Brief to the Standing Committee on Finance's Pre-Budget Consultations in Advance of the 2017 Budget

Canada's National Design Network®

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Creating value from advanced manufacturing depends on the availability of highly qualified people. In Canada this has been achieved, over the last 30 years, by supporting university researchers and collaborating companies through the mechanism of Canada's National Design Network (NDN), built and managed by CMC Microsystems (CMC). At a time when there are increased opportunities for industry this infrastructure is at risk.

The Opportunity

Micro-nanotechnologies, which have underpinned the digital revolution in computers and communications, are now finding their way into all vital sectors of our economy. Distributed systems and intelligent controls will enable efficient energy usage; microsystems and nanoimplants will transform health monitoring and personalized medicine; and networks of autonomous sensors will optimize agricultural practices, monitor environmental conditions, enable higher performance and greater safety in automobiles, and enable advanced manufacturing practices.

To quote the US Secretary of Commerce in February of this year when introducing the National Network for Manufacturing Innovation program:

> *"Whether for disruptive innovation or incremental improvements of existing manufacturing, the value of advanced manufacturing is immense. The interplay of advanced manufacturing with products generates creative synergy: innovative products made possible by new technology often require equally innovative manufacturing methods; conversely, new manufacturing processes may be the key to commercializing a product design previously thought unrealizable".*[1]

All of the major players in advanced manufacturing are investing heavily and increasing the pace of innovation. A recent Deloitte study found that China is the most competitive manufacturing nation…for now. The USA is expected to take over the number one position from China by the end of the decade while Germany holds at number three. In the opinion of more than 500 senior manufacturing executives around the world **talent remains the number one driver of manufacturing competitiveness**. While all three North American countries are in the top 10 nations today and are expected to remain so five years from now, it is likely that competitiveness will also be directly correlated to the strength and robustness of collaborative networks and ecosystems. Analysis shows that high skills and technology intensive exports form a major portion of overall manufacturing exports from Germany, the USA, Japan, and the United Kingdom, which are the nations that have moved up in manufacturing competitiveness ranking since the start of the decade.[2]

Canada is projected to drop from 9th to 10th in Global Manufacturing Competitiveness by 2020, if the current trajectory continues. **There is an opportunity to reverse this trend.** The NDN addresses this challenge by making accessible to industry and academe otherwise unavailable micro-scale and nano-scale technologies, and related facilities and tools, to create the next wave of advanced technologies. The work fostered by this infrastructure contributes to value creation through the highly trained graduates who join companies in Canada, and through the companies themselves, as they engage markets globally with the benefit of increased understanding of the capabilities of competing

[1] *National Network for Manufacturing Innovation Program Annual Report*, Executive Office of the President National Science and Technology Council Advanced Manufacturing National Program Office, February 2016.

[2] *2016 Global Manufacturing Competitiveness Index*, Deloitte Touche Tohmatsu Limited (DTTL) Global Consumer & Industrial Products Industry Group and the Council on Competitiveness.

technologies. This builds on CMC's experience facilitating collaborations among universities, government, companies and not-for-profit organizations, to deliver benefit to Canada. It places great emphasis on partnering with other organizations or companies, nationally, and internationally with a shared vision of the importance of advanced manufacturing.

Connecting Student Researchers to Canada's Advanced Manufacturing Businesses

The NDN, a pan-Canadian public-private sector network operating in every province, is a collaboration among **62** post-secondary institutions, connecting **9100** academic participants with **850** companies to design, make and test microsystem prototypes. CMC is a federally incorporated not-for-profit corporation established in 1984 to create, develop and manage the NDN. In this capacity, CMC delivers core micro-nano innovation capability to every region. Engaging strategically with 40 supply sources in Canada and 50 more sources worldwide, CMC provides services to professors and their research teams in support of research excellence. It seeks to extend these services used by academics to companies in Canada, filling a major gap in the innovation system. CMC's five key services are:

- Microsystems design tools and methods
- Fabrication services to create working prototypes
- Equipment and services for product testing
- Microsystems training and support services
- Network management, including connecting and mentoring participants

Among several international organizations, CMC has provided strategic leadership for more than 10 years, most recently with the intensification of NDN research in photonics and advancing the use of Canada's considerable investments in nanofabrication laboratories. CMC convenes these organizations to discuss best practices and leads in the adoption of emerging technologies.

These activities support the Federal Innovation Agenda by producing talent for Canada's advanced manufacturing sector, helping create high quality jobs in Canada. Over the last five years more than 500 researchers joined industry annually, growing to 700 by 2015.

Addressing the Issue of Manufacturing Competitiveness

The NDN users in academe and their industrial collaborators, situated in all regions of Canada, experience lowered barriers to participation in research and innovation activities exploiting micro-nano technologies:

- **Awareness barrier** – CMC alerts researchers about emerging technologies and provides training, support materials and vital information about their feasibility of use in R&D. Users explore technologies, pool expertise, solve problems, and share solutions. The result is more readily usable technology and leads to a Canadian competitive advantage.
- **Access barrier** – R&D in micro and nanotechnologies involves complex software design tools, manufacturing technologies, specialized equipment and training. CMC partners to provide nationally and internationally-supplied technology not otherwise available to individual researchers. CMC ensures equipment, software and technologies work together allowing professors and their teams to focus on research rather than purchasing, licensing and installation. The techniques are scalable putting all of this within reach for small and large institutions in every region. Staff competencies support users with the means to develop their novel prototype, to demonstrate commercial potential, and to scale marketable developments to manufacturing volumes.

- **Affordability barrier** – Industrially-relevant technologies, particularly emerging technologies that will become part of future manufacturing, are not affordable to professors. CMC negotiates prices, pools demand, and coordinates the sharing of equipment and techniques to provide affordable access. Lowering these barriers stimulates universities and companies to work together to explore technologies, understand the risks and select technologies that will become essential to future manufacturing processes. In Client Satisfaction results gathered on behalf of CMC by SECOR KPMG in 2013, over 90% of professors reported that the NDN was "significant" or "vital" to their research. By reducing these costs, more researchers participate and use a wider range of technologies, and students graduate with exemplary qualifications— talent needed for advanced manufacturing business where demand tracks a long-term growth path.

What's at risk?

For Canada

- Risk of a decline in Canada's advanced manufacturing sector at a time when microsystems and nanotechnologies deliver an increasing proportion of product value.
- Diminished capacity to be part of global supply channels. Many other countries are increasing support for this sector with notable examples in the USA, Europe, China, Singapore and Taiwan.
- Recruitment challenges – diminishing ability to attract the best professors and researchers from within Canada or internationally to subjects relevant to the sector.
- Loss of opportunities to exploit a differentiating advantage for Canada resulting from 30 years of investment that continues to deliver and grow socio-economic benefits.

For CMC Microsystems

- Skills erosion as employees are attracted away from jobs of expert support for R&D.
- Reduced services and support to users (capability and capacity).
- Reduced ability to develop technology or paths to technology with global partners.
- Continuity of Canadian business connection knowledge and relationships is at risk.
- Continuity of international relationships and emerging technologies expertise is at risk.

For the National Design Network and Regions of Canada

At risk are thousands of current and planned research projects dependent on the platform of technologies, services and cost-effective support. The projects range from microelectronics research, to photonics, to mechatronics, to embedded systems that incorporate micro and nanotechnology devices producing novel applications. Without a new NDN funding arrangement by March 2017 whole lines of research and related relationships, developed over the span of careers, will need re-direction or will cease. The priority would be to assist current students to close projects on an orderly basis.

Putting this into perspective, we estimate that a potential future increment to GDP of no less than $200M over five years, driven by more than $2B of economic activity involving these hires would not be realized.

For the five-year period ending 2015, the replacement cost of delivered technology and expert support was estimated to be $132M based on use in 62 institutions. These users were extraordinarily productive, reporting over that period: 65 new companies launched, 2600 industrial projects attracting industrial resource support valued at $110M, 1000 patents awarded or applied for, 845 awards and 15000 technical publications.

With a more regional focus another way to view these results is as follows:

- West: 2550 researchers supported; 745 hired into industry in Canada; 760 industrial projects attracting industrial resource support valued at $26M; 335 patents awarded/requested.
- Ontario: 3850 researchers supported; 1245 hired into industry in Canada; 1110 industrial projects attracting industrial resource support valued at $50M; 415 patents awarded/requested.
- Québec: 2200 researchers supported; 700 hired into industry in Canada; 640 industrial projects attracting industrial resource support valued at $30M; 215 patents/requested.
- Atlantic: 400 researchers supported; 110 hired into industry in Canada; 90 industrial projects attracting industrial resource support valued at $4M; 35 patents awarded/requested.

For Canadian cities within these regions the results were equally impressive:

- Toronto: 1200 researchers supported; 380 hired into industry in Canada; 7 new companies supported; 375 industrial projects attracting industrial resource support valued at $19M; 120 patents awarded/requested; 130 awards and 1960 technical publications.
- Montréal: 1350 researchers supported; 505 hired into industry in Canada; 9 new companies supported; 430 industrial projects attracting industrial resource support valued at $19M; 155 patents awarded/requested; 125 awards and 2500 technical publications.
- Vancouver: 600 researchers supported; 150 hired into industry in Canada; 5 new companies supported; 210 industrial projects attracting industrial resource support valued at $6M; 80 patents awarded/requested; 50 awards and 1020 technical publications.

These results are remarkable. This regional intensity is made possible by national operations managed by CMC and linked globally to a range of technology suppliers and partners. The sophistication and complexity required to create a functioning ecosystem could not be duplicated locally. All of this is currently at risk for individuals, regions and Canada.

The NDN is not only a source of insightful well-trained people in demand by industry but it is also where new technologies are investigated. This means there is increased risk to industry—a loss of industrial attractiveness and competitiveness, diminished global interaction and the loss of CMC as an organization that connects together the collaborators, facilities and technologies central to R&D activities. Over the last 30 years the participants have delivered! Without a major financial partner there are few if any prospects to continue resourcing the NDN and stimulating the training, collaborations and technology exploitation opportunities.

Recommendations

Recommendation 1: Fund Base Operations of the NDN for Research Purposes

This will permit CMC to provide its five key services (Design, Make, Test, Train, and Manage) to connect 9100 academic participants in 62 post-secondary institutions with 850 companies and enable it to respond to the year-over-year growth in the user base which has led to a steady annual increase in economic, social and environmental benefits to Canada.

Recommendation 2: Fund an Extended NDN for Direct Use by Industry

This will increase use of the NDN by companies, with preferential arrangements for small and medium-sized enterprises and start-ups. These funds would assist in the commercialization of developments at a product demonstration stage.