Submission to Federal Expert Panel on Research and Development

on behalf of

The Canadian Academy of Engineering

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The Canadian Academy of Engineering is pleased to make this submission to the Expert Panel leading the Review of Federal Support to R&D.

Summary:

Canadian federal support for business research and development (R&D) would, we believe, be more effective if the engineering design component of innovation were supported more explicitly and strongly. Design is an essential part of R&D, coming into the process where researchers have largely handed off to engineers, and continuing as a key creative element of D (development) all the way downstream to the introduction of the final product into the market. Since design takes into account the needs and constraints of the customer, recognizing and supporting engineering design as an essential part of the process of innovation will bring Canadian innovation closer to meeting the needs of the market. This is essential since an innovation will succeed and create wealth only when the new product or service receives market acceptance.

We have attached a supporting document in the Annex.

Background

Several recent reports have highlighted Canada's shortfall in its innovative capability relative to other modern economies. A good example is "Innovation and Business Strategy: Why Canada Falls Short" released by the Council of Canadian Academies in 2009. This assessment focused on innovation as "an economic process rather than as a primarily science and engineering activity". It emphasized the "upstream" nature of Canada's economy tied to our natural resource base and the relatively small and geographically fragmented domestic market. The focus on economic aspects, including taxation and trade barriers, has been typical of such recent reports.

Innovation, by definition, leads to commercially viable new products and services. Innovations do not necessarily start with a discovery or a result obtained in a laboratory, though many do. They can also start with an idea for something new that will fill a need in the marketplace and which in turn may lead to a need for research and development to obtain necessary fundamental knowledge and data.

It is common for commentators to refer to science and technology as components of innovation. An example would be "State of the Nation 2008" published by the Canadian Science, Technology and Innovation Council. However, science and technology by themselves are inanimate. They represent

knowledge, information, devices, materials, software, whatever, that can be used in an innovation. But, by themselves, they do not accomplish the innovation.

It has to be recognized that most innovations are engineered. Engineering is a process that accomplishes a task to meet specifications set by an end user. A crucial element of this process is design; design of a robot to perform surgery, of a pipeline to transport oil sand, of an automatic electrified train, of a process to recover and sequester carbon dioxide, of a smart phone. Design is often an iterative process, but the final design has to satisfy a customer, meet economic considerations, and be safe in manufacture or deployment and in use.

In this brief, we argue that "engineering" as a process and "engineering design"* in particular are under-appreciated components of innovation and deserve to be encouraged and better supported by our Federal Government. Specifically, we make the case that engineering design be regarded as part of business-focused research and development particularly when focused on taking a new product from the prototype stage to a manufactured product.

**** The Current definition of Engineering Design from the Canadian Engineering Accreditation Board (CEAB)***
Engineering design integrates mathematics, natural sciences, engineering sciences, and complementary studies in order to develop elements, systems, and processes to meet specific needs. It is a creative, iterative, and open-ended process, subject to constraints which may be governed by standards or legislation to varying degrees depending upon the discipline. These constraints may also relate to economic, health, safety, environmental, societal or other interdisciplinary factors.

Engineers and Engineering in Innovation

There are many branches of engineering, for example as reflected in the programs offered by our engineering schools - aerospace, biomedical, chemical, civil, computer, electrical, environmental, geological, industrial (systems), materials, mechanical and nano, to name most, but not necessarily all. Several of our engineering schools are ranked among the top 100 in the world based on the quality of their research, their size and impact, and reputation. (See The Times of London Higher Education Supplement rankings over the past four years www.timeshighereducation.co.uk/) A majority of their graduates at all levels go on to careers in business and industry. Some become entrepreneurs and start new enterprises. The role that these graduates play, and will continue to play in the innovation process needs to be better recognized, supported and promoted.

It was Theodore von Karman, who proclaimed that, while "a scientist studies what is, an engineer creates what never was". This view supports the crucial role that engineers with their aptitude and advanced knowledge can play in the process of innovation. It is our belief that this role is not fully appreciated in the wider community of politicians and the citizenry.

Engineers typically work in teams because most projects are multi-dimensional. They work to meet a time-line and budget. Engineering is often an iterative process in which alternatives are considered with a view to obtaining the best solution. Regardless, the engineering methodology features design utilizing the principles of physics, chemistry, mathematics, and increasingly biology, as well as

thermodynamics which often places limits on what can be achieved in practice.

It is important to appreciate that engineering design is almost always a key and necessary component of the process leading to an innovation. Support for the teaching of design is offered by NSERC through the Chairs in Design Engineering (CDE) Program established at Canadian engineering schools. Ways should be found to expand this program with a view to broadening its reach to more students and link it to the urgent national need for enhanced innovative capability for the future.

Above all, engineers are action-oriented, have a strong desire to build, and thrive on solving problems. They are, and must be, an important part of the way forward.

Our responses to specific questions follow:

1. *In addition to the R&D activity defined by the OECD, should government be funding other business activities related to the commercialization of R&D? If so, what and why?*

We believe that the definition of R&D should be broadened to include engineering design, as we argue in the above Background.

2. Does Figure 2, the model of business innovation presented above, capture the key structural factors and inputs to innovation? If not, what is missing?

We do not see any reference to include the importance of engineering design in Figure 2.

5. Regarding networks, collaborations and linkages, what are the main impediments to successful business-university or business-college partnerships? Does the postsecondary education system have the right capacity, approaches, and policies for effective partnerships with business?

We recommend that the Expert Panel seek guidance on effective partnerships between post-secondary institutes and business by reviewing the Fraunhofer Institutes and Research Establishments' approach of long standing presence in Germany. www.fraunhofer.de

7. Regarding talent, is Canada producing sufficient numbers of graduates with the right skills to drive business innovation and productivity growth? If not, what changes are needed? Where demand for advanced skills is low, what are the reasons and what changes, if any, are needed?

Canada is not strong in the area of experiential learning and therefore building competitive high-technology companies. Building such companies (which offer products for which there is a sustained, global market demand) strongly depends on non-scientific expertise, which is acquired through

experience. This is something that therefore needs strengthening, it being additive to strong science and engineering research.

We believe that the creation of a new type of professorial appointment – the 'Industrial Practice Professorship' could make a fundamental difference to Canada's capability in growing technology-based commerce. The lack of industrial experience in Canada's engineering professorate is a significant difference from that in other industrialized countries, and this consequently makes it more difficult for us to impart "real world" knowledge to our students.

9. With which federal programs supporting business or commercially oriented R&D in Canada do you have direct experience and knowledge? In your view:
a. Which of these programs are working, and why?
b. Which programs are not working, and why not?

The IRAP program has been a long-standing and well-regarded reliable program for small and medium size companies to access in support of their research and development activities. This program is valuable because it provides mentoring and business advice as well as financial support. It works and has a great track record.

As an improvement, the program should be extended to include engineering design.

10. If you have direct experience and knowledge of the SR&ED tax credit, what are your views in relation to the following:
a. Does the current structure of the SR&ED tax credit encourage incremental investment in R&D? Does it free up capital to invest in other aspects of innovation activities in the firm? Does this vary by size, ownership, sector or nationality of firm?
b. What are the strengths and weaknesses of the refundable portion of the SR&ED tax credit for Canadian-controlled private corporations and to what extent does it encourage the growth and commercial success of SMEs?
c. Bearing in mind the improvements being made by the Canada Revenue Agency, are there additional opportunities for change to simplify the administration of the SR&ED tax credit and facilitate the applications process?

Experimental Development in the SR&ED tax incentive program should be explicitly expanded to include engineering design, as long as this design work relates to the development of new products and/or services. We do not want the program to be applied to engineering design done on contract for others that is for standard products or services. Engineering design done to take a new product from prototype to manufactured product should qualify.

We also believe that the SR&ED program should be revised so that claims can be made quarterly. Currently, cash spent on R&D activities is not recovered through the SR&ED for up to 18 months later.

The most difficult part of supporting R&D activity is cash flow, so shortening the gap between the expenditure and recovery would be most helpful.

12. How could the Government of Canada be more innovative and responsive to meet new needs or opportunities, and try alternative service delivery-approaches in its programs?

Domestic Canadian companies must be encouraged to buy new innovative products and services from Canadian companies. It is disappointing how little support Canadian SMEs get from local buyers. Numerous examples exist where Canadian companies sell their innovative products all over the world before local domestic buyers can be found. This attitude change must take place in order for more successful companies to be launched.

15. Is there a difference between R&D and innovation? If yes, how are they different? Should government focus on R&D or Innovation? What should the balance be?

Yes - Innovation, by definition, leads to commercially viable new products and services. Innovations do not necessarily start with a discovery or a result obtained in a laboratory, though many do. They can also start with an idea for something new that will fill a need in the marketplace and which in turn may lead to a need for research and development to obtain necessary fundamental knowledge and data.

Furthermore the obvious gap is the lack of support for the engineering design component of the innovative process which we believe is essential to help meet the urgent national need for stronger innovative performance in Canada.