A BRIEF to the HOUSE OF COMMONS STANDING COMMITTEE on FINANCE

by the

CANADIAN ASSOCIATION of PHYSICISTS (CAP)

EXECUTIVE SUMMARY

1. ***CAP recommends that NSERC's budget for basic science (its "Discovery Grants Program") be increased by 10%. Cost: about $40M p.a.***

2. ***CAP recommends that Canada start detailed planning to supersede the NRU reactor in Chalk River with the proposed Canadian Neutron Centre, a world-class multi-purpose facility for advanced research with neutron beams, for nuclear power R&D, and for isotope production. A formal design and costing would require about $5M.***

3. ***CAP recommends that significant new funding be provided for the costs of major science infrastructure, not covered by ongoing programs. Specifically, CAP recommends renewal of funding for TRIUMF and a doubling of NSERC's Major Resources Support Program. Cost: about $96M p.a.***

---

1. The CANADIAN ASSOCIATION of PHYSICISTS ('CAP')

CAP is the Canadian national organization representing physicists in all sectors, including universities, government laboratories, and the private sector. Established in 1945, CAP has a membership of about 1,600.

Physics is the most fundamental of the sciences, being increasingly essential as an enabler of advances in all other science and technology, especially as the development of devices now converges on the ultra-small scale. Advances in physics were at the foundation of integrated circuits (on which the computer and PDA revolution is based), and are of increasing importance for ultra-large scale integration using new physics-based principles aimed at light-speed computation. Physics gave the world lasers, on which are built modern communications and entertainment media, vision-correction and other medical procedures, high definition printing, and advanced automobile technology. Medical imaging devices like X-rays, PET scans and MRI are all founded on physics, along with a host of other technologies that have changed our world for the better. Inventions based on just one branch of physics (Quantum Mechanics) have been estimated to account for over 25% of the industrialized nations' GDP, and this is expected to increase with developments in quantum computation. The vastly unmet demands for renewable energy may only be met by third-generation solar cell science, which is impossible without basic physics advances. Even the world-wide-web originated in the 1990s with physics (section 4.3).

CAP aims to communicate to policy-makers and to the public the central importance to modern economic growth of both basic and applied scientific research. We recognize the importance of the substantial improvements that have been made to research funding in Canada over the last decade or so. Significant weaknesses remain, however, and it is critical to build on the improvements if Canada is to rise to imminent and foreseeable competitive challenges. In the current climate, we also stress that research funding can create rapid stimulus.

Canadian Association of Physicists, c/o Dr. Robert Mann, President
University of Waterloo, Waterloo ON N2L 3G1; (519) 885-1211 x36285

2. THE SIGNIFICANCE OF BASIC RESEARCH

We shall give considerable emphasis to *basic* research: research that aims to gain knowledge or understanding, without immediate specific applications in mind. While applied physics and other scientific research and engineering have played essential roles in the economic growth and prosperity that the world has enjoyed over much of the last century, the key underlying advances have come from basic research, and we have already given some examples from physics.

The value of basic research lies partly in its ability to discover and understand entirely unexpected phenomena. It therefore counters the natural tendency of the market to 'use up' the existing stock of ideas and relationships and to lock society into particular technological options. It is thus essential to the production of applied knowledge and applied science. These in turn lead to new technologies and ideas that generate new products, processes, businesses and jobs, and even entirely new industries. The fruits of basic research are therefore the foundation of social and economic progress. Basic researchers also often recognize truly novel application opportunities very early, allowing them to be pursued quickly.

Mindful of this, the U.S. is proposing to significantly increase its support of basic research, and Canada risks being left behind. But could a country like Canada afford to simply fall behind in basic research, and to merely import the results of that research? After all, the results of basic research are published internationally, and nothing prevents a "free-rider" country from reading the published results. However, it is now widely acknowledged that a critical component of any country's economic growth is the ability to fully understand, internalize and apply the advances of other nations; this essential 'receptor capacity' requires the experience and 'tacit' knowledge (the type of hands-on, experiential knowledge that cannot be transferred verbally) that comes from the direct conduct of all types of research. Tacit knowledge cannot simply be purchased, but is a vital component in enabling researchers and companies to translate their own and other countries' research results and technology into new made-in-Canada applications and benefits. In short, Canadians must be excellent in made-in-Canada research, both basic and applied.

Basic research excellence is also Canada's 'entry-ticket' into the international R&D networks and social interactions that are essential for nurturing world-leading Canadian research and companies. In addition, and critically, cutting-edge university research institutions generate and inspire world-class graduates, skilled employees, and creative entrepreneurs, essential to Canada.

Canada's basic research also generates important spin-off companies. A recent study of the non-medical natural sciences compared the economic impacts of such companies with all government research funding going back to the 1960s. Even allowing for the 'time-value' of money, both the estimated impacts and the incremental taxes generated by the spin-offs exceed the government funding by a substantial margin. We do not perform basic research just to produce spin-off companies, but the study shows that their very direct impact *alone* more than justifies the funding. First class research universities, and the resulting companies, have also spawned dynamic regional economic clusters -- such as Waterloo, Ontario -- in Canada and abroad.

In a global knowledge economy, then, the nations that successfully weather the challenges of the current economic environment, and that will return to long-term growth quickest, will be those that include world-leading applied *and basic* research and innovation in their efforts to stimulate their economies. The federal government has recognized this need with a variety of measures in

recent years, but it needs to build on these accomplishments to ensure Canada's prosperity in a world of ever-increasing competition.

3. WHY SUPPORT RESEARCH NOW?

In addition to its medium- to long-term benefits, research has more immediate impacts. Research funds can be used *quickly* to create jobs for professionals, students, and support staff, and to buy materials and equipment. Universities also have unusually large economic multiplier effects: new money *quickly* trickles down to the community as the university and its employees purchase needed products and services and, in turn, the vendors purchase their own supplies.

Moreover, a recession encourages many Canadians to consider continuing their studies at the graduate level. Additional research support now can therefore capitalize on this, generating additional extremely valuable highly-trained Canadians.

Attempting to save money in the short term by under-funding research has serious long-term implications. Research teams and networks built-up over many years may be lost, often to other countries, and may be impossible to reconstruct even if funding is later restored. For example, a leading HIV/AIDS researcher at the Université de Montréal accepted a position in Florida earlier this year, and indicated that he would take up to 25 of his team of skilled researchers with him.

4. RECOMMENDATIONS

4.1 Recommendation 1: *CAP recommends that NSERC's budget for basic science (its "Discovery Grants Program") be increased by 10%. Cost: about $40M p.a.*

Since nobody can predict how a particular piece of new knowledge might be applied to address social or economic issues, the private sector is generally reluctant to support basic research activities. It thus falls to governments to ensure that such research thrives as a public good, creating economic impact as outlined above. For researchers at Canadian universities, the principal vehicle for funding basic (*and* much applied) research in the natural sciences is NSERC's core Discovery Grants Program ("DGP").

Of course, we recognize (as does NSERC) that targeted (applied) initiatives should play an important role in university research, which on occasion will involve new targeted initiatives. However, as the International Review Committee on the DGP said in its 2008 report:

> *The DGP is therefore an exceptionally productive investment and thus deserves additional funding to ensure that the value of its grants keeps pace with the growing opportunity.*

And in the context of the commercialization of research, the Expert Panel on Commercialization reported to Industry Canada in 2006*:*

> *The recommendations in this report are based on one key premise: continuing government commitment to publicly funded research carried out with little or no expectation of commercial application …..… The challenge for government is to increase - not merely maintain - its investments in publicly funded research….*

In short, Canada needs to carefully balance the allocation of new money between basic and applied (or targeted) research. The trend of federal support for university research over the last decade has been positive, after many years of stagnation. Worryingly, however, initiatives in recent years have tended to focus on targeted activities, leaving the resources available for the DGP to decline, or stagnate at best, in nominal terms. This amounts to a real (after-inflation) reduction, especially since research costs increase significantly faster than general inflation. In

fact, adjusting only for general inflation, average annual Discovery Grants over the last 3 years are more than 10% lower than they were 20 years ago! Recommendation 1 would redress this. Conversely, if recent trends continue unchanged, the damage to Canadian basic research, and to the economic and societal benefits that flow from it, will be serious.

Budget 2009 contained some significant and welcome stimulus measures, such as support for university infrastructure, which have been indirectly beneficial by providing relief to the institutional homes of research. However, these measures do not necessarily lead directly to increased research activity. Also, unfortunately, NSERC's overall budget was actually decreased by Strategic Review decisions announced in 2009.

4.2. <u>Recommendation 2</u>: ***CAP recommends that Canada start detailed planning to supersede the NRU reactor in Chalk River with the proposed Canadian Neutron Centre, a world-class multi-purpose facility for advanced research with neutron beams, for nuclear power R&D, and for isotope production. A formal design and costing would require about $5M.***

In 1994, Canada's Bertram Brockhouse won the Nobel Prize, the highest honour in all of science. Now his Canadian legacy is in danger of being wiped out. The lack of a replacement for the "NRU" reactor at Chalk River goes well beyond the isotope shortage crisis, serious as it is, and threatens Canada's industrial and scientific competitiveness.

Since its start-up in 1957, NRU has led to (i) the creation of a $350M p.a. international medical isotope business, contributing to the health of tens of thousands of Canadians every year, and over 20 million around the world, (ii) the establishment of a $6.6B p.a. domestic nuclear power industry that produces 15% of Canada's electric power with no greenhouse gas emissions, (iii) the development of materials research using neutron beams; this earned Brockhouse his Prize and has been adopted around the world. Neutron beams help companies in every sector of the economy -- including aerospace, automotive and manufacturing, as well as Canada's four priority areas: energy, environment, health, and communications -- to develop safer, more reliable, and less expensive products. This improves Canadian competitiveness and opens new markets. The NRU is a resource for more than 500 individual researchers, including academic users from over 50 faculties in 20 universities across Canada, represented by the Canadian Institute for Neutron Scattering (CINS). It has trained thousands of Canadian engineers and scientists. NRU is arguably one of the most rewarding investments ever made by the Canadian Government.

The NRU must be retired by 2016. The worldwide lack of capacity for neutron beam research, and the essential need for it, has been recognized by every industrialized nation. All G8 countries (except Canada) have already taken action to address the problem. As ageing foreign facilities are retired, others are refurbished and new facilities are being built to meet the growing need.

The Canadian Neutron Centre (CNC) proposed by CINS would be a new, world-class facility that would surpass the NRU in each of its functions: production of medical isotopes, nuclear energy R&D, and production of neutrons for materials research. It would be a vital part of Canada's scientific and industrial infrastructure. Over a 50-year lifetime, it would enhance Canadian innovation and the competitiveness of our science and industry, reassert Canada's international leadership, continue one of our key national innovation centres, educate and develop skills for thousands of highly qualified people, and support thousands of individual

science projects. But without such a facility, all areas of science would be impacted, as essential information about materials would be unavailable, and there would be an irreversible migration of talent out of the country. Canada would also be unable to develop the next generation of nuclear power reactors sorely needed to reduce our dependence on fossil fuels.

It is critical that the Government move rapidly on this project, since bringing the CNC online may take up to ten years. The next step is to establish a formal engineering design. A suitable Federal Agency should be identified and given the mandate and funding to coordinate a multi-departmental working group and to produce a properly costed design proposal in 2010.

4.3 <u>Recommendation 3</u>: ***CAP recommends that significant new funding be provided for the costs of major science infrastructure, not covered by ongoing programs. Specifically, CAP recommends renewal of funding for TRIUMF and a doubling of NSERC's Major Resources Support Program. Cost: about $96M p.a.***

It is essential to fund key research infrastructure needs that are not currently provided for. Specifically, funding is needed for TRIUMF, a vital national facility and a major Canadian success story, and for operating, maintaining, and upgrading research infrastructure nationwide.

Owned and operated by a consortium of 15 Canadian universities, TRIUMF provides research infrastructure and tools that are too large and complex for a single university. Its current 5-year government funding cycle ends in early 2010. With its user community, TRIUMF leads Canada in addressing a wide range of important science and technology questions, from subatomic physics to materials and molecular and life sciences. Now in its 40th year, TRIUMF is home to a world-leading program in the physics, chemistry, and biology of isotopes, including basic research into the origins of the universe, and the biological mechanisms of neurological diseases and cancer. TRIUMF allows Canada to play a leading role at the LHC (the world's largest scientific project, located at CERN in Switzerland). New properties of space and time may be discovered there, with potentially profound scientific and possibly practical implications – after all, CERN gave us the World Wide Web! TRIUMF research has resulted in a Canadian economic impact of about $200 million per year, including a 30 year partnership with MDS Nordion to produce 15% of Canada's medical isotopes. For 2010-2015, TRIUMF would continue to provide leadership in the transforming field of nuclear medicine, and would maintain its focus on infrastructure, including the LHC and the development and deployment of a major innovative accelerator technology. This last technology has applications to basic research and to the production of medical isotopes, the imaging of cancer, and environmental remediation. About 1,500 researchers will use TRIUMF each year. TRIUMF's funding request for 2010-2015 is $328 million, of which $23 million has already been awarded by the Canada Foundation for Innovation (CFI), leaving a net $61M p.a.

Since 1997, CFI has invested in other major items of research infrastructure. Its $750M funding in the 2009 budget, while apparently aimed mainly at targeted research, was important and much appreciated. In order to leverage the maximum benefit from the essential investments that CFI and others make, it is critical to spend significant amounts on operating, maintaining, and upgrading research infrastructure across Canada. While CFI and NSERC provide some funds for these activities, this support is much less than is needed if Canada is to benefit fully from these investments. This shortfall is approaching crisis dimensions. A doubling of NSERC's Major Resources Support Program (cost: $35M p.a.) would go some way to address this crisis.