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The Importance and Needs of Canadian Research in Science†

We Canadians sometimes try to belittle our own accomplishments. A few years ago in a report on "Research Policy in the Universities of Canada" the statement was made: "Canada will never be able to identify many great researchers." The same sort of statement presumably could also be made about art, literature, and music. Such statements are obviously not a good starting point for encouraging the intellectual and cultural growth of this country. It seems clear to me that the number of intellectually outstanding people in a nation or country is a nearly "constant" fraction of the population. Obviously Canada, with one-tenth of the population of the United States, cannot produce as many outstanding people as our neighbour to the south.

There are countries in which, for ideological reasons or because of a peculiar educational system, excellence of a few is not encouraged and as a result such countries will fail to take advantage of the "constant" fraction of outstanding people. They engage in the de-emphasis of excellence at their own peril. They will not be remembered a hundred or a thousand years from now for their contributions to human heritage and even at the present time they will not profit by scientific discoveries in their technological development.

Canada has had in the past, and I believe has now, a considerable number of outstanding research scientists. The whole development of nuclear physics started when Rutherford spent eight years at McGill University. He received the Nobel Prize (in Chemistry) one year after leaving Canada for Manchester, England, for the work that he had done in Canada; his extraordinary pioneering contribution can therefore be

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clearly claimed by Canada. Rutherford did not believe in the possibility of practical applications of nuclear energy (he considered that those envisaging this possibility were "talking moonshine"). Nevertheless the practical use of nuclear energy was a consequence of Rutherford's work. The development of the heavy water reactor by the Chalk River Laboratories under W.B. Lewis is another example of outstanding research produced in Canada. The heavy water reactor is considered by many experts in Canada, the United States, and elsewhere as the best solution of the nuclear power problem.

There are many other unique contributions of Canada's physical scientists to the world pool of knowledge which readily come to mind even without studying the history of Canadian science in detail. I shall not mention any specific names but should like to refer to the early recognition of the structure of our galaxy, which was accomplished in Canada, and to more recent Canadian work on intermolecular forces, on various aspects of laser phenomena, and on energy storage, all of which have attracted world-wide attention. Even outside the physical sciences, where I have obviously only very indirect information, one immediately thinks of the discovery of insulin, of the development of rust-resistant wheat, of the discovery of sex chromatin, and of the development of the cobalt treatment of cancer. Thus it is evident that Canada, when given the opportunity, is quite capable of making a significant contribution to world science.

I believe that almost all scientists, including most of those working on applied problems, are well aware of the need for basic research in order to maintain the flow of new ideas and discoveries for the development of new innovations in technology. Even politicians have come around to acknowledging the need for basic research. There are some exceptions. For example, Mr Drury, the former Minister of State for Science and Technology, has been quoted as saying that we can leave to other nations the advancement of knowledge and simply use their results. The fallacy of this method I think is obvious to all scientists. Because of the complexity of modern science only those who are themselves creatively involved in research can fully appreciate the nature of the advances made elsewhere and the possibilities of their applications.

In this connection it is perhaps appropriate to point to the development of science and technology in Japan. Since the Japanese early in this century did not have a proper base in basic and even applied research they simply imitated the western models in various industries. They soon found that they could achieve a far higher level of technology if they also developed basic research. Today the Japanese have arrived at a level in both basic research and technology which is close to that of the most advanced countries at a time when the latter are cutting back. Even

now the Japanese government is funding new institutes in basic research and there is no question that they will reap the benefits in rich measure.

Quite apart from the economic need to support basic science in Canada there is also the need to support science as an intellectual and creative effort of the highest order. Surely as the second or third richest country in the world Canada cannot abdicate, in financially difficult times, its obligation towards pursuing the high aims of mankind to try to find out what is the nature of man and of the world in which we live, even if this activity would not gain us material rewards. (In fact, of course, it always does.)

The past ten years have seen, especially in Canada, an endless number of reports on science policy. Some people, like Senator Lamontagne, do advocate support for basic science but qualify their support by the demand that the main effort in basic research should be in fields that are relevant to possible applications. The historical fact is that in many instances even the discoverers of some new phenomenon were unable to foresee the practical consequences of their discoveries: it is not possible to make a reliable prediction of the "relevance" of a given basic research project.

Senator Lamontagne and people with similar views seem to have in the back of their minds the idea that science, including basic science, can be centrally organized and that a "coherent science policy" can be established. They do not realize that science does not work that way. Science, especially basic science, flourishes under conditions where there is a minimum of organization. The great discoveries of the past can, almost without exception, be attributed to the genius of individual scientists who were able to pursue their ideas in an atmosphere free from the restraints of excessive organization. A certain amount of organization is, of course, necessary at the operating level (as Steacie said "there must be light, water and power, people must be paid, there must be technicians and workshops, the better people must have assistants, the less experienced people must have some guidance, and so on") but the attempt to plan and organize science at the administrative level will lead at the best to a mediocre routine science deprived of the inspiration that leads to the outstanding discoveries.

At this point I must quote again, as I have on a number of previous occasions, a remark by Michael Polanyi which illuminates the situation: "Any attempt at guiding scientific research towards a purpose other than its own is an attempt to deflect it from the advancement of science ... You can kill or mutilate the advance of science, you cannot shape it. For it can advance only by essentially unpredictable steps, pursuing problems of its own, and the practical benefits of these advances will be incidental and hence doubly unpredictable."

In this day and age we talk a lot about teamwork: in certain fields teamwork is certainly very important but nevertheless the real advance is made by some bright idea in the mind of one individual. Faraday, when he discovered electromagnetic induction (the basis for all electric power production today), was working alone, so was Roentgen when he discovered x-rays and Einstein when he developed relativity theory and discovered the equivalence of mass and energy. None of these scientists was motivated by practical problems, by the wish to improve the standard of living or to help the survival of mankind. They were motivated by the thought (as expressed so beautifully by the famous mathematician Jacobi more than a hundred years ago) that "the sole aim of science is the glory of the human spirit."

The only workable concept of science policy that I have been able to find is the one given in the First Report of the British Council for Scientific Policy:

> Science policy does not direct the advance of scientific knowledge, though it may well be concerned to encourage or to direct the application of the results of scientific advances. The tasks of science policy are of another kind: to maintain the environment necessary for scientific discovery; to ensure the provision of a sufficient share of the total national resources, to ensure that there is balance between fields and that others are not avoidably neglected; to provide opportunities for inter-fertilization between fields, and between the scientific programmes of nations.

In the 1950s and early 60s we had in Canada, and especially at NRC, the "environment necessary for scientific discovery." But then the government of the time appointed the late Mr Glassco, an accountant, as the chairman of a Royal Commission on Government Organization. The Glassco Commission was not interested in ensuring that the environment necessary for scientific discovery was maintained. Rather it was interested in good accounting. I said in my Convocation Address at York University in 1969: "The Glassco Commission considered the National Research Council in the same way as the Post Office or the Justice Department." In quoting this part of my address in his book *The Chaining of Prometheus* Ronald Hayes remarks that I "might have added that the application of Glassco precepts to the Post Office has also been baneful." This statement is even more accurate today than at the time when Hayes was writing his book.

It is interesting to note that while Mr Glassco and his Royal Commission were appointed by the Diefenbaker government their report was completed under Mr Pearson and implemented at an accelerated pace during the Trudeau administration, suggesting that accountants stand

much higher than scientists on the totem pole of politicians no matter what party they belong to.

In one of his speeches Dr Steacie aptly described the method of Glassco and his successors by saying: "An efficient organization is one in which the accounting department knows the exact cost of every useless administrative procedure which they themselves have initiated." It was, I believe, at the instigation of Glassco that the Treasury Board introduced PPB (Program Planning and Budgeting) to the Public Service and applied it indiscriminately to all agencies even though its strongest advocates had questioned its application to the management of scientific activities. As faith in its usefulness has decreased, PPB has been followed by a number of other management techniques all distinguished by acronymic designations and all equally inept as applied to research. The trouble is that in estimating the advantages of these procedures no account is taken of the time wasted by scientists in filling in the endless forms and in producing what can only be unreliable forecasts. In their preoccupation with organizational details and management procedures the politicians and the bureaucrats quite overlook the fact that, for a scientist, the only thing that counts is the quality of his research. They are consistently led astray by what Bertrand Russell has called the "administrator's fallacy," that is, the error of mistaking means for ends. The implementation of management procedures becomes more important to them than the completion of outstanding research or the production of innovative techniques. This attitude is nicely illustrated by the recent reorganization of the grants system. We have now a nice pyramid of councils which must be a joy to every bureaucrat, but whether the system will work as well as the old is a big, big question. Even if it does, the added bureaucracy will swallow a sizeable fraction of the available funds.

The needs for science in Canada and basic research in particular are not reorganization but simply support by adequate funds with as few strings attached to them as possible. No scientific advance has ever been made by reorganization. We should stop the production of more reports on science in Canada – reports that are quite costly. We should rather spend the money used for such reports on the direct support of research.

The most important need in our support of science, and especially basic science, is to single out research workers of high purpose and ability and to give them funds to do the research that *they* consider as most promising without all sorts of bureaucratic rules. In Canada and elsewhere our politicians seem to be so concerned about the possibility that one in a hundred scientists might abuse the freedom that the Canadian scientist had in the 1960s, without noting that in all human activities there are people who do not pull their weight. In the peer system of

selection of grant recipients the best possible guarantee for a minimum of failures is given. Everyone, including the politicians, is agreed that the top people should get what they need for their research. The real problem is to judge the people a little below the top who will eventually replace the top people. We should not be too stingy in the support of the very good but not yet excellent workers.

Support of this kind is needed for the future of Canadian science and of Canadian technology, indeed for the future of Canada.