500,000 persons were involved in ADP activities and applications in Germany. Again the data vary in completeness and detail, and the differences must be carefully examined to determine the extent to which they are significant rather than mere numeric illusions.

The Hungarian and Canadian figures appear to be the most comprehensive, and they suggest surprisingly similar occupational distributions if the figures for "managers" and "others" are considered as one unit. There is little doubt that the Canadian estimates treat as "managers" many working supervisors who would not be so classified in official statistics, and official records of ADP employment in the Canadian federal government show the proportion of "managers" to be the same as indicated by the Hungarian report. Hungary has only about 1.3 ADP staff per thousand population while Canada has 4.1; a difference of this sort is consistent with the indicated difference in extent of computer use. Even the sharp difference in ADP staff per computer is of the order that might be expected given the much higher proportion of very small computers in Canada

(such machines are frequently "user-operated", and report no dedicated ADP staff) and of large and medium computers in Hungary (assuming that these computer classifications can properly be compared).

The figures for Sweden provide little occupational detail, but suggest about the same ratio of ADP staff to population as the Canadian estimates. Staff per computer is also similar to that for Canada, especially when allowance is made for likely underestimation or overestimation of very small computers. The data for the United Kingdom relate only to government ADP staff, but the indicated occupational distribution is similar to those for Hungary and Canada. The German figure may have much broader coverage than those for other countries, since it yields a ratio of 17.3 persons involved in ADP per computer. This is at least twice the level that might be expected given the mix of computers apparently in use in the Federal Republic. This could also be accounted for if the number of computers in Germany were considerably underestimated.

The estimates for the United States show several differences in pattern. They do not include managers, and appear to cover a smaller range of "other" staff. The most notable difference is the very high proportion of "equipment operators". It is surprising, given the U.S. lead in computer use, to find only about the same ratio of ADP staff to population as in Canada and Sweden. It is also surprising, given the greater proportion of the largest machines in the United States, to find a lower ratio of ADP staff per computer than in Sweden and Canada. These indicators all suggest that the U.S. estimates may not take the same account of ADP staff located away from computer installations as do the estimates for other countries.

5. User Costs or Spending

The best indicator of the extent of ADP use in any country, and of changes in that use, would likely be provided by the proportion of national resources directed to ADP. Four reports provided estimates of user costs for ADP, but examination of the data suggests that they are not sufficiently comparable to justify calculation of such proportions, even by the very loose standards used in this review.

The Canadian figures represent an attempt to estimate the full costs actually incurred by all end users of ADP for all the ADP services that they use. They therefore include both current expenses and overhead, and the amortization of capital costs. However the figure shown for computing equipment refers only to computing equipment owned or rented by end users, and does not include computing equipment installed in service bureaus (this enters user costs only indirectly through payments for data services and consulting services). Likewise, the figure for personnel refers only to the staff of end users, and excludes consulting and service bureau staff (it is not directly comparable with the ADP staff figure in part 9, which is composed of some 83,000 ADP staff of users and some 13,000 staff of consultants, service bureaus, etc.).

The German data are from a study by the International Data Corporation (IDC). They likely relate to a survey of ADP department budgets, and would therefore exclude both non-budgetary costs and any expenditure by other organizational units. Service bureau spending is likely to be largely missed in such surveys. Data communications costs are likely included in the "other" total. Subject to these qualifications, the pattern revealed has similarities to that for Canada and even more to that for Sweden.

The Swedish figures are from a survey by the National Central Bureau of Statistics. The survey is not described in detail, and it is uncertain whether it dealt only with current expenses, or with expenses plus overhead. It seems likely, however, that an official statistical survey would avoid any significant duplication or omission, and that the four categories shown for Sweden have much the same coverage as the five shown for Canada. Data communications costs would have been small in 1972, and are likely distributed between the equipment and data services categories. Computing supplies, and perhaps some other costs, appear to be included in the equipment figure. There is little doubt that the higher use of consulting and data services indicated for Sweden is valid, or that a lower percentage of direct expenditure on personnel would be associated with this.

The United States figures are estimates, and their pattern differs greatly from those for the other three countries. The personnel component is a far lower proportion of the total even when allowance is made for fringe benefits which appear to be included in the "other" total. The equipment figure would certainly be higher than the Swedish figure if adjusted to include data communications equipment (about 4%) and supplies (3%) which appear to be in the Swedish equipment total. It is not possible to make a valid comparison with Germany in the absence of information about the amount of money spent on service bureau use. These differences raise the same doubts about the comparability of the data as arose in comparing the ADP staff figures. The comparison of spending on purchased services may be less distorted by conceptual differences; it appears that U.S. users rely less on purchased services than do those of Sweden and Canada.

To some extent, the differences in spending patterns suggested by the data may reflect real differences in relative factor costs among the four countries. However, what information is now available, especially for Canada and the United States, suggests that the main differences are more likely to result from data incomparability.

6. Conclusions

A well-known review of data processing prospects and problems in the United States declares:

> "Before a problem can be solved, it must first be clearly stated so that it is understandable to those charged with solving it; and in order to evaluate the worth of a proposed solution, one must be able to determine how that solution will change things. This implies some sense of history. The data processing industry can at best only guess where it has been and where it is today. For example, one cannot determine with any reasonable degree of accuracy any of the following:
>
> - the number of new general-purpose computers installed during any particular year;

- the amount and kind of software produced and in existence;
- the number of programmers and the growth rate of the programmer population;" [2]

These comments seem equally applicable to most of the countries covered by this review.

The lack of accurate quantitative information on the state of informatics does not only cripple attempts to make international comparisons. It also cripples attempts to investigate the progress and impacts of informatics within any country. And efforts to develop more adequate information in particular countries are hampered by the lack of any accepted standards or concepts - indeed by a veritable conflict between the requirements of this area of study and established statistical structures. Even where similar approaches are adopted they may be concealed by random differences in vocabulary (cf. the United States and Canadian meanings of "large" computers).

It would be useful if an appropriate international body were to develop recommendations as to the concepts and terminology that would be most useful in compiling data on the computer population, the terminal population, computing staff and computing costs. While the field is still evolving, there is little doubt that reliable and comparable information would be of considerable economic value.

Computing has already become an important component of economic activity in all six countries reviewed here, and in many others. It certainly accounts for more than 1% of economic activity in all six countries, and for more than 2% in at least two and perhaps others. Whether one believes with the SILT Committee that the share of computing in economic activity will continue to rise

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2. Dolotta, T.A., et al., "Data Processing in 1980-1985" (the SILT report). John Wiley and Sons, New York, 1976, p.89.

rapidly to perhaps 8% of GNP by 1985 [3], or whether one believes that declining equipment costs and simplified methods of use will prevent the rise from going much beyond 3%, its growing importance is clear. Equally clear is its spread to all countries. Better and more comparable information than is now available is essential to an adequate assessment of its effects on national economies and the world economy.

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3. Nyborg, P.S., et al., "Information Processing in the United States - a Quantitative Summary". AFIPS Press, Montvale, N.J., 1977. Note by T.B. Steel, p.45. A similar view is taken in a EUROECONOMICS forecast which estimated that ADP would account for 4.6% of West Germany's GNP by 1980.

Table I Quantitative Comparisons Among Participating Countries
(footnotes at end of table)

Item	Canada	Germany, Fed. Rep.	Hungary	Sweden	United Kingdom	United States
1. POPULATION, 1976[1]	23,143,000	61,513,000	10,599,000	8,222,000	55,928,000	215,118,000
2. AREA (Sq. Km.)[1]	9,976,000	249,000	93,000	450,000	244,000	9,363,000
3. POPULATION/SQ. KM.	2.3	247.0	114.0	18.3	229.2	23.0
4. SOURCE OF GROSS DOMESTIC PRODUCT, 1976[2]						
	%	%	%[2]	%	%	%
Agriculture	4	3	16	4	3	3
Industry	25	41	47	29	30	29
Construction	7	7	13	6	6	4
Wholesale-Retail	11	10	13	10	9	18
Transport and Communications	7	6	6	5	8	6
Other	35	31	6	35	33	37
5. FIRST COMPUTER OPERATIONAL	1951	-	1959	early '50's	1948	1946
6. NUMBER OF COMPUTERS						
a. By Size	1975[3]		1977[4]			1976[5]
	Large 240		Large 19			Very Large 16,000
	Medium 1,750		Medium 149			Large 16,000
	Small 5,070		Small 353			Medium 98,500
	Very Small 8,900		Mini 330			Small 98,500
	Total 15,960		Total 851			Total 229,000
b. By Type		1978[6]		1975[7]	1977[8]	
		Universal Process Control and Mini 10,385		General 1,580	Mainframe 4,660	
		Total 18,446		Office 1,220	Small Business 17,050	
		28,831		Mini 900	Mini 20,080	
				Total 3,700	Total 41,790	
c. Population/Computer[9]	1975: 1,420	1978: 2,130	1977: 12,510	1975: 2,210	1977:1,340	1976: 940
d. Annual Compound Growth in Number of Computers	1970-77: 31%	1970-77: 19%[10]	1970-77: 29%	1975-80: 22%[11]	1970-77: 13%[12]	1971-76: 21%
7. COMPUTER DISTRIBUTION BY INDUSTRY	1975[3,13] By No. %	By Value %	1977[10] By No. %	1977[14] By No. %	1975[15] By No. %	1978[16] By No. %	1975[17] By Value %
Agriculture, Industry and Construction	32	23	46	41	40	31	27
Commerce and Finance	17	19	32	5	23	45	25
Public Administration	12	16	5	19	7	5	15
Transport and Communications	7	6	17	5	3	3	33
Others	32	36		30	27	16	

- cont.

Table I Quantitative Comparisons Among Participating Countries - continued
(footnotes at end of table)

Item	Canada	Germany, Fed. Rep.	Hungary	Sweden	United Kingdom	United States
8. TERMINALS IN USE	1976[3,18]	1978		1975[15]	1977[19]	1976[20]
a. Number by Type	Keyboard, CRT 53,000 Bulk Terminals 5,000 Others 9,000 Total 67,000	Screen display 93,000 Printing 15,000 Others 16,000 Total 124,000		Part total 18,600	Intelligent 18,600 Others (incl. data entry) 3,100 Part total 21,700	Total 1,800,000
b. Terminals per Computer	3.3	4.3	-	-	-	7.9
c. Distribution by Industry	%	%		%		
Agriculture, Industry and Construction	10	39		17		
Commerce and Finance	42	37		21		
Public Administration	16	6		14		
Transport and Communications	11	18		4		
Others	21			44		

9. ADP STAFF	1975 No.	1975 %	1978[21] No.	1977 No.	1977 %	1976 No.	1976 %	1977[22] No.	1977[22] %	1974[23] No.	1974[23] %
Managers	12,500	13		851	6	-	-	678	4	-	-
Systems Analysts	28,800	30		2,021	14	15-20,000	50-57	4,493	31	97,000	11
Programmers				2,707	19					195,000	23
Equipment Operators	15,300	16		1,662	12			1,847	13	246,000	29
Data Conversion	28,800	30		4,203	30	-	-	7,583	52	249,000	29
Others	10,600	11		2,729	19	-	-			66,000	8
Total	96,000	100	500,000	14,173	100	30-35,000	100	14,601	100	853,000	100

10. ADP STAFF PER COMPUTER	6.0	17.3[21]	16.7	6.7-7.8[24]	-	5.6[25]

11. USER COSTS OR SPENDING FOR ADP SERVICES	1975[26] M.C$	1975[26] %	1978[27] M.US$	1978[27] %	1972[28] M.Kr.	1972[28] %	1976[29] M.US$	1976[29] %
Personnel	1,135	43	2,621	41	1,020	41	9,910	25
Computing Equipment	530	20	2,410	37	790	32	11,915	30
Consulting Services	505	19	469	7	160	6	5,305	14
Data Services					520	21		
Data Communications	110	4	-	-	-	-	2,575	7
Supplies	380	14	366	6	-	-	1,200	3
Other			559	9	-	-	8,400	21
Total	2,660	100	6,425	100	2,490	100	39,305	100

Footnotes on following pages.

Notes to Table I

General Note: Most of the information in this table was extracted from the six country reports submitted to Data for Development, except for that appearing in parts 1-4. Footnotes indicate the sources used, including sources used by the authors of country reports where these were stated. Where no source is footnoted, the data was taken from a country report which did not specify its source.

Some information in the country reports had to be rearranged to permit comparisons among countries, in particular the classifications by industry (parts 7 and 8c), by occupation (part 9) and by cost class (part 11). Comparisons based on such rearrangements of differing national classifications (for which more detailed descriptions were not available) must be regarded as rough approximations only.

To the extent permitted by national data, "computers" were limited to user-programmable digital machines, including "minicomputers" and "small business computers", but excluding "microcomputers", terminals and special-purpose accounting machines.

1. United Nations Statistical Office, Statistical Yearbook, 1977. United Nations, New York, 1978. Table 18.

2. Ibid., Table 189. For Hungary the figures are for "net material product" which excludes such non-material services as finance, insurance, business and personal services, public administration and defence. For other countries the percentages do not add to 100 because of the exclusion of some or all import duties.

3. Estimates based on the annual Canadian Computer Census published by the Canadian Information Processing Society, Toronto. The four value classes used here divide at monthly rentals in Canadian dollars of $1,000, $5,000 and $50,000.

4. Basis of classification not described.

5. Nyborg, P.S. et al., op. cit., pp. 10, 15. The four classes divide at monthly rentals in United States dollars of $2,500, $10,000 and $40,000. A recent GSA report places 64% of government computers in the lowest class in 1978 (EDP Weekly, March 12, 1979).

6. Diebold Management Report, April, 1978. These figures can not include all of the "office computers" specified elsewhere in the German report (and used as the basis for parts 6d and 7). It is assumed here that some "office computers" are microcomputers, terminal systems or non-programmable. Cf. notes 10 and 21.

7. Quantum Science Corporation.

8. Pedder Associates Limited annual census. This source gives substantially higher totals than the National Computer Index series used in some other parts of this table, especially for "small business computers" and "minicomputers". Both British series provide separate totals for "visible record computers", "intelligent terminals" and "data entry systems", none of which is included here. The latter two are used in part 8. Cf. general note.

9. Calculated using population estimates appropriate to the period for which statistics of the number of computers were available (part 6a or 6b). Additional population estimates were taken from the United Nations Monthly Bulletin of Statistics, January, 1979, and the United Nations Population and Vital Statistics Report, Series A, Vol. XXX, No. 3.

10. Diebold Management Report, September, 1977. The figures on which these percentages are based refer to "office computers", defined as small machines with a purchase price below DM 250,000 which are mainly used for data processing activities in offices and administrations. Their total is given as 66,000 units; only some can be included in the computer totals used in part 6b. Cf. note 6. The German report also indicates that the installed value of central processors and peripherals increased at about 14% per annum between 1973 and 1978.

11. The time period used here is significantly different from those used for other countries.

12. National Computing Centre, National Computer Index. Only "mainframes", "small business computers" and "minicomputers" were used in calculating this rate. The NCI series seriously underrepresents the latter two categories, which are increasing four times as rapidly as mainframes according to its records. If a time series for the Pedder Associates Limited census were available, it would probably show an annual compound growth rate of about 20% - 21%.

13. Note the difference between these two presentations. This may provide an indication of how a distribution by computer number for the United States would differ from the distribution by installed value. It is less likely to be a good indicator of how European distributions by installed value would differ from distributions by computer number. These distributions do not include computers with monthly rental values below C$1,000.

14. The difference between the percentages itemized in the Hungarian report (p. 8) and 100% is assumed to apply to public administration.

15. National Board for Economic Defence, Statistical Office. These figures relate to only 999 computers, and do not include "advanced office computers".

16. Based on a sample of entries from the National Computer Index (Tables VII and VIII of U.K. report). This sample appears to underrepresent minicomputers and small business computers even by their NCI counts, and includes some visible record computers, intelligent terminals and data entry systems. However, it appears more appropriate than the full NCI record in Table IIIa of the U.K. report.

17. Nyborg, P.S. et al., op. cit., p. 23. Note that this distribution is by installed value, and may not compare directly with the data for other countries (except Canada). Cf. note 13.

18. CRT = cathode ray tube. These estimates are very preliminary, and may not make sufficient allowance for terminals owned or rented by users who do not have their own computers. The estimate of terminals per computer is based on an estimate of 20,600 computers for 1976.

19. Pedder Associates Limited annual census. These figures do not include "dumb" terminals, except for some of those included in data entry systems.

20. Nyborg, P.S. et al., op. cit., p. 10. This is the larger of two apparently relevant estimates and is preferred because it is a "consensus" estimate even though it appears to include some key punch and key tape units (these are presumably no more numerous than data conversion staff, and likely less). The alternative estimate (by IDC) is 1,200,000 general-purpose, auto-transaction and special purpose terminals; it is cited on pages 5, 16 and 33, ibid.

21. Estimate provided by author of German report, from Diebold Statistik, 1/78. The coverage of this figure may be much broader than those for most other countries, judging by the very high figure for ADP staff per computer. It is also possible that the number of computers is underestimated.

22. Civil Service Department, April, 1978. The figures relate only to U.K. government administrative computing staff (including military staff).

23. Nyborg, P.S. et al., op. cit., p. 39.

24. Calculated using estimate of 4,500 computers for 1976.

25. Calculated using estimate of 151,000 computers for 1974, obtained from Computers in the Federal Government: A Compilation of Statistics, National Bureau of Standards, Washington, 1977 (NBS Special Publication 500-7), p. 12.

26. User cost estimates. "Personnel" includes fringe benefits as well as salaries. User-owned computing equipment included on the basis of depreciation rather than cash payments; service bureau computing equipment not covered (except as an element of the cost of computing services). Data communications equipment included in "computing equipment". "Other" includes accomodation costs, financing costs and similar overheads as well as supplies and some other current expenses.

27. ADP expenditure estimates by International Data Corporation; likely exclude most service bureau use and overheads.

28. SOU 1974: 10. Could exclude some overheads and some current expenses. Uncertain whether "personnel" includes fringe benefits, or whether owned equipment is included on the basis of cash payments or depreciation. "Computing equipment" appears to include computing supplies.

29. Nyborg, P.S. et al., op. cit., pp. 29, 30. User spending plus overheads. "Personnel" appears to include salaries only (fringe benefits in "other"). "Computing equipment" excludes data communications equipment (included in "data communications"). "Other" is an estimate of total overhead costs.

C. INSTITUTIONAL COMPARISONS

ADP has developed during a period in which governments have been expected to ensure steady economic progress accompanied by an improvement in material standards of life for most individual citizens. It is therefore not surprising that most governments have taken an active interest in this new technology, and that many have developed specific policies or plans to deal with at least some aspects of its development.

The nature of these government activities has varied from country to country. Three of the countries reviewed here are federal states, and in these countries the federal government's powers are less extensive than are those of the central governments of the three unitary states. Five are market economies and therefore rely on a different range of techniques than does the one planned economy. But perhaps the most important difference has derived from the much greater effective market for new technology in the United States because of the size and relative wealth of that country, especially in the crucial period of the 1950's.

1. National ADP Plans and Policies

Hungary is the only one of the six countries with a formal plan which sets objectives and development trends for informatics, and provides direction for resource development and use. Both Germany and Sweden appear to have developed a comprehensive set of programs which suggest a de facto if not de jure ADP plan and policy. The United Kingdom also has a number of programs in place which, though perhaps less comprehensive, nevertheless suggest a degree of planned and monitored government response to ADP developments. Canada came close to developing a policy for computer/communications in the early 1970's, but only fragments of this policy have been embodied in government actions.

The United States, which has led the world in most facets of ADP development and use ever since it completed the first fully programmed electronic computer in 1946, has no official ADP plan or policy. It does, however, appear to have a very effective (if basically reactive) de facto policy, based on three main principles:

- the computer is just another tool, useful for what it can do;
- government should ensure that it is profitable for U.S. firms to develop improved tools to meet specific government requirements;
- government should regulate competition to prevent the development of monopoly.

The policy development and planning efforts of the other five countries have been influenced by both economic and strategic considerations. They have tried to weigh the need to exploit the new technology to remain competitive (which has required substantial imports of U.S. technology and its products) against its balance of payments effects and the danger of undue dependence on external suppliers. Most have developed arrangements to promote, coordinate or control government use of ADP. In all five countries there has been some encouragement of the domestic production of ADP equipment, and of ADP education and training. Data communications is becoming an increasing concern in all responses because of its growing importance to the effective use of ADP technology. Different countries have perceived differently the need to support national computing service suppliers or to pass special legislation relating to ADP. Non-government and semi-official institutions have developed different roles depending in part on the extent and nature of government action. These elements will be reviewed in turn.

2. Government ADP Use

In all six countries the first uses of computers appear to have been in academic-scientific applications, but governments soon became major users of

computing in their day to day administrative work. The high cost of ADP equipment in the 1960's resulted in some attempts at coordination of government acquisition and use in all countries, and in some cases became a means of implementing a national equipment policy. Hungary's 1971-75 and 1976-80 plans provided for accelerated ADP development, and directed some 25% of planned ADP investment to the public administration sector. The plans provided mechanisms aimed at achieving efficient use of this investment and also of that directed to state enterprises and cooperatives.

Government applications of ADP tend to be both extensive (in all areas of government) and intensive (using the full range of technology). In Hungary the official finance and statistical agencies are pioneering the development of special purpose networks connecting central and regional agencies. The United States developed the basic technology for computer interconnection to meet defense department contracts in the 1950's. In several countries the needs of police work have led to the development of advanced on-line information systems which can be used without extensive computer training. All governments have developed registers and data base systems to meet particular needs of public administration.

The United States has assigned responsibility for fiscal control and administrative policy to its Office of Management and Budget, and responsibility for acquisitions to its General Services Administration. These are the agencies normally responsible for budget control and purchasing. The management of installed equipment and particular applications is left to individual user departments. Canada has followed a similar course, although its Treasury Board considers administrative policy to include a broad concern for the effectiveness of installed equipment and the ADP applications in use. Neither of these federal states attempts to coordinate ADP use between the federal and state (or provincial) levels of government. The United Kingdom has also worked through existing government mechanisms and has made no strong effort to coordinate government ADP use except to ensure its conformity with support for national equipment production.

The Hungarian plan provides for coordination of its Central Development Programme for ADP through a special interdepartmental committee made up of deputy ministers of departments with relevant responsibilities. Reports of this committee are reviewed at least annually by the Council of Ministers. This mechanism (supported by other committees with departmental or sectoral responsibilities) is responsible for ADP development and use in all government departments, state enterprises and cooperatives: some 95% of the whole economy and probably all the computer use.

Germany and Sweden fall between the two extremes. Both coordinate government ADP through mechanisms with a responsibility for administrative coordination which extends beyond ADP. The Swedish Agency for Administrative Development (SAFAD) has been armed for its task with control of the state computer fund through which most government computers must be acquired, and earlier with a veto over any proposed government use of private data service firms. Germany uses an Interministry Coordinating Committee which is concerned with all activities of federal agencies which require an interministerial approach. It also has an ADP Cooperation Committee made up of representatives of federal, state and local governments which exercises considerable influence on the actions taken by each level of government in its constitutional sphere. A federal government structure clearly need not rule out a significant measure of overall coordination of government ADP use.

3. Computing Equipment and Software

All six countries have promoted the production of computing equipment. The techniques used have differed considerably, as have the results. Some have also provided an important stimulus to the development of a domestic software industry.

The United States produces the full range of computers, peripherals, terminals and software. The development of these industries was greatly assisted by the award of contracts to develop and produce equipment and software

to meet the requirements of government programs, especially the defence and space programs. Having achieved early development and profitability, the U.S. industries have so far needed no special support to hold the large U.S. market (both government and private sectors) and to develop massive exports (it is estimated that only half of total revenues of ADP firms in the U.S. is earned from U.S. sales).

The United Kingdom produced its first computer almost as early as the United States, but its industry did not receive the same massive stimulation during the 1950's. During the 1960's the industry was rationalized by the formation of ICL (25 % state-owned), and supported by a government loan and a purchasing policy that encouraged the use of ICL computers by governments and government agencies in the U.K. This has permitted the U.K. to maintain production of a full line of mainframe computers (some U.S. firms also have branch plants in the U.K.). More recently there has been some funding of software development by a government agency (financing is a major problem for software firms in a market economy because of their lack of bankable assets). The current microelectronics industry program has introduced important government support in another area. Although each of these programs has been an ad hoc response to a particular problem, they amount in total to a fairly comprehensive attack on the production of ADP goods and services. To date they have not been sufficient to prevent an import balance on trade in this area.

Germany, Hungary and Sweden are all promoting the production of small computers, peripherals and terminals. Germany is also maintaining a role in large mainframe production, and has branch plants of some U.S. firms. Hungary's production is coordinated with that of a group of planned economies; this has helped Hungary achieve an export surplus in this trade with other planned economies. Sweden recently rationalized its computer production through a company with 50% state ownership. Over half of its production is exported, but there is probably still a net deficit on trade in this area because of the need to import components. Germany and Hungary also promote national software development.

Canada is the only country which has made no systematic attempt to promote a national computer equipment or software industry. The government tries to ensure that multinational producers with significant sales in Canada do locate some production in Canada, and this has resulted in several manufacturing facilities and some development activity. There are also a number of small Canadian firms making ADP-related equipment.

None of the six countries has attempted to promote software production through patent law, and only Germany (through copyright) and Hungary (through its civic code) now provide any special rights for authors of software.

4. ADP Education and Training

All six countries include computer science courses in their university offerings, and appear to provide some ADP courses in their secondary and post-secondary schools and colleges. There are wide differences in the governing structures and the extent to which training is conducted outside the formal education system. In general, there appears to be a lack of applications-oriented training (at least through official institutions), and a relative overemphasis on computer science programs.

In Canada and the United States, education and training fall within the constitutional authority of provincial or state governments, rather than of the federal government. In both countries, however, federal funds have facilitated the installation of computers in universities and the establishment of degree courses in computer science. A considerable proportion of students in other disciplines also learn to use computers in the course of their studies. Some courses in data processing, programming and systems analysis are available in secondary schools and technical institutes. However there are no recognized or prescribed qualifications for practitioners in these fields, and the greater part of practical training is provided by employers and private organizations. In both countries, a private association of data processors has tried for some years to develop and promote a certification program, but this has not achieved

general acceptance. Federal authorities provide some retraining in computer skills for the unemployed.

The situation in the United Kingdom is similar, though in many respects individual schools and universities are even more independent of detailed government control or influence than in North America. An important difference is that the certification program of the British Computer Society (for systems analysts and programmers) is more widely accepted and therefore provides an unofficial standard towards which training development can be directed. Government retraining plans directed towards ADP employment also appear to be more fully developed.

In Germany and Sweden the national governments appear to have a stronger role in improving formal education programs relating to ADP, and also in ensuring the availability of retraining programs. German and Swedish trade unions also appear to be active supporters of ADP training and retraining; as yet no similar active interest has been significant in the U.K. or North America.

Hungary has developed its ADP training within the context of the Central Development Plan. Basic foundation courses in mathematics are provided in the schools, and advanced training courses (available at universities, colleges or evening schools) provide the qualifications needed for programming and systems analysis. Programmers and analysts must obtain the now-prescribed diplomas; older practitioners are not automatically considered to be qualified, although they are allowed a reasonable period to take the prescribed courses. Hungary has not allowed its present shortage of analysts and programmers to block its efforts to improve qualifications in this field.

Hungary's semi-official John von Neumann Society for Computer Science is limited to the best systems analysts, programmers and other technologists. The existence of such an "academy" may be a useful device for encouraging improved professional standards in ADP.

5. Data Communications

In Germany, Hungary and the United Kingdom, a single government agency is responsible for postal, telegraph, telephone and data communications services. These "PTT" organizations determine what services will be available, the standards of service, and what equipment can be attached to the telecommunications network. The Swedish Telecommunications Agency is separate from the post office, but otherwise has the same characteristics as the PTTs. In most of Canada and in the United States, telecommunications services are provided by private enterprises operating under government regulation. The development of telex and data communications has in both countries resulted in a trend to greater competition in the telecommunications area. Telecommunications policy in the United States now places more emphasis on competition and less on government regulation than formerly. No similar change in policy is yet visible in Canada.

Digital data transmission services are already available in Canada and the United States. Local connections are usually through dial-up analogue facilities. Germany is developing a digital network, and such networks are under study or planned in other countries.

Packet switching networks are available in the United States and Canada, and have been introduced on a trial basis in the United Kingdom. Germany has installed packet data facilities in West Berlin, and Sweden is expected to have packet switching facilities in the early '80's.

Canada, Sweden, the United Kingdom and the United States are all testing fibre optics transmission facilities. These techniques are also under active study in Germany.

The regulated oligopolies of North America seem to date to have been more responsive to the pressures for new types of data transmission facility than have the state monopolies of Europe. In addition, the independent regulatory agencies of North America have limited the freedom of telecommunications companies to deny attachment of user-owned devices to the telecommunications network.

Institutional differences have not prevented cooperation among the agencies responsible for data transmission. Data are regularly sent from one continent to another using established telephone networks. Special-purpose networks such as the SWIFT banking network and the SITA airlines network have been serving their industries for some years. The Nordic countries have cooperated in the design of a common public data network. The ease of data flow across national borders is at the root of the growing concern about the effects of ADP on national sovereignty and some of the other issues reviewed in Part I.

6. Computing Service Suppliers

In all six countries service bureaus, software suppliers, and applications development suppliers have played an important part in making ADP services more widely available. The institutional frameworks vary widely from "complete" reliance on private enterprises in the United States to equally complete reliance on state enterprises in Hungary. However all countries have allowed competition a significant role in this area.

The Hungarian plan provides for provision of a network of regional computer centres through one state enterprise, and for functional and sectoral services through others. In addition, institutions with their own computers can sell surplus time. Users are allowed some freedom of choice among available sources of service, as well as the choice of acquiring their own computer. About 30%-35% of CPU use in Hungary is for external customers, probably a higher ratio than in any other of the countries under review. The Hungarian enterprises typically offer a full range of machine services, software development and consulting, although one enterprise specializes in helping with the selection, installation and maintenance of computers, and the provision of a user software registry (these services are restricted to computers manufactured in the planned economies).

In the United States, the computer service organizations are more often specialized. Many offer only program development services, or only package software, or only service packages directed to a specific group of users (e.g., seismic data processing, or demand deposit accounting). Many of the largest

firms specialize in "real time" or "interactive" services. The total revenue of these firms is estimated to have been about US $6 billion in 1976, including export and "captive" revenues; between two-thirds and three-quarters of the total is from machine-based services, the balance from software and consulting.[1]

Although the U.S. industry is far larger than that of any other country, it appears to account for a smaller proportion of the total consumption of ADP services in the U.S. than do service industries in other countries.[2] The service bureau portion of this industry has developed without significant government assistance, although several software firms in the U.S. owe their existence to defence and space contracts.

The Canadian industry is primarily a private sector activity, although some provincial governments operate their own service bureaus and one encourages its bureau to compete for private business. To date the Canadian service bureaus have concentrated on remote batch processing to a greater extent than those of the United States, and are much less specialized by industry or function. In Canada the software section of the industry has had little government support, even though the federal government encourages its departments to use private service bureaus.

The United Kingdom industry is again largely a private sector activity, but the pattern of government encouragement is the reverse of that in Canada.

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1. Based on Eleventh and Twelfth Annual Reports on the Computer Services Industry. Association of Data Processing Services Organizations, Inc., Montvale, N.J., U.S.A.

2. Cf. the 30%-35% range indicated for Hungary, or the 27% and 19% indicated for Sweden and Canada in Table I, part 11.

The U.K. provides some assistance for software firms (chiefly financing) but none for service bureaus. Despite this, over a quarter of the U.K.'s computers have some "service bureau" uses, and these computers account for more than a third of the value of installed capacity.

Germany and Sweden make considerable use of government data centres to meet government needs. There also appears to be a healthy private computer services industry in both countries. A 1972 survey of corporate users in Sweden indicated that 62% relied chiefly on service bureaus, and this proportion was as high as 77% for users with less than 100 employees.

7. Special Legislation

Neither the United Kingdom nor Canada now has any legislation dealing specifically with ADP, although the revised Bank Act now being considered by the Canadian parliament proposes some limitations on where banks perform their data processing. The federal government and one province have Human Rights Acts which deal with government personal data registers, but these apply whether the registers are manual or automated. Some other Canadian provinces also have legislation which deals with specific types of information, but again regardless of whether automated.

Germany and Sweden, on the other hand, both have legislation specifically designed to protect privacy from undue encroachment by automated data systems (in Germany both the federal government and most states have passed very similar legislation). These laws restrict data exchange or transfer, and the Swedish law requires advance approval before a personal data register can be established. Sweden also has provisions in its Accounting Act and its Companies Act which set conditions for computer use for certain purposes. The German and Swedish laws apply to both public sector and private sector ADP.

Hungary and the United States appear to take an intermediate position. The Hungarian Civic Code of 1977 and the U.S. Privacy Act of 1974 contain provisions to protect individual rights against encroachment by ADP systems, and

impose certain obligations on the custodians of relevant data bases. The Hungarian law has general application, while the U.S. law applies only to the federal government and its agencies.

The need for legislation to deal with other facets of the information age is widely recognized. Specific problems (patent and copyright laws, admissibility of computer-produced records in evidence, electronic funds transfer, etc.) have been studied in many countries. As yet, however, legislative solutions have not been developed and implemented in most countries.

8. Other Institutions

In all countries there is a considerable range of non-government institutions concerned with general or specific aspects of ADP. The United States has the greatest number and variety of these, ranging from special computer sections of pre-computer professional associations, through "user groups" sponsored or promoted by equipment manufacturers, to independent associations of people with a general or specific interest (pro or anti) in ADP. In spite of - or perhaps because of - this diversity, no single organization has been able to acquire the leading role which appears to have been achieved by the British Computer Society, the Hungarian John von Neumann Society, or the German Society for Mathematics and Data Processing.Instead, the principal U.S. societies have formed the American Federation of Information Processing Societies (AFIPS) which acts as a focus for many activities of mutual interest.

Canada, because of its location, has branches of or members in many U.S. associations, to an extent that hampers the development of national associations. The largest Canadian association, the Canadian Information Processing Society (CIPS), has fewer members than the number of firms and institutions with computers which are listed in its annual computer census. The voluntary activities of CIPS have nevertheless been the main sources of quantitative information about ADP in Canada. Until recently, CIPS has not been active in developing positions on public policy issues, unlike AFIPS or the British Computer Society. However CIPS has now begun to develop positions on

important regulatory issues, and is cooperating with the Consumers' Association of Canada in investigating and resolving citizen problems which relate to computer use.

An awareness of the possible implications for employment of the spread of ADP use is developing in most countries. Only in Germany and Sweden, however, do the trade unions appear to have developed a significant role in dealing with these effects. The Swedish Joint Regulation Act of 1976 requires employers to negotiate with unions before introducing important changes in the workplace (such as ADP methods) and to keep the unions informed of the financial and production aspects of the business (which again may include ADP aspects). German unions frequently negotiate to protect their members from possible negative impacts of ADP technology. The British Trades Union Congress has only begun to consider ADP impacts, and in North America only a few individual unions have shown any real awareness of the possible employment impacts of ADP.

9. Conclusions

From the information presented in the separate country reports, it is not possible to demonstrate any correlation between the existence or non-existence of a formal ADP plan or policy in any country, and the degree or success of ADP use in that country. Nor is there yet any evident relationship between the amount of coordination of government ADP use and the scale or success of that use. The justification of ADP plans should therefore lie in the attainment of some objective other than the promotion of ADP use, such as capital and other resource conservation, or the advancement of some national interest.

The development of successful computing equipment and generalized or package software industries does appear to require government support, since such industries do not appear to have attained viability where such support was lacking. However, government support may not be a sufficient condition for successful development. National efforts to develop mainframe production in the face of competition from established U.S. manufacturers have not been universally successful. It is still too early to determine the success of efforts to develop national lines of small computers.

ADP training, computer service bureaus, and applications software production all appear to develop regardless of the institutional framework or the support of governments. However the development of data communications has been noticeably more rapid in environments of regulated competition or oligopoly than in monopoly environments. The declining cost and improving quality of data communications may be opening the door to the same sort of international competition among service bureaus as has already occurred in mainframe production.

Most existing legislation was written before computer use was widespread, and even current legislation rarely makes specific mention of ADP. Privacy protection is the principal exception, but as yet there is no clear evidence that personal privacy has suffered relatively greater erosion where protective legislation does not exist. The lack of special legislative attention may even have helped the development of ADP use. The role of unofficial or semi-official associations in the ADP community does appear to be greatest where the state itself has been least active, although state support can certainly expand the authority of such voluntary associations as trade unions.

The effective use of ADP technology can clearly occur within a wide range of institutional frameworks and policy options. The range of options appears to narrow if there is a decision to attempt production of most ADP goods and some ADP services, especially if this decision is taken in the face of competition from established enterprises.

Table II The Institutional Environment

	Canada	Germany, Fed. Rep.	Hungary	Sweden	United Kingdom	United States
Government Type	Federal	Federal	Unitary	Unitary	Unitary	Federal
Type of Economy	Market	Market	Planned	Market	Market	Market
1. National ADP Plans and Policies	- no overall ADP plan or policy - little coordination of fed. department or fed.-provincial actions re ADP	- no formal ADP plan but de facto plan - coordination of fed. dept. actions - coordination of fed.-state-local actions re ADP	- Central Development Plan sets ADP objectives, resources - full coordination of govt., institutions, co-ops.	- no formal ADP plan but de facto plan - coordination of govt. actions re ADP	- no overall ADP plan but partial plans cover several areas - coordination of central govt. actions re ADP varies	- no overall ADP plan or policy - no coordination of fed. department or fed.-state actions re ADP
2. Government ADP Use	Government is a major user of ADP in all six countries. Common uses include statistics, financial accounting and registries; common techniques include local batch, remote batch and data base systems.					
	- on-line systems in use - fed. govt. share of total ADP use is decreasing - general administrative guidelines for fed. ADP use - central purchasing - no fed. - prov. coordination	- on-line systems in use - coordination of fed. ADP use - coordination of fed.-state-local use - some cooperation among local govts.	- Plan directs 25% of ADP investment to administration - Plan provides coordinating agencies for all ADP use in govt., state institutions, co-ops.	- on-line systems in use - coordination of govt. ADP use including acquisitions, applications and facility use	- on-line systems in use - little coordination of govt. ADP use except equipment selection	- on-line systems in use - fed. govt. share of total ADP use is decreasing - general administrative guidelines for fed. ADP use - central purchasing - no fed. - state coordination
3. Computing Equipment and Software	- no special support for production of ADP goods, software - some branch plants of U.S. multinats. - some independent production of peripherals	- support for design, production of computers, peripherals, software - some branch plants of U.S. multinats.	- production of small computers, peripherals, software coordinated with other planned economies	- support for design, production of small computers, peripherals by 50% state owned company	- design, production of mainframes (25% state owned firm) - some financing for software producers - support for microprocessor prod. - some branch plants of U.S. multinats.	- support for ADP goods, software by development contracts, acquisition policy (ad hoc) - widest product range, half revenue from exports
4. ADP Education and Training	All six countries have university degree courses in computer science, technical institute courses in systems analysis and programming, and some elementary or preparatory courses in secondary schools.					
	- provinces responsible for educ. - federal funds for univ. computers - no recognized standard for programmers, analysts - much training private or by users	- federal support of ADP education and training - trade unions promote ADP training - much training private or by users - retraining courses for displaced workers include ADP skills	- all training provided in context of Plan - programmers, analysts must take required courses	- retraining courses for displaced workers include ADP skills	- stimulation of course development by govt. agencies - British Computer Society has exam, certificate for analysts, programmers - much training private or by users	- states responsible for educ., training - federal support for educ. costs - no recognized standard for programmers, analysts - much training private or by users.

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Table II The Institutional Environment - continued

	Canada	Germany, Fed. Rep.	Hungary	Sweden	United Kingdom	United States
5. Data Communications	- provided by 2 regulated carrier groups - some restrictions on attachment of user equipment - digital transmission, packet switching available	- provided by PTT which determines services, standards and attachments - packet switching being introduced - digital network being developed	- provided by PTT in context of Plan - digital network planned for '80s - most data exchange by tape	- provided by Swedish Telecom. Agency which determines services, standards and attachments - packet switching being planned	- provided by PTT which determines services, standards and attachments - packet switching in trial stage	- provided by regulated common and value-added carriers - few restrictions on attachment of user equipment - digital transmission, packet switching available
6. Computing Service Suppliers	- mostly private sector activity - provides some 19% of services used - federal policy to use bureaus if cost competitive	- local govts. have many centres for joint use - several private suppliers	- separate state enterprises provide regional, sectoral, functional services - users can choose among suppliers - 30%-35% of CPU use by external users	- govt. has own service bureau, software house; much joint computer use - private suppliers chief source for 62% of user firms in 1972	- largely private sector activity - no govt. support for bureaus, some financing for software suppliers - PTT provides bureau services	- private sector activity with 2,600 firms in 1976 - provides some 14% of services used - no govt. support for bureaus, some for software from purchasing policy
7. Special Legislation	- no ADP legislation - some legislation affects data files and records whether ADP or manual	- data protection laws enacted by fed. govt., most states; apply to all personal data, restrict exchange or transfer of data - has copyright for software	- civic code protects personal data in computers and author's rights in software	- Data Act of 1973 limits files of personal data and their transfer - other laws set some conditions for computer use (Accounting Act, Companies Act)	- no ADP legislation	- Privacy Act of 1974 requires disclosure of fed. govt. data files, sets standards of access, confidentiality - Fair Credit Reporting Act affects private sector
8. Other Institutions	- unions have little interest in ADP except printing, postal unions - most voluntary ADP associations are branches of U.S. societies	- unions concerned about ADP, effects on jobs, working conditions; subject of bargaining - national voluntary ADP associations are influential	- John von Neumann Society of Computer Science has influence on ADP policy and practice	- unions have legal right to negotiate introduction of ADP and resulting changes in work methods	- unions concerned about ADP, effects on jobs, working conditions; becoming subject of bargaining - British Computer Society influential	- unions developing interest in ADP but not yet regular bargaining topic - voluntary ADP associations many and influential

D. COMPARISONS OF ADP USE

Each of the six country reports discussed some of the uses to which ADP technology has been and is being put. The examples cited, while differing among reports, provide some evidence of similarities and differences in the way in which the technology has been applied in different countries, and of similarities and differences in the extent of ADP use. The discussion first considers the general penetration of ADP in the six countries, then four broad areas of ADP use, and finally five selected types of application.

The differences among applications emphasized in the six country reports should not be allowed to obscure the fundamental similarities in the pattern of ADP development. The following paragraph from the Hungarian report could, with changes of dates, apply to any of the six countries:

> "Each stage of development has necessarily affected new layers of users. In the initial period, i.e. the 1960s, computers were mainly used by scientific institutions and by large institutions of state administration; the applications in 1970 to 75 extended to large industrial enterprises, banks, the distribution industry and from 1975 on - owing to a sudden diffusion of minicomputers - applications have reached the medium-size enterprises and institutions." [1]

1. The General Penetration of ADP

All six country reports commented on the extensive use of ADP in administrative-type applications, and cited specific examples of its application both in government administration and in industry. Administrative data processing clearly accounts for the majority of computer use in all six

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1. Aranyi, A., et al: National Policy of Informatics in Hungary, p.21.

countries. It is also clear that computers play an important role in scientific-academic research in all countries, and that all have begun to develop process control and similar industrial applications. These latter categories use a much smaller part of available computing services than administrative applications, perhaps of the order of 7-1-1 (only the Hungarian report provides data on this point). The eight most common uses of British computers all appear to fall in the administrative data processing category.

The United States report notes that most large local governments, as well as state governments, make regular use of ADP. Estimates of ADP penetration in particular industry areas in 1976 range from 27% of firms of all sizes in primary industry to 76% in insurance. Canadian estimates suggest that at least 18,000 firms and institutions used ADP in 1976, including almost all firms with revenues in excess of C$10 million, and 85% of firms with revenues in excess of C$5 million. About half of these users (mostly the smaller users) relied entirely on service bureaus and other sources of external supply. In Hungary only about 1,400 out of 4,400 enterprises and cooperatives make use of ADP, and only about 100 of these use it sufficiently to require their own computers.

No quantitative estimates of the degree of computer penetration were contained in the reports for the Federal Republic of Germany, Sweden or the United Kingdom. The discussion suggests that ADP use is of the same order as in Canada: below that in the United States but well above that in Hungary.

The penetration of ADP into new fields is continuing. "The considerble progress in the hardware field, particularly the recent improvements in semi-conductor technology, and the increasing automation of technology production have led to a continuous reduction of information technology costs. Thus, new areas for the application of information technology do appear continuously. One can recognize a growing inter-relationship among data and communication technology. On one side, the desire to exchange digital data between data centres, data banks, and data stations via appropriate communication paths is increasing. The existing communication technology seems to be able to accommodate for that. On the other side, the possibilities of

utilizing the processing, transmission, and storage capabilities of ADP for text, language, and image communication purposes are explored. The current state of technology allows the combination of various communication forms to new effective systems." [2]

2. Selected Areas of Use

Informatics has been applied in a number of "industry" or market areas with somewhat different characteristics. None of these was discussed thoroughly in all reports, but enough information was provided for a short review of the use of ADP in manufacturing, in commerce and finance, in transportation, and in the new area of personal computing.

2.1 Manufacturing and process control

In manufacturing industry ADP is still much more widely used for administrative tasks than for actual production. Financial accounting and billing, sales and orders processing, and inventory control and purchasing are probably the leading application areas. United States data indicate that almost a third of all manufacturing establishments make some use of ADP, and suggest that ADP typically absorbs some 1% of revenues (there is considerable variation in its use in different types of manufacturing and among firms of different sizes).

When computing was first developed there were many predictions of factory automation and of drastic reductions in factory employment. This has not yet happened. "The use of computers in an industrial production process is dependent on the nature of the product and on how computerization has taken place. Computerization is at its most complete in the processing industry, in

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2. Hansen, H. and Schafer, J.: New Trends in Informatics and Related Government Policies in the Federal Republic of Germany, Part II, p.1.

which both the flow of materials and manufacturing operations are determined and controlled by computers. There are usually a number of mini-computers which can communicate with one another or with a central computer. In other industries calculation and design work is often entirely computerized." [3]

But computer use is now spreading to more typical factory operations. A Swedish example is "a Volvo factory which now employs 1,200 workers for welding of car bodies. About 100 of these jobs have already been replaced with industrial robots in order to eliminate tasks which were very taxing from the viewpoint of the working environment. The interesting point is not this partial automation but that further robots can reduce the number of workers needed from 1,200 to 18." [4]

The Swedish report estimated that about 600 industrial robots were in use in that country in 1977. Comparable data are not available for other countries, but this figure suggests that Sweden may be using a higher proportion of its computing resources in automated production than are others. Data for Hungary show that more than 9% of CPU time was used for production control in 1976, and process control was the principal use reported for almost 10% of Canada's computers (most of these were computers in the smaller size ranges). It is unlikely that these uses were entirely in manufacturing in any country; in Canada manufacturing accounts for about the same proportion of process control computers as of computers in total.

The development of inexpensive microprocessors seems likely to widen considerably the extent to which computing can be successfully applied in the actual production of manufactured goods, as well as permitting smaller firms to

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3. Freese, J. and Palsson, U.: Trends in National Policies for Automatic Data Processing - Sweden, p.11.

4. Ibid., p.41.

automate their administrative data processing. This has sparked a renewed concern about the unemployment effects of the spread of computing in several countries.

2.2 Commerce and finance

Commerce and finance - particularly the latter - are probably the areas with the highest computer penetration in the five market economies under review. Five of the eight top "industry" penetration figures for the United States fall in this category: insurance (76% of firms of all sizes), banking (71%), finance (54%), wholesale (53%) and retail (40%). These rankings appear to be directly related to average firm size; the spread of smaller computers since 1976 (the reference year) is therefore likely to have had considerable impact in raising the figure for retail trade.

As in manufacturing, most of the commercial applications developed to date are administrative in nature. Point of sale data gathering systems are also mentioned in the Canadian, Swedish and United States reports, and on-line customer credit checking systems are becoming common in the United States and Canada. Automated checkout systems (especially in grocery stores) are no longer rarities in the United States, and have had some use in several other countries. Canada also reports a successful "teleshopping" system, by which a retailer's computer accepts customer orders which are given using touch-tone telephones. The major problem in developing consumer interface systems is not technical but psychological: one of accustoming the consumer to new behaviour patterns. This limits the rate at which new systems can be successfully introduced in a competitive situation.

Banking is a leading area of computer application in all six countries. Internal bank administration and inter-branch operations have been successfully automated everywhere, and inter-bank transactions have also been extensively automated. Two different aspects of financial automation are stressed in the U.K. and Swedish reports:

"Electronic funds transfer will develop rapidly in the City. The SWIFT system for international money transfer is well-known. It acts merely as a switching mechanism for payments messages. It uses no concept of account as does the Clearing House Automatic Payment System, CHAPS, being developed in the City. This will handle settlements in Sterling handled by the Clearing Banks with net movements between these banks settled at the end of the day by the Bank of England. Every day will start at zero in each account and the system will carry immediate transfers usually of large sums of money. The position of each participant and records of transactions will be maintained." [5]

"A large proportion of the transactions between banks and large companies are now computerized and will to a great extent take place by on-line transactions between bank accounts. In many cases salaries and pensions are paid out by authorities and companies with the help of computers which turn them over to banks or the post office. Cash register terminals in banks, post offices and sales outlets provide even small companies and private individuals with considerable opportunity to take advantage of the computer." [6]

Bank-customer interfaces are being automated everywhere. The Hungarian report notes the successful automation of payments among enterprises and institutions, using a system of uniform identifiers related to bank account numbers. The other five countries all mention automated teller services (which differ somewhat in range). The major British clearing banks and some consortia of trustee saving banks have centralized data bases of accounts which are accessible from any of the branches of the bank. One Canadian bank has just introduced a similar system of multi-branch banking, whereby an account maintained at one branch can be accessed and transactions conducted through

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5. Stamper, R.: "Informatic Applications in the United Kingdom - 1978 and Future Trends, p.56.

6. Freese, J. and Palsson, U.: op. cit., p.12.

almost any other branch in the country (the bank has some 1,200 branch offices across Canada). In no country, however, does there seem to be any great eagerness to leap into the brave new world of electronic funds transfer, at least of the type which was heralded by computer experts a decade ago. Instead there has been a slow evolution of new customer services which operate in parallel with traditional methods of conducting business.

2.3 Transportation

Transportation is another area which has led in ADP use in all six countries; like banking it demonstrates both the essential uniformity of the industry tasks and the suitability of the new technology to these tasks. In Hungary: "Several computer networks have evolved in recent years under the aegis of organizations of national authority. The computer network of the railways, of raod transport of goods, of academic research projects can be regarded as advanced. Connected to the central computer are remote batch terminals, intelligent terminals, display units by means of data transfer over leased or switched lines. The networks are mainly used to remote job entry, transaction processing, access to data bases." [7]

"One of the world's first commercial on-line real-time systems was developed in the early sixties by Trans-Canada Airlines (now Air Canada) for its reservation system. Reservation clerks at all major airports and at downtown centres have direct access to terminals hooked into the system. Links are provided to SITA, for direct reservations on other airlines." [8]

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7. Aranyi, A., et al: op. cit. p.58.

8. Robinson, P. and Gotlieb, C.C.: Trends in National Policies for Automatic Data Processing - Canada, p.25.

Transport data systems which make extensive use of telecommunications are also widespread in other countries for controlling and speeding the movement of goods, and reducing the massive paperwork required. Seat reservation systems for airlines were among the first uses of on-line technology in all six countries. Routine administrative tasks have also been extensively automated in transportation.

2.4 Personal computing

This area of application was mentioned in four of the six country reports. The concepts of "personal computing" differ somewhat; here the discussion excludes appliance control applications of microcomputers, and packaged TV games devices, in keeping with the definition suggested in Section II-B-2.

Personal computing in the office environment does exist in most countries but is available only to a relatively restricted number of trained scientists, engineers, econometricians and similar specialists. These specialists have been accessing computers through terminals without programmer assistance or operator intermediation for a decade or more. Some now are equipped with small desk-top programmable computers, or with programmable terminals which need not always access a remote machine. As such devices decline in cost their use will doubtless become more common, however the chief constraint on their use is already skill rather than cost.

Personal computing in the home has two main aspects. One is the possible use of videotex systems to deliver computing services to the consumer, the other the acquisition by the consumer of his own programmable computer to be used as he wishes. Videotex is nowhere in full operation yet. Only in the United States does there appear to be a large number of home computers at present - for 1977 their number was estimated as 15,000-20,000. Most of the owners of these home computers are believed to be computer users at work (about 75%); the other hobbyists likely include a high proportion of young people. The existence of an active second-hand market in computing equipment likely helped to develop the

home market, although many manufacturers are now producing simple systems and kits aimed specifically at home use. These devices are now spilling over into the Canadian market as well.

3. Selected Types of Application

The discussion of ADP use by market area has tended to focus on the similarities which have resulted from the application of common technology to common problems, regardless of institutional or other national differences. A review of some of the types of applications which are suitable for use in a number of industries may provide a better indication of differences. Five types of application have been selected for this review. Two, data banks and on-line systems, are in use in all six countries. Three, electronic mail, office automation, and videotex are in the process of being introduced.

3.1 Data banks

Data bank techniques are extensively used in systems for government administration in all six countries. Most country reports mentioned them as in use by large firms and institutions concerned with activities other than government. The Canadian and United States reports also mention the existence and use of public data banks.

The Swedish report provides a brief description of one major government application of data bank techniques. "The National Social Insurance Board (RFV) data system is a tool for RFV itself and the local social insurance offices. The activity is divided into three main areas:

- health insurance,
- subsidies,
- pensions,

which in principle are treated as three different applications but which together make up a total population register. The insurance offices are linked to a central computer system by means of some thousand terminals over a nationwide communication network. A large proportion of insurance matters pass through or are carried out by the computer system. The system is also used to a great extent for enquiry services for public insurance, and also for the accounts of other authorities and outsiders. Such issues are expected to occasion 86 million transactions in the system in 1978. On the busiest days 445,000 transactions are handled, nearly 55,000 of these during the busiest hour." [9]

Government and private data banks have occasioned some public concern in most countries. This concern underlies the strong privacy legislation which has been adopted in Germany and Sweden, and the somewhat more limited legislation in Hungary, the United States and Canada. In all cases there has been some action to limit the transfer of records held in government and private data banks.

No such concern seems to have been directed towards the public data banks which have developed in the United States and Canada. These offer information to any who wish to purchase it; there are some 300 public data bases in the United States and over 100 in Canada.[10] All or most of the information content of these public data banks is clearly in the public domain, and the service provided is essentially that of making such information easier to use or more readily available. In both countries some public data bank services are provided by government agencies but, especially in the United States, most of the available services are from private firms and institutions. The cost of these services generally restricts them to institutional rather than individual users at this time.

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9. Freese, J. and Palsson, U.: op. cit., p.8.

10. Toronto Public Libraries: Urban Libraries Study Project, 1979 (in progress).

3.2 On-line systems

"The appearance of a viable computer communications industry is one very important outgrowth of recent technological innovations. The introduction of mini and microcomputers, improved data transmission services, and expanded facilities for data storage are contributing to the economic distribution of computer processing functions. In 1976, $5.9 billion or 30 percent of the total U.S. expenditures for data processing were directly related to computer communications. It is expected that between 50 and 70 percent of all computers will be connected to telecommunications facilities and terminals by 1980." [11]

There appears to be some use of on-line systems in all six countries, although in Hungary such systems are in use only in the transport industry, public administration and academic research. In the other countries such systems are also in use in several additional business and industrial areas (though at least some transport applications seem generally to have preceded government and other uses). The Canadian, German and United States reports refer to on-line applications in finance and some other industries. The United States and Canadian reports refer to the provision of direct services to the public using on-line systems.

On-line techniques for use within a firm, an industry or an area of administrative responsibility are clearly well developed and can be applied wherever their use has sufficient priority. Direct interfaces with individual members of the general public are clearly nowhere past the pilot project stage at this time, although interfaces monitored or intermediated by members of the service-provider's staff are no longer uncommon, at least in North America.

3.3 Electronic mail

The provision of electronic mail services is under study by the PTTs or telecommunications authorities of Germany, Sweden and the United Kingdom.

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11. Powell, D.: New Trends in Informatics and Related Government Policy in the United States, p.14.

They are also under study by the Post Office authorities of Canada and the United States. In these latter countries there has been some limited availability of a form of electronic mail service for some time.

Most of the electronic mail services now available are store-and-forward message systems which can be accessed by terminals in a corporate network, or through similar services operated by value-added networks or computer service firms for their customers. There are also some facsimile transmission services in operation. While these services are still considerably more expensive than conventional mail, they are also much speedier and somewhat more reliable. Their cost is already competitive with long-distance telephone use. There is little doubt that the incursion of these services into the former monopoly markets of the postal authorities and the telephone companies will continue to grow.

It is unlikely that an electronic mail service which attempted to make its services generally available could do so without heavy investment in terminal equipment. An indication of the size of this investment is provided in the German report: "In order to proceed with the implementation of the first phase of electronic mail services in the private and public sector approximately 400,000 communication typewriters and 200,000 telecopy-devices will be needed. Based on this estimate the time for introducing the service is assumed to take five to ten years." [12]

There has been some concern about whether an adequate level of privacy can be maintained in any generalized system of electronic mail.

3.4 Office automation

Word processors have been available for some years, and the reports for all five market economies indicate that the use of these devices is spreading. Most word processors now in use are stand-alone machines, with limited editing capabilities and not equipped for communications. The proportion of

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12. Hansen, H. and Schafer, J.: op. cit., Part II, p.11.

communications-oriented word processors is growing, but this growth may be restrained by the lack of de facto standards which limits the interconnection of different manufacturers' products.

There are also word processor systems which use a central computer to handle the processing for a number of relatively "dumb" terminals. These range in size from configurations suited to the work of a medium-size office to systems tailored to the needs of a newspaper enterprise or a specialized service bureau. These latter systems are usually integrated with automated typesetting facilities; the use of such systems by newspapers is mentioned in the reports for Canada, Germany, the United Kingdom and the United States. Their introduction has been resisted by craft unions in all four countries, and has frequently been accompanied by strikes.

It is technically quite possible to link word processing systems to electronic filing systems, thus eliminating the need for paper files. Several large enterprises in North America are working on the development of such systems. Another approach which has had some success is to use computers to manage files retained on microfilm; this type of automated filing has fewer legal and psychological barriers to overcome. Although development has been proceeding for a decade, automated filing systems still seem to be at the "prototype" stage, rather than the "production" stage.

"The extent to which office procedures are being automated is uncertain. Some feel that the office environment remains essentially unchanged with the exception of individual automated components such as word processing systems which are increasing in popularity. The integration of separate computerized functions to form a sophisticated office system with word processing capabilities, security applications, environmental controls, electronic mail, teleconferencing, and so on is limited to very large organizations. For smaller organizations the costs involved in automating an office compared to the expected benefits are usually too high." [13]

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13. Powell, D.: op. cit. p.19.

Office automation, like factory automation, is frequently cited as a likely cause of considerable future unemployment. This could result from the greater productivity made possible by improved equipment, even without any impacts of system changes. System changes of the types discussed to date seem more likely to reinforce than to offset this tendency.

3.5 Videotex

The introduction of videotex systems was mentioned or discussed in all reports except those for Hungary and the United States. The Swedish report notes that the telecommunications authority is experimenting with such systems. The German PTT is field testing some alternative television text services with a view to having a service generally available by 1982. Canada has planned field tests of two systems for 1979: the government-developed "Telidon" system and the less expensive and more limited "Vista" system developed by the production arm of the largest telephone company. The United Kingdom appears to have moved furthest towards general availability with its PTT "Prestel" system, the British Broadcasting Corporation's "CEEFAX" system, and Independent Television's "ORACLE" system. In the United States, a feasibility study is known to be in progress, involving major publishers and high technology companies. An adaptation of the British "Prestel" system is also being tested.

"From an applications point-of-view, the most exciting development today is the Viewdata service called Prestel. This allows subscribers to the normal telephone service access to large data banks using their telephone and a modified colour TV set. This development is at the confluence of all the main streams of informatics: computing, telecommunications, data storage and broadcasting. A high proportion of households already possesses the basic equipment for other reasons. It is simply extended by a microprocessor and a keyboard in the user's home, office or shop, and by mainframe computers handling the stored data at regional centres run by the Post Office. At the same time, broadcast teletext will be available on each of the BBC and ITV television channels. When the modified television sets are mass-produced the same set will

serve for all three services, Prestel, Oracle and Ceefax. The Prestel and the BBC Ceefax systems are currently (September 1978) live." [14]

Videotex has some commercial potential, although this has not yet been thoroughly explored. "Packaged holidays for example are for sale over the Prestel network; this is a good commodity to sell this way because it is not open to direct inspection at the time of purchase. For slightly different reasons, technical consumer goods such as hi-fi or cameras can also be sold over Prestel because the relevant information on products is normally communicated via specialist magazines. The customer tends to know the serial number of the equipment he wants and makes his purchase on the basis of price." [15]

It is noteworthy that the initiative for developing the home videotex systems that are furthest advanced has come from state agencies and a private near-monopoly. There is a possibility that the relative lack of progress by the powerful U.S. private sector may indicate a real doubt as to the commercial viability of home videotex services. The ghost of the "Videophone" development of the '60's may still be walking!

4. Conclusions

The United States has led in most applications of informatics, just as it has led in computer mainframe production since the massive stimulation by government procurement in the '50's. It certainly has developed the broadest range of ADP use, and also has made ADP a working tool for the highest proportion of its population.

This lead does not, however, appear to be universal or inevitable. The United States does not appear to lead in videotex applications, and may not be the leader in manufacturing applications relating to goods production. Other countries also appear to be equally advanced in office automation at this time.

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14. Stamper, R.: op. cit., p.39.

15. Ibid., p. 50.

While "catch up" in the use of ADP seems open to other countries - and even world leadership in particular areas - there do seem to be some prerequisites for development. Certain basic applications of informatics appear to be relatively easy and profitable in every country, and appear to promote the development of the infrastructure, the pool of trained staff, and the general awareness of the technology and its prospective benefits which provide a foundation for emerging applications. Electronic mail and office automation probably require a build-up of experience and confidence based upon familiarity with the more basic administrative applications and with their associated equipment. And the marginal productivity of computer use is probably still highest in those applications where it paid to introduce the much more expensive equipment of the distant past - the 1960's.

The potential uses of ADP are continually expanding as costs decline and reliability improves. Although there is still little evidence that ADP use has resulted in a significant net reduction in employment, there seems to be some increase in concern about this threat, especially in connection with factory and office automation. This possibility will have to be carefully watched for some years to come.

Table III The Application of Informatics

	Canada	Germany, Fed. Rep.	Hungary	Sweden	United Kingdom	United States
1. GENERAL PENETRATION	- used by federal, provincial, and large local govts., by 85% of firms with revenue>C$5m - over 18K firms and govt. agencies use computers, 9K have own installations	- used by federal, state and large local govts., by large and medium size business - now spreading to small business	- used by national govt., and by 1,400 large enterprises and cooperatives - about 100 enterprises and coops. have own computers	- used by national, large local govts., by large and medium size business	- used by national, large local govts., by large and medium size business	- used by federal, state and large local govts., most large and medium size business, many small firms - industry penetration from 25% to 76% of all firms
2. SELECTED AREAS OF USE						
a. Manufacturing and Process Control	- extensive admin. use in manufacture - primary industry, utilities lead in process control use	- extensive in administration, some process control	- moderate use now but spreading	- extensive admin. use in manufacture - 600 industrial robots in use in 1977	- extensive in administration, some process control	- extensive in administration, some process control
b. Commerce and Finance	- extensive admin. use now spreading to smaller firms - commerce has credit checking, some auto. checkout, teleshopping - banking has automated inter-branch operations, some teller services-multi-branch banking started	- extensive admin. use now spreading to smaller firms - banking has automated inter-branch operations, some teller services	- moderate administrative use in large enterprises - some automated payments among large enterprises and institutions	- extensive admin. use now spreading to smaller firms - banking has automated transactions between banks and large customers, automated withdrawals from accounts	- extensive admin. use now spreading to smaller firms - banking has automated internal operations, now automating inter-bank operations - widespread teller services	- extensive admin. use now spreading to smaller firms - commerce has credit checking, many auto. checkout systems - banking has automated internal operations, now automating inter-bank; auto. tellers widely used
c. Transport	- extensive internal use including traffic control - pioneer area for on-line systems	- extensive internal use including traffic control	- moderate internal use - early user of teleprocessing in Hungary	- extensive internal use including traffic control	- extensive internal use including traffic control	- extensive internal use including traffic control - pioneer area for on-line systems
d. Personal Computing	- available to trained staff in many offices - few home computers or computer-based services	- available to trained staff in many offices	-	- available to trained staff in many offices	- available to trained staff in many offices	- available to trained staff in many offices - 15-20K home computers in 1977 - few computer-based services to home

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Table III The Application of Informatics - continued

	Canada	Germany, Fed. Rep.	Hungary	Sweden	United Kingdom	United States
3. SELECTED APPLICATION TYPES						
a. Data Banks	- used in govt. and large firms - some public data banks	- used in govt. and large firms	- used in govt.	- used in govt. and large firms - all personal data banks require authorization	- used in govt. and large firms	- used in govt. and large firms - about 300 public data banks, some export services
b. On-Line Systems	- used in govt. admin. and large private firms - some use to provide service to public	- used in govt. admin. and large private firms - some use to provide service to public	- under development in govt. admin. - some use in transport and research	- used in govt. admin. and state agencies	- used in govt. admin, and large private firms - some use to provide service to public	- used in govt. admin. and large private firms - some use to provide service to public
c. Electronic Mail	- limited services available from service bureaus, private networks - under study by Post Office	- under study by PTT	-	- under study by Post Office	- under study by PTT	- some services available from value-added carriers, pvt. networks - under study by Post Office
d. Office Automation	- automated typesetting and text editing in use - word processors spreading - little automated filing	- automated typesetting and text editing in use - word processors spreading	-	- word processors spreading	- some automated typesetting and text editing - word processors spreading	- automated typesetting and text editing in use - word processors common - large firms developing integrated office systems
e. Videotex	- 2 systems in field test stage in 1979 (1 by fed. govt., 1 by telephone co.)	- field testing by PTT with service target of 1982	-	- Swedish Telecom. Authority conducting experiments	- 2 broadcast services operational in 1978; telephone based service to be operational in 1979.	- feasibility study in progress by pvt. consortium - market test of U.K. PRESTEL system

Appendix

List of Individual Country Reports

CANADA

"Trends in National Policies for Automatic Data Processing: Canada" by Peter Robinson (Canada Department of Communications) and C.C. Gotlieb (University of Toronto)

GERMANY, FEDERAL REPUBLIC

"New Trends in Informatics and Related Government Policies in the Federal Republic of Germany" by Hans Hansen and Joachim Schafer (DATUM - Institute for ADP-Assisted Planning, Bonn)

HUNGARY

"National Policy of Informatics in Hungary" by Attila Aranyi, and Jozsef Dornyei (Hungarian Statistical Office), and Lorant Németh (National Bureau of Computer Applications)

SWEDEN

"Trends in National Policies for Automatic Data Processing: Sweden" by Jan Freese and Ulla Palsson (Data Inspection Board)

UNITED KINGDOM

"Informatic Applications in the United Kingdom - 1978 and Future Trends" by Ronald Stamper (London School of Economics)

UNITED STATES

"New Trends in Informatics and Related Government Policy in the United States" by Debra Powell (DUALabs, Arlington)

Each of the above reports gives its own list of references in footnotes or in a bibliography.