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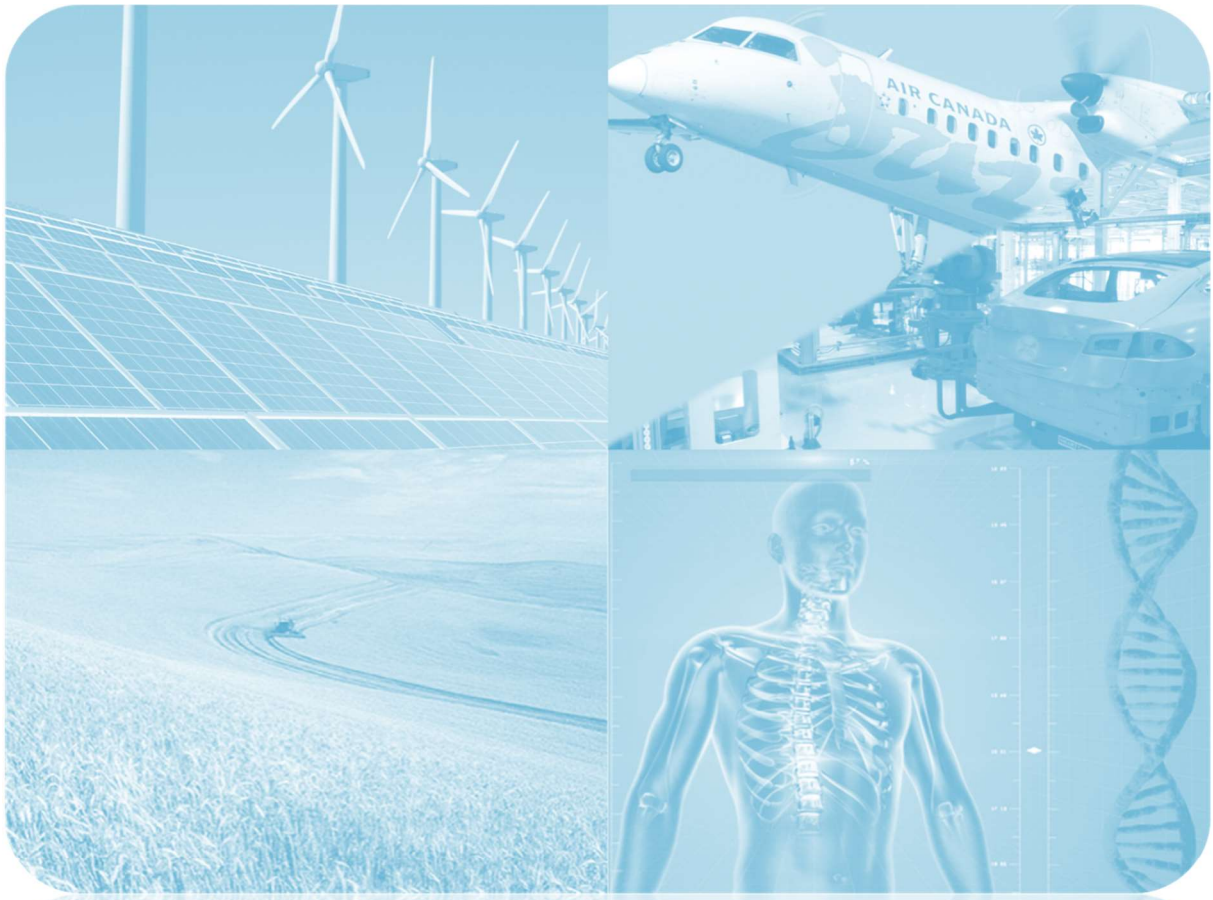

Pre-Budget Consultation Submission to the House of Commons Standing Committee on Finance

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Recommendations

To remain competitive, Canada must:

Recommendation 1: Invest in microelectronics, photonics and quantum technologies as strategic technology platforms essential for autonomous vehicles, Artificial Intelligence (AI), Internet of Things (IoT), 5G telecommunications, advanced manufacturing, Industry 4.0, clean technologies, precision agriculture, and robotics

Recommendation 2: Continue significant infrastructure and operating funding for Canada's Major Research Facilities/Major Science Initiatives, including Canada's National Design Network (CNDN)

Recommendation 3: Recognize Canada's National Design Network (CNDN) as a unique Canadian accelerator of innovation, essential to academics and industry including the Superclusters

Recommendation 4: Implement recommendation 6.10 of the Naylor Report regarding the reduction of matching funds in national networks to 40% from the current 60%

ECONOMIC GROWTH: ENSURING CANADA'S COMPETITIVENESS

The Importance of Advanced Technologies to Competitiveness

Advanced technologies are present in every major economic sector in Canada, but they are often taken for granted because they are almost invisible, highly-integrated components. Every technological product requires some form of intelligence and this is enabled using high-performance computing, microelectronics, micro-electro-mechanical systems, photonics or nanofabrication. It is vitally important that we reduce the barriers to technology adoption, increase the pace of innovation, and simplify access to state-of-the-art technologies.

Innovations in advanced technologies have certain properties:

Foundational – they cross over application areas into every market segment

Durability – they are defensible through patents or know-how and provide long-lasting competitive advantage

Transferable – innovations in one industry sector can be reused and reapplied elsewhere thereby multiplying their benefits if a suitable network is in place to facilitate this

Productivity Improvement – when the barriers to technology adoption are reduced, companies use these technologies to produce better products at lower cost

Economic Impact – Canadian advanced technologies lead to higher performance products, increased exports, and more manufacturing employment

The Competitive Landscape

Advanced nanotechnology manufacturing involves unprecedented complexity in research infrastructure, an ever-widening array of disciplines and skills in R&D projects, and concerted, collaborative effort among industrial engineers and scientists, university researchers, and not-for-profit organizations whose mission is to catalyze innovation. To be a leader in advanced technologies such as micro-nanosystems is to be a leader in highly competitive **global** supply chains.

In Europe, companies have access to state-of-the-art technologies through Research and Technology Organizations such as Fraunhofer (Germany), TNO (The Netherlands), VTT (Finland) and CEA (France).

In the USA, DARPA announced a further 1.6B$US over 5 years to stimulate a rebirth of microelectronics and funded AIM Photonics to increase the competitiveness of USA-based companies in photonics, a total investment of 610M$ including 110M$ in federal funds.

Other organizations are either operated as part of a government department (CIC/Taiwan, ICC/China and part of EUROPRACTICE/Europe) or as part of a university facility (CMP/France, IDEC/South Korea, MOSIS/USA, VDEC/Japan). The bottom line: companies in Canada are competing with firms overseas who are benefiting from extraordinary domestic support.

ECONOMIC GROWTH STRATEGY - INCREASED INNOVATION PRODUCTIVITY

The competitiveness of Canadian advanced technology firms depends on their ability to position themselves in global supply chains, to ensure their products and solutions can access global markets, and to attract foreign direct investment to allow scaling of manufacturing in Canada. Many companies are actively engaged in the Canadian innovation ecosystem developing world class products using micro-nanosystems, include Blackberry, Ciena, Cisco Canada, IBM Canada, Lumerical, TeraXion, Teledyne-DALSA, Optiwave, Ericsson Canada, Lumentum Operations (formerly JDSU Canada), RANOVUS, and Celestica. Large or small, emerging or established, competitiveness in innovative products and services that incorporate micro-nanotechnologies is enabled by an ecosystem with the following attributes:

- **People:**
  - A steady supply of skilled and knowledgeable new employees from a broad range of disciplines who train on commercial design tools and advanced manufacturing technologies. High quality talent is critical to SMEs focusing on growth and demand is expected to increase far faster than we have seen over the past decade.
  - Access to online and in-person training on design tools and manufacturing technologies
- **Simplified Logistics**:
  - Centralized purchasing, support and training of industrial strength design tools
  - Simplified access to prototyping capability to explore new product concepts
  - Access to process design kits (PDKs) – software that checks for manufacturability during the entire design cycle. Foundries in Canada (e.g., NRC's CPFC/Ottawa, Teledyne-DALSA/Quebec, Micralyne/Alberta) need help to create and distribute PDKs to grow their global customer base.
- **Reduced Risk**:
  - Low cost rapid prototyping to advance technology readiness levels (TRL) and manufacturability readiness levels (MRL) to de-risk product R&D
- **Reduced Cost**:
  - Sharing of state-of-the-art design tools to reduce duplication of effort
  - Sharing of minimum purchase quantities of prototype fabrication lots, out of reach of many researchers and SMEs
- **National Scope**:
  - Link academic research and industrial innovation
  - Provide industrial access Canada-wide to academic expertise, IP and costly R&D facilities to help solve difficult technical issues, accelerate R&D, and identify exceptional students for future hiring.
  - Access to a national "patent pool" and Intellectual Property (IP)
  - A network with activities to share and connect business to business or to academics
  - Assistance in working with university tech transfer offices (TTO) and other services

- **Competitive technology intelligence** for early recognition of emerging market opportunities; an understanding of techno-economics, especially by academics (who otherwise may develop impractical solutions to market opportunities)
- **Capabilities in emerging technologies** such as silicon photonics and quantum technologies (sensing, communication, and computing)
- **A vibrant ecosystem** that is attractive to multi-nationals, particularly those with head offices outside Canada, to encourage them invest in R&D in Canada. Foreign direct investment (FDI) is important for the long-term sustainability of the ecosystem

MEASURABLE IMPACT[1]

Not-for-profit organizations generally provide the "glue" that hold a nation's ecosystems together. At present there is no coherent strategy, federal or otherwise, that links the various players in Canada's micro-nanotechnology ecosystem (especially one encompassing photonics and quantum technologies) or ensures that there are no critical gaps now or in the foreseeable future. This is within the context of critically important and high performing institutes (e.g., for quantum science and technologies, at Université de Sherbrooke, UBC, Waterloo) and initiatives (e.g., AMN Supercluster, ReMAP BL-NCE).

How can we ensure that Canadian firms can compete in a global economy which requires technology platforms for use in Smart Cities, Energy, Advanced Manufacturing, Safety and Security, Human Health, Agri-foods, Transportation and Digital Communications? We can do this by providing access to state-of -the-art technologies and by taking advantage of cost sharing to make them accessible to researchers in academia and industry.

CMC Microsystems is a not-for-profit corporation created in 1984 to develop and manage Canada's National Design Network (CNDN). The CNDN serves academic researchers, company engineers and commercial suppliers that support innovation in the field of microsystems and nanotechnology. CMC **annually** delivers services to:

- over 1200 university and college professors,
- 950 companies,
- 8200 post-graduate and undergraduate students,
- 400 post-doctoral fellows, and
- 300 research staff.

Program participation is impartially Canada-wide and diverse, via equitable access for all professors, students and company researchers, including those in small geographic centers away from large business hubs, in small institutions, in start-ups, and/or individuals at the early stages in their career.

CMC works closely with and has clients supported by the ReMAP BL-NCE, MiQro Innovation Collaboration Centre (C2MI) CECR, Institut National d'Optique (INO), and ReSMiQ (le Regroupment stratégique en microsystems du Québec). CMC has a significant international presence and recently partnered with Advanced Micro Foundry (AMF), a Singapore-based manufacturer of silicon photonics

[1] Final Report - CMC Microsystems – Visioning Exercise, Global Advantage Consulting Group Inc., June 15, 2018

integrated circuits, to develop a new design automation platform for R&D use in Canada. CMC also convenes regular meetings of its peer organisations internationally.

Over the past five years, more than 290 professors in 33 institutions submitted more than 1,800 designs for manufacturing, and more than 50 designs were manufactured for companies. Academic productivity included 7400 publications and more than 700 national and international awards. Industry participation also grew to $115M with 1400 companies collaborating in research projects or hiring graduates. Nearly 3400 Highly Qualified Personnel (HQP) were recruited to industry supported by CMC training. Innovation outcomes included nearly 900 patents applied for or issued; and 150 technologies licensed.

The economic benefits of the CNDN are lowered R&D costs, increased R&D productivity, and accelerated time to market and time to publication. Predicted impact over the next five years:

- Stimulation of **$3.1B in economic activity** and creation of 3,000 jobs in Canada's Advanced Manufacturing industries and corresponding digital economy
- **1,400 companies** benefiting from new talent, ideas, equipment, and prototyping access. Lowered R&D costs via CMC's bulk purchasing of design tools and prototyping manufacturing, by access to and reuse of technology platforms (pre-designed and proven building blocks for incorporating into product prototypes), and by tapping into knowledge on making designs more likely to work first time and be inherently manufacturable, thereby reducing time to market and time to profit.
- **10,000 students** will gain critical work-integrated learning experience using standard industry design tools, and learn to design prototypes that are manufacturable, lowering costs for the companies they are collaborating with. Students will be productive more quickly on beginning a Masters or PhD study program (by 3 months or more), completing their degree sooner and potentially lowering their student debt.
- **3,500 trained HQP** will find employment in Canadian industry and each will be more productive by 6 to 18 months, translating into $150M in economic benefits for Canadian companies
- **80 start-ups** will benefit, primarily by lowered entry costs to design and manufacture product prototypes, by access to critical talent, and faster time to market by use of technology platforms
- Canada's National Design Network as an "innovation hub" to broker collaborations and contracts among academic research capability, government priorities and programs, and domestic and global private sector needs
- **25,000 participants** will benefit from the micro-nanosystems innovation hub for:
    - Training for students, faculty, industry and government scientists/engineers
    - Access to prototyping advice and tools, and R&D to advance in-house capabilities
    - Business development services, including an IP pool on behalf of members, market trends analysis, industry sector trends analysis, global supply chain analytics, and technology road mapping
    - Ideation support, access to key researchers, business planning support, collaboration and networking support, marketing, sales and distribution, Techno-economics

The nature of support required is broader than what is singularly available from existing programs. Most funding programs target narrow subject areas (Human Health or Agri-foods or Transportation), yet micro-nanotechnologies are foundational in virtually all application areas and markets. It is inefficient and impractical to seek funding from many disparate sources. Other programs (e.g., NCEs, BLNCEs, CFREFs) typically target funding for faculty and graduate students or companies and aim to fund the research itself.

No single, existing government funding program fits this platform model.

To ensure Canada's competitiveness, funding must be allocated for the unique R&D infrastructure and services so critically needed in Canada if institutions and companies are to compete globally.

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