The Research Investment: The Return to the Nation

Dr. Tom Brzustowski

President

Natural Sciences and Engineering Research Council of Canada

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Good afternoon, Ladies and Gentlemen, and thank you for coming to hear my message. It's a great honour for me to speak at The Canadian Club of Toronto.

I hope that you will agree with me that today's topic is of national importance -- our public investment in research, and the return to the nation on that investment. I intend to argue that the future of our economy depends on today's investments in research, and that our young people are the link between the two.

I am very pleased to be speaking in Toronto, and in front of such a distinguished audience. This city is as much of a home town as I've ever had. It was my destination when I arrived as an immigrant. I went to high school and university here, I have worked here, and I have two sons living here. Business brings me to Toronto often -- to make announcements of major research awards, to visit labs and meet researchers, to give the occasional speech or even a lecture to students. With three universities, Toronto keeps me coming back. And, of course, I still manage to be a Blue Jay and Argo fan even though I live in Ottawa. Mind you, the Leafs are a different story. Did you know that the Senators are going to make the playoffs again this year?

As Nalini has just told you, I'm the president of an agency of the Government of Canada called the Natural Sciences and Engineering Research Council of Canada -- a difficult and eminently forgettable name that doesn't get any better in French -- le Conseil de recherches en sciences naturelles et en génie du Canada, dont l'acronyme est CRSNG. In fact, most of the people we work with across the country refer to us by our English-language acronym – NSERC.

And to answer the obvious question, the natural sciences are all the sciences except for the medical and the social sciences.

You may not know much about NSERC. Most people outside of the universities don't – even in Ottawa. Of course, that may change now, because people in Ottawa tend to remember who gets new money in the budget.

Underlying everything I will be telling you is something else that's not well known. This subject, which may well have become -- by omission -- one of the best kept secrets in Canada for the last twenty years, involves billions of dollars, tens of thousands of people, hundreds of companies, and most of the universities in Canada.

This secret is the excellent research in science and engineering in Canadian universities.

This excellent research gives Canada a strategic capacity to compete in the knowledge-based global economy, an economy whose rapid pace of change owes much to the pace of advances in science and technology. I'm sure that the business people in the audience know very well that being up to date on the technology base of the business is essential to their long-term success. This afternoon, I shall ask you to think about that same capability on a national scale.

And when Canadians think about our science and technology capability on a national scale, we must remember that the Canadian capability is much more dependent on university research than in most of the countries we trade with. We certainly do have some major companies that invest heavily in R&D and are world leaders in their markets, but, for the nation as a whole, industrial R&D spending is relatively much smaller than it is in most other industrialized countries. There are many reasons for this state of affairs, but I am not here to explain it or propose how it might be changed. It is a fact, it has been a fact for a long time, and it has had consequences.

So where does NSERC come into the picture?

NSERC was founded twenty years ago as a separate agency to take over one of the functions previously handled by the National research Council of Canada. Our mission is to promote the creation and application of knowledge by supporting three essential activities in Canada's universities: basic research in science and engineering, project research on industrial problems, and the advanced education of some of our brightest young people through that research. In this way, NSERC is the national instrument for making strategic investments in Canada's capability in science and technology.

In the next few minutes, I will address four topics. I shall start with some numbers, telling you about the amount of investment made over the last twenty years, and the way that the investment decisions are made. Then, while the Oscars are still fresh in all our minds, I shall put forward my personal list of the first members of Canada's missing Hall of Fame – eight Canadian university researchers in science and engineering who have been acknowledged world-wide for the excellence and influence of their work, but in my opinion not sufficiently in Canada. After that, I shall go back to some numbers to give you an indication of the

great return on that investment in research. And finally, I shall tell very briefly tell you what you can do to make things better.

This year marks NSERC's twentieth anniversary. Over the last twenty years Canadian taxpayers have invested nearly $7 billion through NSERC, and the rate now is about $500 million per year.

Where does this money go, and how are the funds allocated?

Each year, more than 8000 professors in 58 Canadian universities receive research grants from NSERC to support basic research. They use this funding for the direct costs of their research: instrumentation, materials and consumable supplies, the services of technicians and research associates, support for postgraduate students who serve as Research Assistants, etc., etc. The indirect costs of their research, notably including their own salaries, are contributed by the universities. This means, of course, that the universities, and the provincial governments that fund them, are silent but essential partners in our work.

All NSERC funding is awarded in competitions that involve peer review. Nearly 500 experts from across the country serve as volunteers on the many selection committees that make the actual

funding decisions. They are helped by another several thousand experts in Canada and abroad who contribute in one way or another to evaluating the applications and the research record of the applicants.

About 13,000 persons, of whom 80% are postgraduate students and postdoctoral fellows, are supported from NSERC funds, either through individual awards or by being paid from a professor's research grant.

I have already mentioned that NSERC supports basic research through research grants. Project research which focuses on solving industrial problems is supported differently -- through partnerships with industry. To date, and particularly in the last ten years, more than 1000 companies of all sizes in all sectors have participated in the research partnership program, and have invested more than $600 million.

Here is just a sample of the companies that have invested more than $500,000 in university-industry research projects in partnership with NSERC during 1996-97: Hydro-Québec, Nortel Technology, Bell Canada, Noranda, Syncrude, Wyeth-Ayerst, IBM Canada, Alcan, Chrysler Canada, QLT Photo Therapeutics, and

Dairy Farmers of Canada. They come from all sectors and all parts of Canada.

In 1997-98, NSERC will have invested approximately $433 million in all its programs. You might have noticed in the recent federal budget that in 1998-9 we will have $494 to invest -- all the cuts have been restored; our budget is back at its 1994-5 level. This is very good news for the future of Canadian capability in science and technology. It's a clear signal that the Government of Canada recognizes its strategic importance.

The research in science and engineering that's done in Canadian universities has an impact in all sectors of our economy -- in all the traditional sectors on which our economy has depended and in all the non-traditional sectors that are now emerging as important. High tech is everywhere -- not just in telecom, computers and biotech.

Project research leads to productivity improvements and innovations that sustain existing product lines in all sectors. Basic research provides the pool of ideas for radical innovations, and may eventually create entirely new sectors. Doing world-class basic research gives Canadians access to the 97% of basic research

in the world that Canada doesn't have to pay for. And the advanced training of young people in both kinds of research provides the human resources capable of competing on a technical basis with anybody in the world. Canadian university researchers are very good and very productive in both basic and project research, and we have a good balance between these two activities.

But let me reflect on what I have just said. As I stand in front of the national flag and address you here today, I suspect that nobody would be making a speech like this in any of the countries we trade with. There seems to be some insatiable and uniquely Canadian need to keep explaining and justifying the public funding of research. The countries with which we trade and compete, the nations among which we like to count ourselves -- the G-7 and the OECD -- have taken the need for the public funding of research as a given. They stopped debating it decades ago.

Let me illustrate what I mean with some language taken from a bill introduced in the US Congress last fall, introduced by Senator Gramm, a name prominently associated with earlier legislation to limit federal spending. This is a bill "To invest in the future of the United States by doubling the amount authorized for basic scientific, medical, and pre-competitive engineering research".

This doubling is to take place over ten years. When the purposes of the bill are enumerated in the text, these words appear: "To enhance the quality of life for all the people of the United States." And then the bill goes on to require that a peer review system be used, and that the results of the research be made public.

In a few short lines this American legislation expresses the accepted reason for the public funding of basic research -- there's no tedious pleading there, no long justification, just a bold assertion that is accepted even by those committed to limits on public spending. But here in Canada we seem to be obliged to make the case over and over again. Why?

Perhaps it's because we don't know how good we are. Perhaps nobody tells us that our best scientists and engineers are just as big players on the world stage as are our best musicians, actors, writers, and athletes. Perhaps we don't realize how much important research has been done in Canada, and how it has affected our daily lives. Perhaps we just don't have the institutions to inform the public of these things.

My vision is that someday we will have a national Hall of Fame that is missing today, a Canadian Science and Engineering Hall of

Fame. It might be a glorious building, but it could also be a virtual institution without walls. Either way, I see it as something that will eventually attract the kind of attention that is lavished on the Hockey Hall of Fame just down the street -- something far beyond what our various science museums are now able to do. Hundreds of distinguished Canadians deserve be honoured in the S&E Hall of Fame, their individual achievements held up as models for our young people, their collective contributions a source of pride for Canadians.

To show why I am proud of Canadian science and engineering, I am going to name eight such Canadian heroes. I shall be parochial in my choices -- these eight are the most prominent Canadian university researchers whose work has been supported by NSERC for a long time. One has won the Nobel Prize, and the other seven are each winners of the Canada Gold Medal in Science and Engineering, Canada's top prize for research in science and engineering which has been presented annually since 1991.

Their research accomplishments illustrate the impacts that excellent research has on our lives -- some immediately and directly, some only after much further work by many other scientists and engineers, and some through the efforts of innovators

who develop the ideas that come out of research and build on them to bring new goods and services to the market.

All eight of these Canadian heroes have already been recognized and honoured around the world, for the excellence and influence of their research.

I begin with the John Polanyi of the University of Toronto, winner of the Nobel Prize for Chemistry in 1986. The Nobel Prize was awarded to him in recognition of his many years of beautiful basic research that has explained a great deal about how molecules behave when gases enter into a chemical reaction. This basic research provided the knowledge that made possible, among many other things, the invention of the chemical laser, a precisely controlled and very powerful source of infrared light which is widely used today as an industrial welding and cutting tool, and in many other ways as well.

Professor Ray Lemieux, now retired from the University of Alberta, is widely recognized as the world's leading scientist in carbohydrate chemistry – the chemistry of compounds that are essential in plant and animal life, such as sugars, starches and cellulose. Professor Lemieux holds patents in areas ranging from

the production of antibiotics, through processes related to heavy water production, and the curing of rubber, to the synthesis of human blood group antigens. Raymond Lemieux received the very first Canada Gold Medal for Science and Engineering in 1991.

William Fyfe of the University of Western Ontario is Canada's foremost earth scientist and widely considered the world's most eminent geochemist. Indeed, the brilliant and original applications of chemistry to geological research early in his career have earned him the reputation as the father of modern geochemistry. Professor Fyfe received the Canada Gold Medal in 1992.

In 1993 the Canada Gold Medal was awarded to Professor Pierre Deslongchamps of the Université de Sherbrooke, a world pioneer in the synthesis of organic molecules. His research led him to find ways to make a certain class of important molecules found in nature that nobody had ever been able to make before, and to discover some important new principles along the way. This achievement is considered a modern milestone in the field of organic chemistry.

The 1994 winner of the Canada Gold Medal was Professor Alan Davenport of the University of Western Ontario, a civil engineer

who has become the world's leading expert on the effect of wind on structures. His research has provided the basis for a whole new field: wind engineering. He has studied every effect of wind flow over structures as diverse as tall chimneys, low-rise buildings, roofs, communications towers, transmission lines, offshore drilling platforms, skyscrapers and bridges.

These days there is hardly a major construction project around the world in which he and his team are not involved -- testing models, analyzing swaying and vibrations, and providing design solutions. The CN Tower may be the nearest structure that they have worked on; the Confederation Bridge to PEI perhaps their most recently completed Canadian project. Their other projects sound like a Who's Who of world construction: The World Trade Center in New York, The Sears Building in Chicago, The Bank of China Building in Hong Kong, the Great Belt Bridge in Denmark, and the list goes on and on.

Peter Hochachka is a professor of zoology at the University of British Columbia. He is world-renowned as a leader in comparative physiology and biochemistry. More specifically, he studies how various animals -- molluscs, fishes, seals, beavers, and humans to name just a few -- adjust to a lack of oxygen. His

pioneering research has advanced our understanding of the metabolic mechanisms underlying the environmental adaptations. His studies of peoples living with a chronic shortage of oxygen at high altitudes have a great potential impact on the treatment of human diseases caused or complicated by a lack of oxygen. Professor Hochachka received the Canada Gold Medal in 1995.

In 1996, the Canada Gold Medal was awarded to Stephen Hanessian, professor of chemistry at the Université de Montréal. He works in medicinal chemistry, and his research on how to make mimics of natural molecules has laid the groundwork for the synthesis of many life-saving drugs including antibiotic, antitumor, and antiviral agents. One of ~~his~~ best-known practical outcomes of his basic research is a computer program which helps decode complex molecules quickly and accurately. It is used in universities and industry around the world.

The most recent Canada Gold Medal was awarded in 1997 to Keith Brimacombe, professor of metallurgical engineering at the University of British Columbia. Keith Brimacombe's research has changed the practices of the metals industry around the world. It was engineering research at its best. Keith Brimacombe connected the scientific elegance of laboratory studies with the dirty, noisy

and scorching processes in which metals are produced in the real world. And Keith knew how to take the last step. He was very active and effective in teaching the people in industry how to make use of the advances that came out of his research.

I greatly regret having to use the past tense in referring to Keith Brimacombe. He passed away a few months ago, with many years of fruitful work still ahead of him.

Ladies and Gentlemen, these heroes of Canadian science and technology are wonderful role models for Canada's students, the people who will translate today's research advances into tomorrow's prosperity.

To conclude my remarks, I want to present some data to illustrate the return on the investments made through NSERC.

We could spend a lot of time on some very important returns on that investment which are qualitative in nature. But that's for another place, with a lot more time. Here I will focus on some of the returns that we can measure. Let's start with highly-qualified people, the key resource in the knowledge-based economy.

NSERC has supported the postgraduate education of 47,000 young people in research in science and engineering who earned master's degrees and doctorates. These people could compete with anybody in the world working at the leading edge of their fields of science and technology. They are educated in research and that means that they can do research. But it also means that they have the skills and knowledge to do other important things, to be superb problem-solvers in many fields, as Canadian employers in all sectors are finding out. They have learned how to learn at the leading edge of knowledge, and they can be counted on to meet the challenge of changing conditions in the future.

Our surveys have shown that just about all of the people supported by NSERC have successfully completed their degrees. 98% of them are employed, and more than 65% are working in R&D. If there's a cloud on that horizon it is that about 8.5% of them intend to pursue their careers abroad. That means a brain drain of 8.5%, but I prefer to look at it as a brain retention of 91.5%!

There is still no generally accepted way to provide a quantitative measure for the value of human resources. In the meantime, we must resort to some common-sense estimates.

The key to wealth creation is added value -- the difference between sales revenues and the cost of purchased inputs. Value added pays wages and taxes and provides profits. They're not found in the daily financial pages, but there exist general statistics on the average value added per employee per year in various sectors. This is not the time for details. Suffice it to say, that $85k is in the mid-range of the average value added per employee per year in all our industrial sectors, and close to the figure for the auto industry.

Let's now do a very conservative calculation. Let's assume that, of those 47,000 young people with advanced degrees in science and engineering, 50% are working in the Canadian economy, and that their value added averages out to $85k per year per individual. That means that as a group they annually add value of the amount of $2 billion. That's half again as much as the sum of all their scholarships and stipends paid out over the twenty years. It's also four times the total annual investment made through NSERC! And that rough calculation completely ignores any economic multiplier effect of what they do. Even in fiscal terms alone, that's a fabulous return on the public investment.

Many new companies have been created as a result of research that NSERC has funded, most of them arising out of the results of basic

research. This may seem paradoxical, but in fact it happens because project research involves established companies as partners, and tends to produce innovations which sustain the products they already make. We don't know the precise number of spin-offs, but we do know that a sample of 106 companies created as an outcome of NSERC funding of university research employ nearly 5,800 Canadians in high value-added jobs that produce over $1.1 B in annual sales. And that last number tells me that the value added calculation I just talked about is very very conservative.

And please remember that these examples show only a small part of the total return to society on the public investment in research.

I hope that by now I might have convinced you that world-class leading edge Canadian capability in science and technology in all the important fields of research is of strategic importance to the country's future prosperity. We must succeed in maintaining that capability in the face of growing competition from around the world and changing conditions at home.

The good news is that we are succeeding, and succeeding on a large enough scale to have an impact. What's needed now is to grow that successful effort and to sustain it long enough to make a

permanent difference in Canada's ability to assure future prosperity and well-being for its people.

That's a challenge, and your help is needed if we are to meet it. But don't worry. What I'm asking for is not painful, and it's not even difficult. I ask only that you get the word out. Pass on the message that you heard here today.

Tell your colleagues in business that this country has the brains to compete and to grow even more competitive in creating wealth. Tell potential investors that there are lots of bright young people here full of ideas for new ways of adding value, and the knowledge and skills to carry them out. Tell the media that there are lots of great stories in Canadian scientific and engineering successes. Tell the politicians that strategic investments in knowledge and in developing the talents of young people are a good use of public money.

But above all, tell the children. Tell them that research in science and engineering requires discipline and skills and knowledge, but it also gives free rein to their imagination and it offers excitement. Tell them that they will be able to develop their interests and their talents in Canada to their full potential, and get an advanced

education in research that's as good as any in the world. Tell them that they will find really good jobs in Canada doing interesting things that can compete with what anybody can do anywhere. And tell them, finally, that they will find great satisfaction putting those talents to use in the country that has invested in their education.

I don't know how many of today's children might have the interest and the talent to become scientists and engineers who produce new knowledge in research, or innovators who use new knowledge to produce new goods and services for the market. I hope that many of our young men and women will follow that path. But I do know for sure that all of them will benefit from living in a society which has the capability to succeed in a world where knowledge is key.

Thank you.