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**In pursuit of excellence: convocation address, University of Manitoba,
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Herzberg, Gerhard

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Convocation Address, University of Manitoba

24 May, 1973

IN PURSUIT OF EXCELLENCE

by

G. Herzberg

Division of Physics

National Research Council of Canada

Eminent Chancellor, Members of the Graduating Class,
Distinguished Guests, Ladies and Gentlemen:

My first and most agreeable duty is to say how much I appreciate receiving an Honorary Degree of Doctor of Science from the University of Manitoba. I am both pleased and proud to be admitted into your academic family and highly value such a compliment. I have visited this University on many previous occasions and have been much impressed by its solid growth. I remember especially one such occasion, in 1961, when I took part in the official opening of the then-new Science Buildings.

One of the things that all of you during your university years will have learned is an appreciation of what we mean by quality and by excellence. Indeed it is one of the important tasks of a university teacher to train his students how to distinguish superior from inferior work, whether it be in the humanities or the sciences; he must try to inspire them to strive for excellence in all their work.

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Gradually you have learned to compare your work not only with that of the brightest fellow-students of your class but also to measure it by standards set by the great thinkers of the past. Such comparisons teach all of us a good degree of modesty and, most important, the ability to admit that we were wrong in this or that aspect of our work, or to admit that the solution of this or that problem requires higher intellectual ability than we are able to muster.

It is a characteristic of crackpots that they think they know all the answers of a given subject without having even begun to learn the difficulties or to acquaint themselves with previous work of competent people. Two years ago I received a letter from a teacher in India asking me for help in finding a publisher for a work entitled "Metaphysics of Creation (The Truth about the Universe)", claiming that his new theory "promises to shake-up the whole scientific world by leaving no question in the matter unanswered". Even though I had not seen the manuscript I recognized immediately from the title that this was a crackpot theory, since the author clearly did not have the necessary modesty to realize his limitations and guard himself against grandiose claims and big mistakes. On several previous occasions I have encountered individuals who were equally sure of themselves and believed that they were the only ones

who had a perfectly coherent world picture. In science such crackpots are always easy to recognize since science is an exact discipline requiring precise answers. I do not know how easy it is in the humanities or social sciences. However, in current discussions on science policy (a field that is not part of science) we find all too often that those who protest most loudly are apt to assume that they alone have the insight to reach definitive answers which have eluded all others. I think we must be very suspicious when, like that teacher in India, somebody assumes that he has solved problems of great complexity where others of long experience have failed. If in your years here at the University of Manitoba you have obtained in some measure the wisdom to distinguish the eternal truth of great thoughts amid the clamorous demands of modern life you will have gained one of the greatest gifts a university can bestow.

In present-day discussions of the development and the support of science in this and other countries the concepts of quality and excellence are often no longer given priority. They are sacrificed to a concern for relevance and to a demand that all scientific research must be directly related to certain practical goals. Such an attitude is understandable, given the large increase in the cost of scientific research and university education. Should not the government, as

the representative of the taxpayer who pays the bill, determine the direction of the research? Those who argue this way have completely failed to understand how scientists work and how it is that science has exercised so great an influence on the material well-being of the world.

Science is concerned with the discovery of new facts about our physical universe and with the understanding and correlation of all these facts. Not even the scientists know what new facts are still to be discovered. How can a politician (even if, as is only too rarely the case, he has some scientific training) decide what scientific programs can most profitably be tackled?

Not long ago the U.S. Congress, against the advice of many responsible scientists, set up at a cost of one billion dollars a new organization entirely devoted to the fight against cancer. However, unless the time is propitious and the fundamental scientific concepts in this field have been truly established it is unlikely that this direct attack will produce the ultimate solution that is being sought. There is a much greater chance that some day a gifted individual working outside this organization and in some field not directly related to cancer will come up with a new discovery that will show a way to the solution from a completely unexpected direction.

A year ago I met an American Nobel Laureate working in the field of medical science close to the problem of cancer. He had a new approach to the nature of cancer which he thought would be an important step in the solution of the problem. However, he was unable to obtain the modest funds required from the National Science Foundation.

These two incidents illustrate nicely the attitude of the taxpayer and the politician. Governments are willing to spend huge amounts of money for a new project devoted to a clearly marked aim with thousands of employees, most of them bureaucrats keeping the scientists in check, but they are reluctant (if not unwilling) to support an individual, even one of proven excellence. The reason is presumably that the support of an individual is a gamble: the individual may turn up with an (important) result that has nothing to do with the original proposal, while the big project will at least come up with a thick annual report that can be presented to the taxpayer.

The experience of the past fifty years, both in Canada and in other countries, has shown unmistakably that the most effective - and the most profitable - way of distributing research funds is to make grants to individual scientists who have either proven their excellence by past performance or (in the case of young scientists) who have shown great promise in their

graduate work. It is individual scientists (not a team) who make discoveries. This is true even of big research projects; they are successful only to the extent that they are able to obtain first-rate individual scientists. But even if they are successful in hiring able scientists, the sheer size of such programs places an emphasis on organization that tends to encourage bureaucratic procedures and to inhibit the spontaneous creativity of the individual scientist. We have prided ourselves in Canada that, through the institutional pattern of NRC and through its enlightened administrative policies, we had developed a government research activity that was free of the worst aspects of bureaucracy. But the recent move to centralize certain personnel and administrative functions of the government, and the demands of the Science Council and the Senate Committee for a "coherent centralized science policy", have greatly altered the atmosphere of research in Canada. The great danger facing Canadian science is not a lack of coordination or even too great an emphasis on basic research; what is apt to kill Canadian science is the development of bureaucratic controls and the denial of the intellectual freedom that allows the individual scientist to exert his creative talents to their limit.

It is usually considered that in the Soviet Union the planning of science has been carried further than anywhere else. But it appears that the Soviet

authorities have learned from experience that planning science is not the best road to success. Here is what Peter Kapitza, the famous Soviet physicist, said to a Soviet audience: "When we in the Academy arrive at the conclusion that some field of science is lagging in our country, at once the question is raised about material support for some laboratory or even about the construction of institutes and so on. But it should be understood that it is impossible for us to maintain all fields on the same high level, so it is rather more correct to concentrate our efforts wherever we are powerful and where there are already good scientific traditions. Science needs to be developed in those directions where we are lucky to have a great, bold and talented scientist. It is well known that no matter how much you support an ungifted person, all the same he will do nothing great and purposeful in science. In the development of any particular field our first duty is therefore to proceed from a consideration of the creative forces of the person who is working in this field. You see, our science is a creative vocation, like art, music, and so on. It cannot be thought that by setting up a department for writing hymns and cantatas we shall get them: unless there is in this department of the conservatory a great composer equal in power, for instance to Handel, nothing will be produced. The lame cannot be taught to

run, no matter how much money you spend on this. It is the same in science as well. The governing body of the Academy should seek out, attract and support the most talented people, and it should be engaged on this even more than on thematics."

Even if we were to accept the idea that the aim of science is solely to contribute to human welfare we still would find it extremely difficult to establish whether a given basic research proposal would, or would not, make a contribution to this purpose. Even at the development stage of a technological innovation it is difficult to forecast the usefulness of the device. Many devices, such as the Arrow aircraft, the STOL aircraft, the CNR turbo train, etc., have been developed at a cost that runs into hundreds of millions of dollars, yet some had to be discontinued and others are still of doubtful usefulness in terms of the pay-off. If there is such uncertainty at the development stage, how can one expect at the much earlier stage of basic research to predict its usefulness? Here the expenses are far smaller and it appears much wiser to choose as the only criterion for the support of such basic research the quality of the scientists who want to do it. They are in a far better position to judge which particular facet is likely to yield significant results, significant in the framework of the particular science and its interdisciplinary connections.

The prime motivation for scientific research is the desire to understand nature. It is an urge that, just as art and literature, lifts man above animal, it is an enterprise of the human spirit. It is true that often the applications of scientific discoveries lead to advances in technology, but history has shown that the pursuit of science solely for the sake of these applications is far less efficient, even from a practical point of view, than letting science develop according to its innate ideals through its ablest disciples.

Three weeks ago the Canadian Government announced that it has given final approval to the construction, jointly with the French Government, of a new telescope at the top of Mauna Kea, a mountain in Hawaii. Naturally, Canadian astronomers are greatly pleased about this decision, but it is also an important indication that our government, and therefore the people of Canada, do appreciate the striving of scientists for knowledge of our universe irrespective of any possible applications.

The question is often asked: How can we justify spending time and money on problems of pure science when untold millions of people in India and other countries go hungry? This question, just as the statement that basic science should be done only insofar as it contributes to economic betterment, shows a

complete misunderstanding of human goals. Should Beethoven's contemporaries have asked him how he could justify spending all his time on compositions when millions of people in Europe at that time went hungry? It is obviously a meaningless question. Of course we must do all in our power to help the poor to increase their standard of living, but should it be done at the expense of those activities that are connected with our culture? Would it be worth saving the human race from extinction if it could only be done by giving up all those creative efforts in the arts and sciences that are not directly related to survival but represent the strongest justification for the attempt to survive? Surely preservation and advancement of our culture should have the highest place in our system of priorities.

Democracy does not mean that all people are equal, it means that everybody should have the same opportunities. Some people are brighter than others and therefore can make better use of the opportunities given to them and thus make greater contributions to the physical and spiritual goals of their country and of humanity. It is not necessarily the student who gets the highest marks in examinations who will become the most creative person. But everyone should strive for excellence to the best of his ability. If he cannot himself make creative contributions he can still help those more gifted than himself to do so. Above all, however, even if he himself

is doing fairly routine work he should, as an academically trained person, appreciate the fact that man does not live by bread alone, that some of our resources must be spent on art, literature and science, that is, on things that have no connection with economic well-being. The countries in past history that we admire most are not necessarily the economically prosperous ones but those that have made major contributions to our cultural heritage. Your aim should be to make Canada a country that is recognized throughout the world, and throughout history, as a country that has advanced in a significant way the progress of science, art and literature. .