Notes for Address to Canadian Club of Toronto,
February 12, 1968
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GOOD INFORMATION FOR GOOD DECISION-MAKING

The production and distribution of knowledge is now estimated to account for about one-quarter of total national income in the United States. Although comparable Canadian estimates are not readily available, it would hardly be surprising to find that the relative dimensions of such activities are now of almost equivalent proportions in Canada. Although these activities are obviously widely diffused through both government and private sectors, it has now become possible to conceive of a "knowledge industry" which is not only growing with striking vigour and speed, but which has already become the largest industry in North America.

Much still remains to be learned about the reasons for the greatly accelerated growth of knowledge over recent decades, but it is clear that the rate of increase in knowledge shows no signs of abating. Moreover, the outlook for the future is, in fact, for a substantial further increase in the proportion of total manpower and social and other resources devoted to the "knowledge industry".

One of the principal fields in which an accelerating growth of knowledge and information is taking place is that of science and technology. This has been widely recognized. In recent years, it has been widely studied. And in country after country, major new institutions and programmes have been created to promote the growth and more effective use of scientific and technological information.

It has, in fact, become almost a cliché to talk of the "knowledge boom" in the field of science and technology; and certain facts about this boom have been widely publicized -- including the fact that about 90 per cent of all scientists who have ever lived in the world's history are alive today; and the fact that the total volume of scientific and technological information is now doubling every 10 years.

The relationship of this rapid growth in science and technology to economic growth poses a number of difficult questions for which there are no easy answers. But it is becoming increasingly clear that the extensive use of advanced science and technology can and does make an important contribution to the development and maintenance of high industrial productivity and high standards of living. The Economic Council has recognized this since the inception of its work, and its First Annual Review included the following statement:

> Inevitably, in a country of vast area and small population [such as Canada] it has been necessary to bring in from outside not only men and capital, but also the most up-to-date technology. Very often they have come together, especially in respect of capital and technical know-how, and have constituted a dynamic instrument for progress and the achievement of a comparatively high level of income. Moreover, by these processes Canada has become one of the advanced industrial nations of the world.

This field of scientific and technological information has come to play a truly central role in many of our newer and fastest growing industries. And the efficient production and dissemination of information in this area must be one of the major concerns in this country. In the kind of world in which we live today, it must of course be recognized that, to a very large extent, the advances which are taking place and will continue to take place on the frontiers of science and technology will be occurring outside Canada's borders.

We must therefore give a high priority in many parts of our economic system both to effective intelligence efforts for monitoring and screening scientific and technological developments abroad, and to the importation, adaptation and utilization of such developments. At the same time, in the more economically mature and advanced Canada of today, we should also recognize that we should be developing rapidly growing capabilities, in our own interests, for the domestic generation of new scientific and technical knowledge. The Economic Council has emphasized that we need to greatly strengthen the basis for such activities in our economic system, and it has made, in particular, a number of suggestions and recommendations for stimulating and accentuating the growth of industrial research and technology. In a broader context, the Council also is exploring a number of aspects of the relationship of science and technology to economic growth, and expects to report further on these issues in due course.

It is clear that knowledge is a very important component of the growth of the modern, technologically based society. The development of new knowledge and the application of existing knowledge provides the essential basis for advances in new technologies, new skills, and new techniques of industrial organization and management. It is therefore important to place the growth of knowledge and information in the context of broader aspects of economic growth. Part of the growth of a modern industrial economy like Canada's results from increases in certain inputs -- certain "factors of production". Economists have generally grouped these "inputs" under the headings of labour, capital, land and resources. Moreover, many of the recent more sophisticated analyses of economic growth have emphasized that such growth is generated not merely by increases in the quantities of such inputs -- for example, in terms of growing numbers of employed persons and machines -- but also by improvements in the quality of these inputs -- for example, in the form of rising skills and

educational qualifications of the labour force, and of more technologically advanced machinery and equipment. In addition, economists have also pointed to the various ways in which growth can be speeded up by using these inputs more efficiently and productively -- for example, by shifting labour and capital out of declining and into expanding industries, through increasing scale and specialization in production, and through more aggressive and imaginative approaches by management to risk-taking, innovation, new product development, cost reduction and expanded marketing.

It would not, I think, do much violence to this widely accepted framework of economic analysis to say that one of the most important inputs in our modern economy is knowledge. In short, knowledge is a resource, and a resource that is becoming an increasingly important one in our increasingly complex and rapidly changing economy.

I do not propose to talk about the whole field of knowledge in my remarks today. Such a vast subject cannot possibly be adequately covered in the course of a brief talk. But in the main body of my remarks, I would like to direct your attention (1) first, to certain more general aspects of the use of knowledge and information -- especially economic and social information -- to achieve good performance and good decision-making in our highly complex modern economy, and (2) second, to the large and rapidly expanding new capabilities for handling information effectively and efficiently through the use of computers.

To a growing extent, the modern economy is coming to run on knowledge and information which needs to be taken into account in economic decision-making at all levels -- whether by consumers, by private producers and distributors, or by governments. Moreover, to use this resource most effectively in our modern society, the information inputs cannot in most cases be raw or casual information.

To be really useful, information needs to be an organized, a processed, a worked-over product. It must be in readily applicable form. It needs to be accurate. It needs to be available in a timely way. And it needs to be relevant to decisions. In short, good information is indispensable to good decision-making and to the efficient performance of a modern economy.

The concept of information as a resource is, of course, not a new one. Let me cite one or two historical illustrations. The building-up of the great Rothschild's banking empire in the eighteenth and nineteenth centuries in Europe depended, in a crucial way, upon the underlying construction of a very effective information system -- upon the clear recognition that great financial power and wealth could effectively flow from the development and maintenance of a basic information system which, in terms of timeliness and accuracy, could be more advanced than that of existing or potential financial competitors. Or, to take an entirely different field, it has been recognized since the earliest days of military conflict that military intelligence -- intelligence providing timely and accurate information on the strength, disposition and intentions of existing or potential enemies -- ranked in importance with other resources such as high-quality generalship, technologically advanced weapons, and well trained military manpower, as an important ingredient for military effectiveness.

In the twentieth century we have been witnessing a widespread diffusion of this kind of dependence on information and intelligence as a crucial element for achieving progress over a rapidly widening spectrum of economic activities.

In our successive Annual Reviews, we in the Economic Council of Canada have been drawing attention to both the opportunities and the needs for developing and using good information as a basis for increasingly efficient performance

of the Canadian economy. There are three distinct elements in this field -- the development and improvement of quantitative information (data and statistics), the more effective harnessing and use of basic data for research and analysis which is essential to good decision-making, and the more effective communication of the results of such analysis in terms which can be readily understood by non-professional decision-makers.

Let me start with the first of these -- the subject of statistics. Many people, of course, have an aversion to statistics. We are all familiar with such expressions as "Lies, damn lies, and statistics!" and disparaging remarks about "reducing people to mere statistics". But, for the purposes of good decision-making in a modern economy, it is an unavoidable fact that statistics are required if we are to avoid incoherence and ignorance in decision-making. In the absence of good statistics, the sort of information which is likely to be involved in decision-making will largely consist of an unusable mass of hunches, suppositions, prejudices, and casual personal observations. We live in an age in which "flying by the seat of one's pants" is no longer good enough. We live in an age in which those who rely on broad generalizations based upon a few individual instances and observations are likely to be at a serious disadvantage in relation to those who have access to, and make effective use of, relevant quantitative data.

Therefore, it is imperative that we collect and organize our information in a manageable and meaningful way into the form of statistics. It is not, I am afraid, as well appreciated as it might be what an important function this is. Much of the function in Canada devolves upon the Dominion Bureau of Statistics -- Canada's central statistical agency. There are, of course, many other centres and agencies and organizations which collect factual information and organize it into statistics, and many of these play very important roles.

But if we are going to have sound, well-informed private and public decision-making, the Dominion Bureau of Statistics must be a strong organization.

The economic information system now provided by the Dominion Bureau of Statistics should be a cause for pride in this country. We now have one of the best statistical systems anywhere in the world. But at the same time this should not justify complacency. The statistical system provided by the Bureau has grown enormously over the past two decades, but so have the demands placed upon it. The quality of much of this economic information has been vastly improved, but the quality required for good decision-making in relation to more demanding and sophisticated objectives in our economic system has also increased greatly. Both business decision-making and government policies now require a far more extensive and demanding set of timely, accurate and relevant statistics than was the case even a decade ago. Also, the basic framework of statistics must be adjusted in a continuing way, in response to rapidly changing requirements for data under rapidly changing conditions -- the curtailment and elimination of statistics whose usefulness has substantially declined, and the swift development of new statistics to meet important new needs.

One of the most frequently repeated refrains in recent years in the reports of Royal Commissions, of government committees and of various other bodies is that we need more information, more timely information and higher quality information than we now have in many fields. These urgings for improvements in our basic economic information system have usually reflected the view -- either explicitly or implicitly -- that high rates of economic returns would flow from the development of improved information. In short, the benefits which can be expected from improvements in our basic information system generally far exceed the costs.

The Economic Council of Canada has also taken up these urgings in its Annual Reviews and has called explicitly for a substantial strengthening of the Dominion Bureau of Statistics. This should be an organization in a position to make full and effective use of the resources of modern, mechanized data processing. This is an organization which should be able to attract able and imaginative people, with a creative interest in statistical analysis and in the many uses to which their work is put. This is an organization whose fundamental role in the Canadian economy should be more widely and fully appreciated throughout this country. If we are to attain the growing benefits which can accrue to our whole society from an improved information base, it should be a matter of high priority in federal government decisions -- even when general government expenditure restraint policies are being applied -- to make sure that this organization has a growing capacity to acquire the resources which it needs. In particular, this priority is crucially important to maintain an appropriate environment for expanding and upgrading the most important resources of all those required in the Bureau's work -- namely, the very scarce and increasingly skilled and knowledgeable manpower, without which a high-quality statistical system cannot be maintained.

Let me now turn to the second aspect of an effective use of an information system. This concerns the fact that even the best set of statistics does not constitute an adequate basis for decision-making. The meaning of the figures must be explored with the tools of economic research and analysis. The numbers must be made to tell their story about how the economy works -- about its complex interrelationships, the points at which private and government policy decisions have their impact, and the scope and nature of such impacts. This calls for research -- some of it in the universities, some in governments, and some in private business organizations and institutions. Here again it has been the Council's strong view that in Canada we have not fully appreciated what

needs to be done in this field -- that we have been, to put it bluntly, backward in supporting economic and social research. In this regard, we are not only behind the United States, but are in fact behind many other countries -- indeed, behind many countries which are much smaller than Canada. We are, in fact, a relatively "underdeveloped country" in terms of the efforts and resources we have been putting into the fields of economic and social science research in Canada.

Large new opportunities now exist in this country, especially with the development of better trained and rapidly growing professional manpower capable of undertaking economic and social research, for a very substantial strengthening of this aspect of information development. It is high time that we gave serious thought to greatly enlarging the resources available in this country for much more extensive and intensive economic and social research and analysis. This is also a matter which the Economic Council has emphasized in its Annual Reviews -- including, particularly, the proposal that we should establish a private economic research institute for developing far more useful shorter-term analysis, and the proposal that there should be greatly expanded government support for economic and social studies undertaken by academic specialists and private, nonprofit research organizations.

There is a further stage in getting information into the form in which it is useful to decision-makers. As many of us know, the product of economic research, as it emerges initially from the analyst, is often not easily intelligible to those who are not themselves experts and professional specialists. The process of translation and communication to a wider public has to take place. I might call it a process of "popularization", adding immediately, however, that this is in no way to downgrade this process. The "popularization" process is absolutely essential, for, without it, information does not get through to the points at which it is particularly needed. Moreover, not only must it get through to the key decision-makers, but also to a wider public in our democratic society.

For in many areas of decision- and policy-making, timely and appropriate actions become very difficult -- perhaps even impossible or unlikely -- if there is not wide public understanding of the needs and rationale for various kinds of crucially important decisions. The job of seeing that this takes place is widely shared. This is a job for many different groups -- government departments and agencies, private institutions like the Private Planning Association of Canada and the National Industrial Conference Board, general newspapers and the more specialized financial press, and many other publications and sources. In this context, radio and television, too, have a highly significant role to play.

Here again, I would record my impression that this popularization process -- this communication of economic information to a wider public -- is not being done as well as it might be in Canada. Where we fall down particularly, I think, is in explaining and interpreting what is going on in the economy and what are some of the most important needs for the future. In this regard, there has obviously been some significant improvement over recent years, but we certainly do not do as good a job as in the United States, and perhaps not as good a job as is done in a number of other countries.

In this field of developing good information for good decision-making, the Economic Council of Canada is attempting to play a significant and constructive role. But I believe that it is highly important that the Economic Council should not be looked to as an institution that should be occupying a predominant role. It is highly important that many institutions and organizations should be playing increasing roles in regard to these functions. The role of the Economic Council should, perhaps, be that of providing, at least in some respects, a lead and an example, but all of these functions should be ones which are widely dispersed through our society.

In the foregoing remarks I have been talking primarily about economic information as such, moving through the three stages of basic statistics, of analysis and research, and of popularization and communication. There are, of course, many other extremely important areas and types of information which are also of vital importance to the efficient functioning of our economy. Let me mention only one of these briefly. This is the field of consumer product information, a subject on which the Economic Council had something to say in its recent Interim Report on Consumer Affairs. Confronted by an increasingly varied array of products, many of them very sophisticated in character, the consumer today needs a large supply of information to help him use his income wisely and efficiently. Some of this information he gets through advertising -- particularly advertising of a better and more factual sort. Some he gets through the grading and labeling of products, and through the establishment of recognized product standards. And some he now gets through the medium of specialized consumer publications such as the well-known Consumer Reports. We can anticipate that, as our economy grows more complex, there will be an increasing need for good consumer product information. This is one of the most important functions which the new Department of Consumer and Corporate Affairs should be undertaking with substantial vigour.

Let me now turn to another question which I mentioned at the outset of my remarks. This concerns the question as to whether traditional methods of absorbing and managing new knowledge are any longer adequate. In this connection, particular attention needs to be focused on two facts -- first, that the total stock of knowledge is growing at an accelerating rate; and, second, that new technologies have appeared in the past decade which have provided large new potentials for the management, storage, retrieval and manipulation of information. In particular, electronic computers are now opening up rapidly growing capabilities for radical new systems for the handling of information.

In commenting on the importance of computer technology, Edward Teller has recently made the following comment:

> The electronic computers are probably the most important result of recent applied science research efforts, not only in the United States, but in the world. In making this statement I am putting the development of electronic computers ahead in importance both of development of nuclear energy and of the exploration of space. Briefly, the reason for this statement is that electronic computers can perform any intellectual function of the human mind, provided that this function is described in a precise and rigorous manner. Though this last qualification is in fact quite restrictive, it is counterbalanced to a considerable extent by another circumstance: those functions that the electronic computers can take over, they perform much faster, far more flawlessly, and more systematically than can any human.
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> The consequences of these developments are almost without limit. On the electronic computers we are basing to an increasing extent the process of automation, which replaces the routine work and sometimes the refined work of the brain, just as human and animal muscles have been replaced in an earlier phase of the Industrial Revolution by the greater power and reliability of machinery powered by non-biological energy sources. One must consider automation not merely as a labour-saving technique, but rather as a means of recognizing additional human needs, to create more products and more skilled mechanical labour for human use so that problems can be readily solved today that were not open to an effective attack a few years ago.

As most of you know, a "computer explosion" is now under way in Canada. Although we are lagging substantially behind the United States in the relative use of computer-based information systems, the rate of growth in Canada is now very high. Surveys made by the Computer Society of Canada show that there were 538 computers in use in Canada in March of 1964, 820 in mid-1965, 1,036 in 1966, and 1,383 in May of 1967. Thus the number of computers has increased by over 150 per cent from 1964 to 1967 or by more than 35 per cent per year on the average. Even with some moderation in this trend, it would appear possible that, by mid-1970, there may be as many as 3,000 computers in use in Canada. In considering this growth, it is also important to recognize that this is a net rate of growth that eliminates the replacement of older computers by newer ones, and secondly, that newer computers tend to be larger, more powerful, and certainly more expensive. Thus, the computing power of installed machines is increasing at a rate far greater than the number of machines installed.

How important are computers to the Canadian economy? It is not possible at this time to estimate the impact on productivity or efficiency in Canada, but it is at least possible to say that the present and potential capabilities in this regard are very large. Moreover, on the basis of at least rough calculations, it can be estimated that we are approaching an annual rate of expenditures of close to half a billion dollars on electronic data processing in Canada. Obviously, this is getting to be an important element in the Canadian economy.

In this context, I would draw your attention particularly to the fact that, in order to use this very large investment adequately, we must concern ourselves with the people to run these complicated "black boxes". Each new computer installed will require a significant number of people. I have been told that, as a minimum, a small computer installation requires two to three machine operators, six programmers, two or three designer-analysts, and a manager or two -- so that even the average small installation requires 10 or more trained people. Therefore, at a minimum, with at least 500 new computers likely to be installed in Canada during 1968, training (and good training) should be given to a minimum of 5,000 persons per year. By 1970, we may well need somewhere in the neighbourhood of 10,000 people per year. Moreover, these are figures of the net additions required and replacements must be trained for those people who may leave. This is a crucial area of training in which we are now relatively underdeveloped in Canada, and it is clear that a quick and very large-scale expansion in training of such specialists is now an urgent necessity. This should constitute a major challenge to our educational institutions.

In conclusion, let me stress, again, that we are living in an age of accelerating technical and social change. And we are living in an age in which we must consciously shape an increasingly sophisticated and extensive information system to the needs of the times. We need more statistical information.

We need more analysis and research using such information. We need a better system of communication to get relevant information to the points at which it can be effectively used. We need more timely, more accurate, more accessible, and in many cases more relevant, information as a basis for good decision-making throughout our economic and social system. In order to achieve all of these things, we need more statisticians and social scientists. And we need to make more effective use of new techniques and new facilities such as the computer -- and, here again, a large increase in skilled computer manpower -- in this whole process of developing good information for good decision-making.

The price tag on strengthening our economic system in this way will not be low. But the benefits likely to be derived from this kind of improvement and strengthening of our information system are likely to be large in terms of a much better functioning of our economic and social system than otherwise would occur in the future.