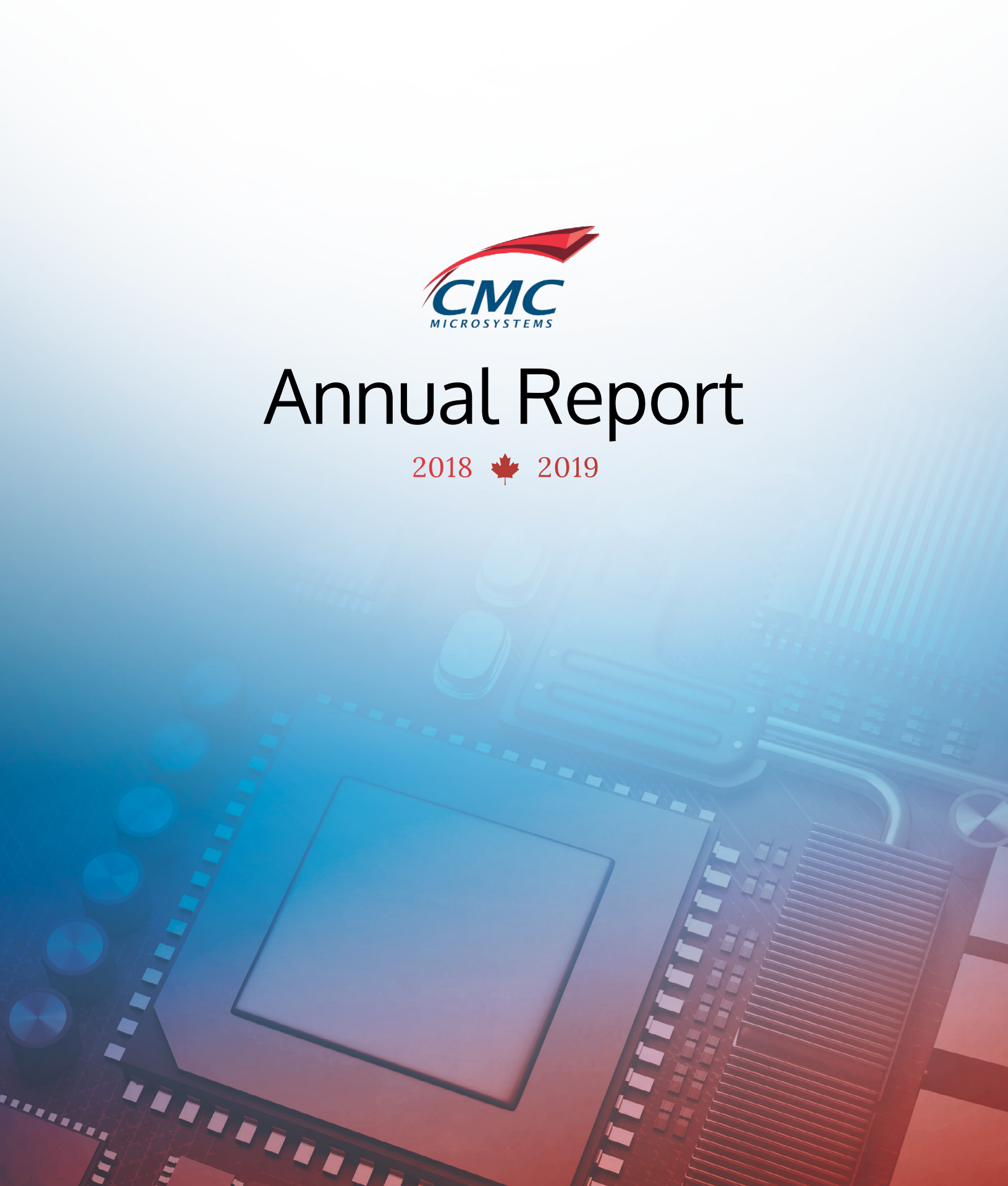
CMC MICROSYSTEMS

Annual Report

2018 2019



Canada's National Design Network® (CNDN) 2018-2019 milestones

New initiatives in support of globally competitive hardware innovation.

CMC awarded Government of Canada Innovation for Defence Excellence and Security (IDEaS) contract to develop novel machine learning platform for monitoring and interpreting aerial surveillance video and imaging. Network-wide release coming in 2019.

250 in attendance from industry and research institutions at annual syposium, **Innovation 360, co-hosted with NanoCanada.**

University of Northern British Columbia (UNBC) and Georgian College **join CNDN.**

14 new technology offerings delivered to users.

360 designs submitted to fabrication.

Explored international opportunities for nanotech SMEs and researchers with **NanoCanada's trade delegation** to Japan and South Korea.

Pilot initiative underway with **Cadence Design Systems and U.S. universities to provide access to leading-edge technology** through CMC's Cloud service.

Thank you to NSERC for 30 years of funding to build Canada's strength in micro-nano innovation.

Welcome to 75 professors using CNDN-provided tools & technologies for the first time.

Table of contents

Letter from the Chair and CEO

It has been a productive and exciting year for CMC and Canada's National Design Network (CNDN) with many improvements to our programs.

We are diversifying and simplifying our operations, growing our regional presence across Canada, expanding our software tool access to academic institutions internationally, and we are offering new services to industrial partners including contract R&D and expanded FAB services.

We have strengthened our collaborations by:

- engaging with Tanner, Luceda, and Advanced Micro Foundry (AMF) to provide commercial access to silicon photonics design and fabrication,
- completing our first research contract for the Department of Defence's Innovation for Defence Excellence and Security (IDEaS) Program, and
- welcoming new colleges and universities from across Canada to our membership.

We have reorganized the company into three logistical groups:

- CAD for deployment of academic software licenses that can be shared and accessed anywhere resulting in significant cost and IT resource savings
- FAB for cost-sharing and privileged access to state-of-the-art fabrication services world-wide in microelectronics, MEMS, and photonics (over 360 devices were fabricated this year)
- LAB for developing new technology platforms which can be deployed across the CNDN or for unique process or design requirements including contract research for industry

We have refined our domain expertise into three technical support groups:

- Microelectronics and MicroElectroMechanical Systems (MEMS)
- Photonics, Optics, and Quantum
- Embedded Computing (including AI and ML)

CMC is responding to client demand by developing technology platforms that lower R&D costs and enable innovation. This year we provided advanced CMOS design training in three cities with both academic and industrial participation. We released our Heterogeneous Computing Middleware Platform (HCMP) and gave seminars in Vancouver, Montreal, and Toronto attracting more than 90 participants from 15 universities and 20 companies.

Along with the many changes we are making our network grew by 75 professors and we completed a full schedule of more than 40 webinars, training courses, and site visits.

75 **new professors joined Canada's National Design Network**

CMC is streamlining processes and messaging – we offer research tools and services to our clients which they can access quickly and easily. We have enhanced our social media presence by more than 2,500 followers and we continue to communicate our new services through multiple channels.

CMC commissioned a third-party impact study from KPMG which shows that by strengthening R&D capacity, supporting the development of new businesses, and increasing the productivity of companies, Canada's National Design Network contributed $231M to the Canadian GDP over the 2013-17 period, while supporting 1,854 jobs.

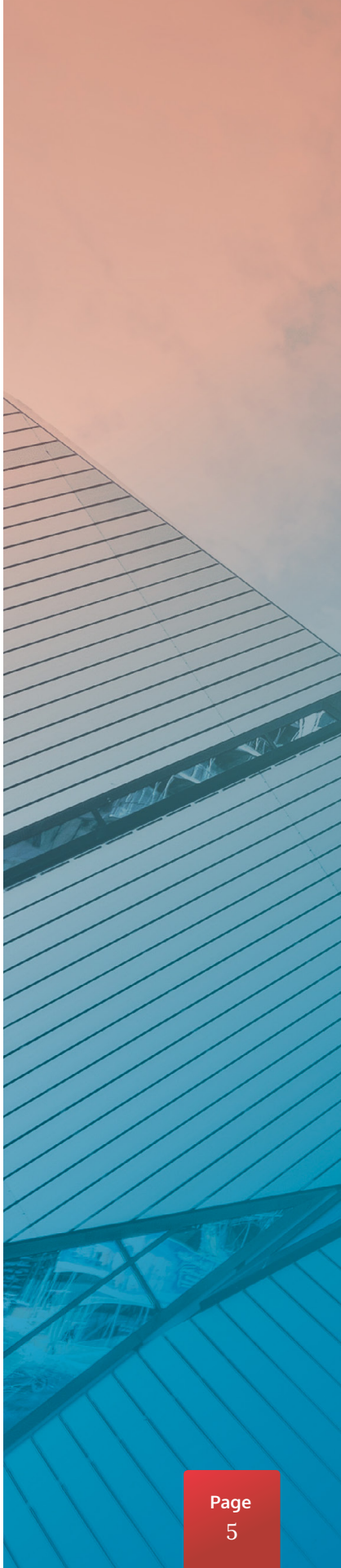
"We are pleased to continue to support microsystems research in Canada and to reduce the barriers to hardware innovation with a renewed organization and new energy!"

BOZENA KAMINSKA, PhD

Chair of the Board of Directors, CMC Microsystems

GORDON HARLING

President and CEO, CMC Microsystems



Technology direction

New R&D capabilities - keeping researchers in Canada at the leading edge

- **CMC partners with Advanced Micro Foundry** to develop a new design automation platform for silicon photonics with a value-add process design kit (PDK) enabling unprecedented first-time-right design of more complex systems.
- **CMC partners with 3IT.Nano** for fabrication of open-gate silicon junction field effect transistors. Devices are delivered with open upper gates so that users can deposit functional materials to create high-performance sensors of all kinds.
- **CMC collaborates with Synopsys** to bring ASIP Designer, the leading toolset for accelerating the design of specialized processors found in most modern Systems on Chip (SoCs), to Canadian universities.
- **CMC partners with Micralyne** to develop a solution to manufacture interposer-based modules incorporating semiconductor wafers with Through Silicon Vias (TSVs).
- **CMC collaborates with industry and academic partners** to deliver a series of Advanced CMOS Workshops to discuss future directions in the semiconductor industry and skill requirements for Canadian competitiveness and deliver hands-on training for designing into advanced technology nodes.

Advanced CMOS Workshop, Dec. 2018

"Thanks to CMC providing affordable access to prototype fabrication for generations of graduate students, Canadian companies have enjoyed a strong edge in hiring new grads with real design experience. In the sub 28nm technologies the design and layout challenges are much greater. I welcome this initiative to equip the next generation with the knowledge and skills to address these challenges and produce the talent that companies like AlphaWave will need to thrive."

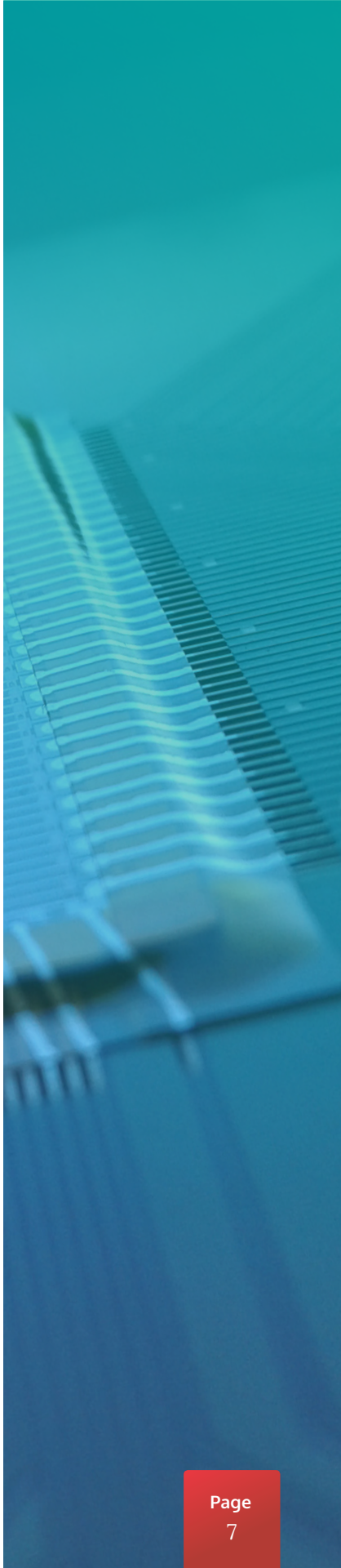
– TONY PIALIS, FOUNDER OF ALPHAWAVE IP

CNDN Technology Roadmap

In June 2018, we released an update to our Technology Roadmap following extensive stakeholder consultations. It includes several important signals about CNDN technology direction, including:

Extending the horizon through 2022

- The emergence of AI and machine learning as a prime force for driving new technologies, architectures, and methods. Much of this hardware will have to be embedded in devices at the edge of the internet.
- Increased emphasis on photonic-microelectronics integration technologies, silicon germanium (SiGe) and CMOS-opto technologies (single-photon sensitive detectors).
- Support for quantum research at the intersection of photonics, microelectronics, nanofabrication, and packaging technologies.
- An opportunity to broaden our product offering through delivery of new CAD/TCAD tool options.
- Reinforced need for more hands-on training, for example, in advanced microelectronic technology design including FinFET layout.



Our Board of Directors

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NSERC Observer (until March 31, 2019)

Dr. Douglas Colton
Director Emeritus

Ms. Nancy A. Marlow
Officer of the Corporation

Thanks to our funders!

Government of Canada

Canada Foundation for Innovation (CFI) Major Science Initiatives (MSI) program

- Major Research Facility: Canada's National Design Network

CFI Innovation Fund infrastructure projects

- ADEPT - Advanced Design Leading to Manufacturing in Micro-Nano Technologies
- emSYSCAN - Embedded Systems Canada

- Canada's National Design Network (1984-2019)

Provincial Funding Partners

Government of British Columbia

- Ministry of Jobs, Trade and Technology, British Columbia Knowledge Development

Government of Alberta

- Ministry of Advanced Education, Alberta Research and Innovation

Government of Manitoba

- Ministry of Growth, Enterprise and Trade, Manitoba Research and Innovation

Government of Saskatchewan

- Ministry of Advanced Education, Innovation Saskatchewan

Government of Ontario

- Ministry of Economic Development, Job Creation and Trade, Ontario Research Fund: Research Infrastructure

Gouvernement du Québec

- Ministère de l'Éducation et de l'Enseignement supérieur

Government of New Brunswick

- Ministry of Economic Development and Small Business, Opportunities New Brunswick

New Brunswick Innovation Foundation

Government of Nova Scotia

- Labour and Advanced Education, Research Nova Scotia Trust

Government of Newfoundland and Labrador

- Tourism, Culture, Industry and Innovation, Research and Development Corporation: Innovate NL

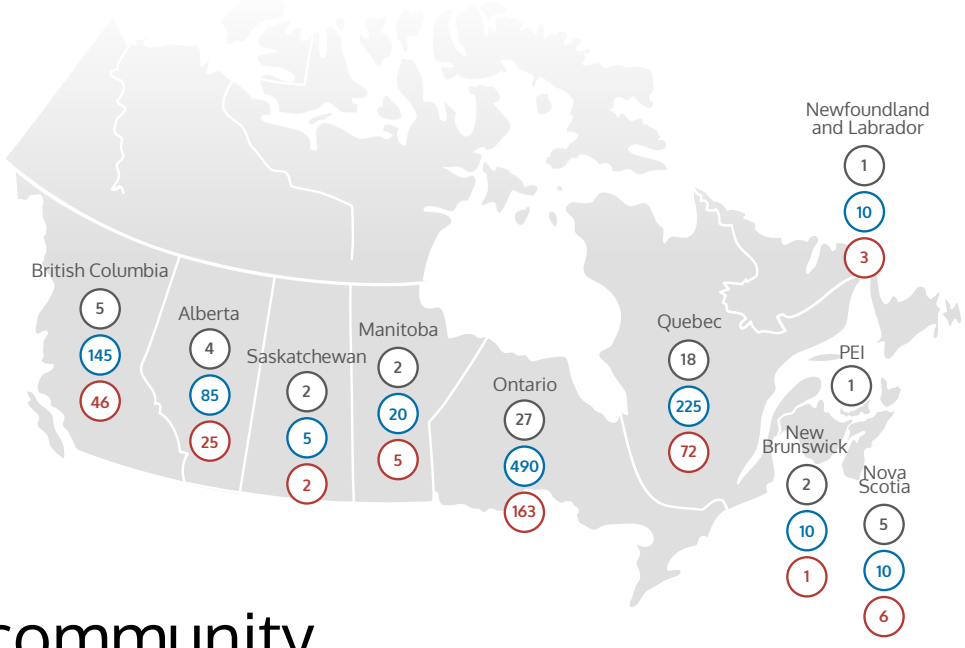
By the numbers

Canada's National Design Network

A national community of 10,000 academic participants and 1,000 companies developing innovations in micro-nanotechnologies. CMC manages CNDN.

CMC Connects:

- Post-secondary institutions
- Collaborating companies
- Companies manufacturing micro-nanosystems products in Canada



A growing community

More than 10,000 users, including:

1,250
professors including 150 research chairs

3,395
graduate students

400
post-doctoral fellows

280
research staff

4,715
undergrads

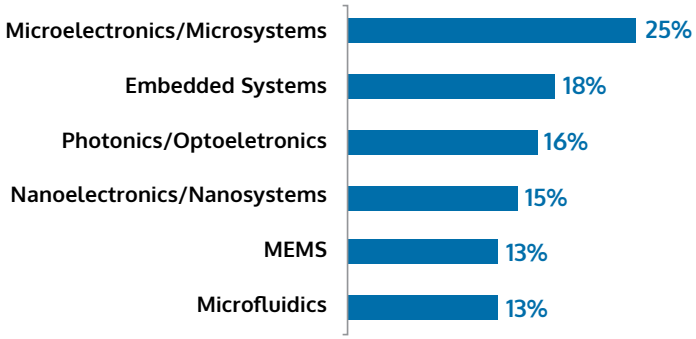
60
college students

An increasing base of companies and academics outside Canada directly used CNDN services

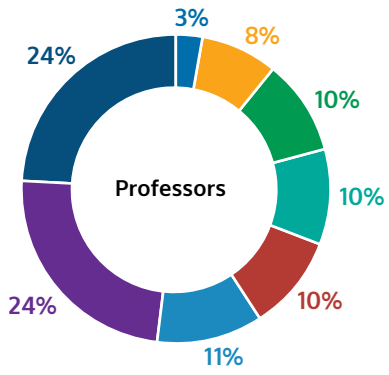
By the numbers

Research interests

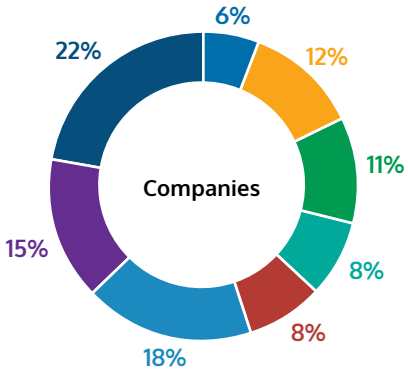
Users' research interests are in a wide range of technology domains.



User application areas target all economic sectors



Collaborating companies work in all sectors



- Agri-food
- Environment
- Auto. / Transportation
- Defence, Security
- Aerospace
- Nat. Resources, Energy
- Health, Biomed
- ICT industries

By the numbers

Industrially relevant research

A strong national network delivering globally competitive, industrially relevant research and innovation.

Research excellence

3,655
publications

165
national and international awards

Industrial impact

40
licensed technologies

225
patents (applied for/issued)

785
HQP moved to industry in Canada

20
startups

By the numbers

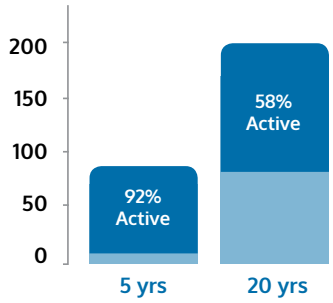
Startups

Startups enabled by CNDN deliver lasting economic impact through revenue, jobs, and R&D spending in Canada

26% would not have been launched without access to CNDN

32% would have taken much longer to launch

21% would have launched but would not have been as successful



Economic Contribution of CMC Microsystems, 2013-2017. Montréal: KPMG, 2018

Trained HQP

415
graduate courses

540
undergraduate courses

Collaborative initiatives

555
collaborations with industry valued at $33M

530
inter-university collaborations in Canada and abroad

125 collaborations with government and not-for-profit organizations

CAD - FAB - LAB

From idea to manufacturable prototype

CAD

High-performance Computer Aided Design tools and environments for successful design from over 25 vendors

- **560 CAD tools and modules** available via desktop or through CMC Cloud
- **6,200 users**
- **420 user guides, application notes, training materials and courses**
- **10 training courses and events**
- **20 webinars**

FAB

Multi-project wafer services, value-added packaging & assembly services and in-house expertise for first-time-right prototypes

- **25 technology runs** through **9 foundries worldwide**
- **360 designs fabricated**
  - 185 were fabricated through CMC's global network of industry-scale fabrication foundries
  - 175 were developed through Canada's MNT network of 40 university-based labs

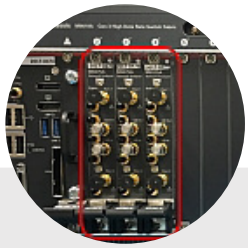
LAB

Device validation to system demonstration

- **675 programmable development systems**
- **80 pieces of test equipment for rent**
- Online support system with over **2000 cases closed annually**

Examples of new additions to support novel R&D

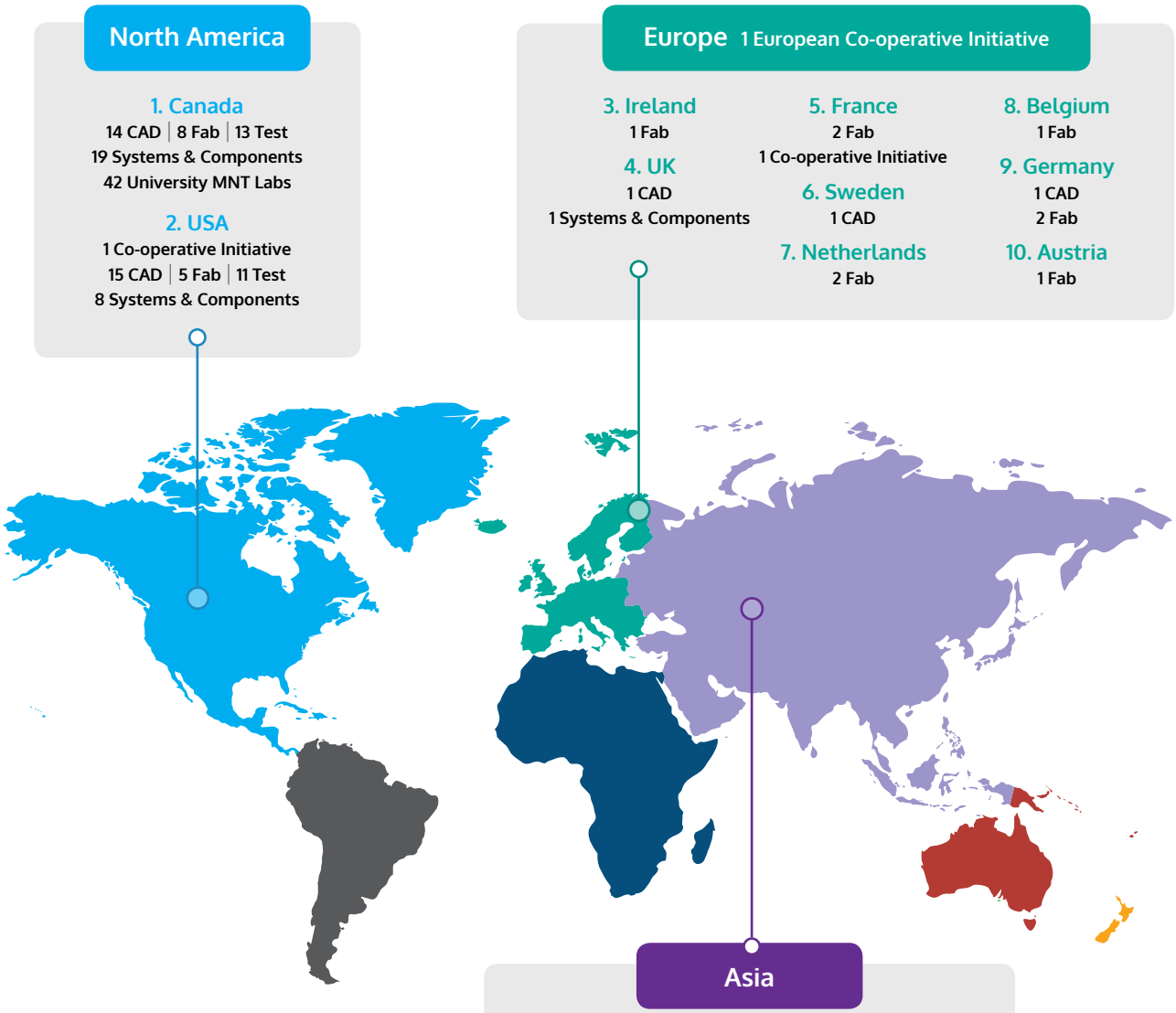
- Heterogeneous cloud/edge computing platform for machine learning (demonstrator)
- Flip-chip assembly for full 2.5D integration
- CAD tools including Luceda and Synopsys ASIP Designer plus dozens of version updates and new modules
- SDAccel platform with a Kintex® UltraScale™ KCU1500 FPGA via CMC Cloud
- Tektronix RSA507A 7.5GHz Portable Real Time Spectrum Analyzer
- Materials Measurement Suite & Dielectric Probe Kit
- PXIe-based 26GHz Vector Signal Analyzer
- NoiseTech Microwave Impedance Generator IG0160C 0.1MHz to 6GHz
- Xilinx ZCU102 Zynq Ultrascale+ MPSoC development boards
- TensorFlow machine learning framework
- Machine learning reference design targeting Xilinx FPGA
- Xperidesk nanofabrication process design environment



Xilinx training, Oct. 2018

Global partners

CNDN's worldwide industrial supply chain - supporting research excellence



International relationships

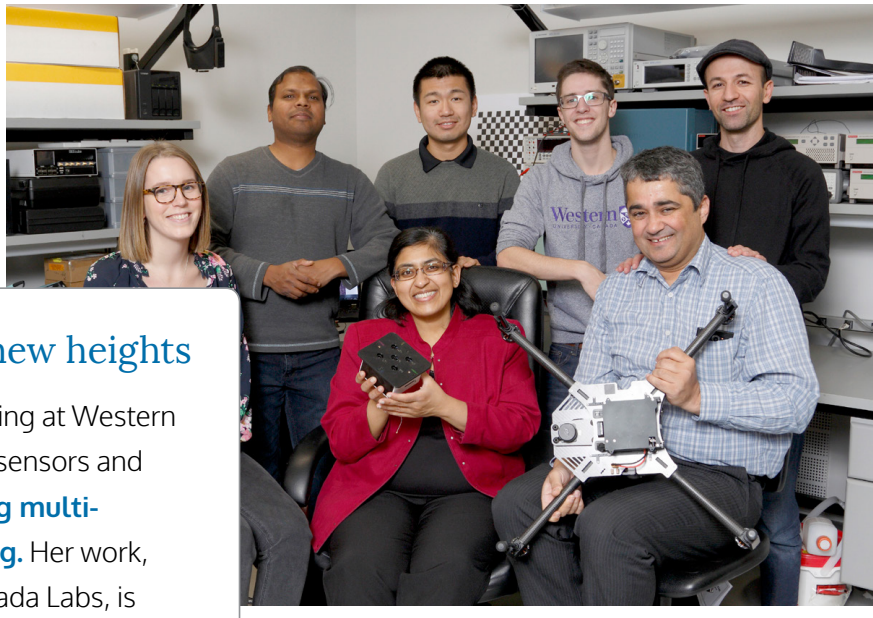
CMC convenes international peer organizations annually to exchange insights, gauge progress, and initiate joint projects on technologies.

- **TSRI** - Taiwan Semiconductor Research Institute **(TAIWAN)** (formerly CIC - National Chip Implementation Center)
- **CMP** - Circuits Multi-Projets **(FRANCE)**
- **EUROPRACTICE**
- **IDEC** - Integrated Circuit Design Education Centre **(S. KOREA)**
- **MOSIS (US)**
- **VDEC** - VLSI Design and Education Center **(JAPAN)**

Memberships

CMC facilitates R&D collaboration through membership in strategically aligned organizations:

Success stories



Seeing modern agriculture from new heights

Dr. Jayshri Sabarinathan, professor of engineering at Western University, has used her experience with microsensors and nanofabrication to develop **higher-performing multi-spectral cameras for agricultural monitoring.** Her work, in collaboration with industry partner A&L Canada Labs, is making crop data-collection even more effective.

Nano-micro electrode opens new frontiers in brain research

A nano-edge microelectrode developed by Drs. Colin Dalton and Pierre Wijdenes, University of Calgary, is opening **frontiers in brain research.** The electrode is showing exciting early potential in understanding and treating neurological diseases such as Parkinson's disease or epilepsy, and forms the basis of a new startup company, Neuraura.

"There are a lot of people out there who have got some great ideas but they can't access the equipment they need. CMC is helping leverage what's actually out there in universities."

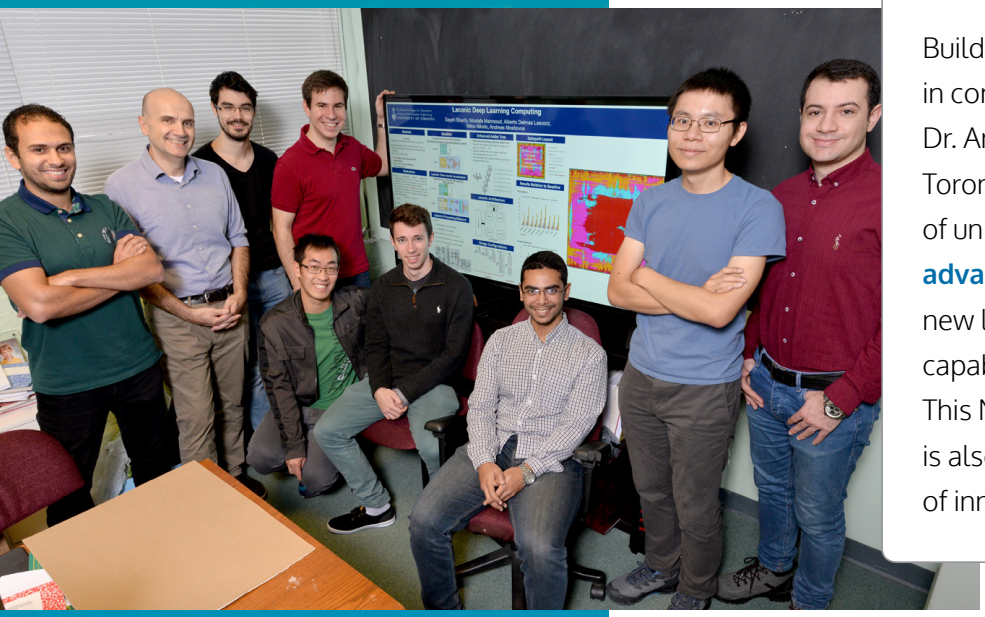
– DR. COLIN DALTON

"The training has enabled my students to find jobs in a broad range of industries."

– DR. WALIED MOUSSA

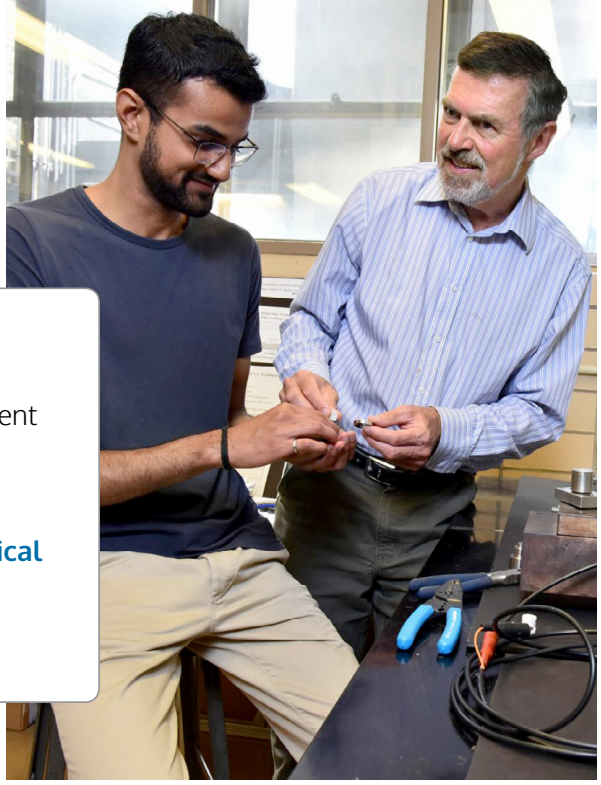
Unlocking the power of 3D touch

University of Alberta professor Dr. Walied Moussa and graduate student Shichao Yue have developed a **"Real Touch" 3D sensor array** that can measure the full range of forces on a surface with unprecedented sensitivity. **NEMSOR**, a U of A spinoff company, is now developing this technology for a variety of applications.



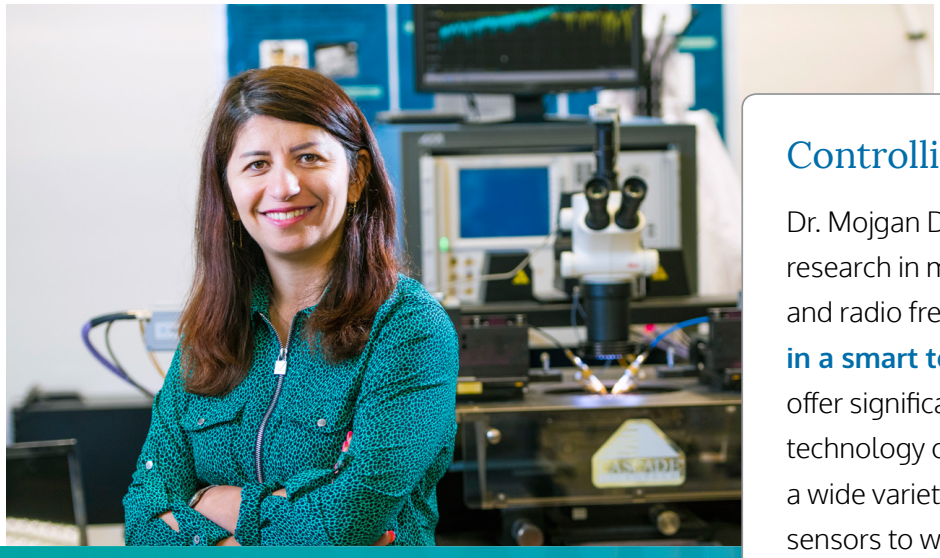
Deep learning, big impact

Building on his ground-breaking work in computer hardware innovation, Dr. Andreas Moshovos of University of Toronto is leading a national network of university researchers focused on **advancing machine learning** into new levels of function akin to human capabilities of hearing, sensing or reading. This NSERC-funded network, COHESA, is also building Canada's next generation of innovators.



Breaking (ultra)sound barriers

Dr. Tony Sinclair, University of Toronto, and Masters student Neelesh Bhadwal, work with business partners on ways to improve the precision and reliability of non-destructive ultrasonic imaging used to **monitor the integrity of critical infrastructure,** from manufacturing facilities to nuclear power plants.



Controlling waves with MEMS

Dr. Mojgan Daneshmand's award-winning research in micro-electromechanical systems and radio frequency is **advancing innovations in a smart technologies.** Her sensors offer significant advancement over current technology on the market and hold promise for a wide variety of products, from environmental sensors to wearable health monitors.

"CMC's funding support for our nanofabrication enabled us to make our millimetre-wave devices, and it gave my students valuable training at our university's nanoFAB lab."

– DR. MOJGAN DANESHMAND

"CMC has provided access to fabrication and design tools at a reasonable cost. Without this we would be nowhere."

– DR. BRENDAN CROWLEY

A new approach to an old cure

Drs. Brendan Crowley and Enver Kilinc, founders of **Micromensio**, worked with University of Toronto researchers to develop a **low-cost, rapid sensing technology that targets infections using natural antibiotics** called bacteriophages. Their platform has attracted the interest of companies looking to address antibiotic resistance through the use of phages.

Taking power conversion to a new level

A novel power converter developed by Queen's University PhD candidate Marko Krstic under the supervision of Dr. Praveen Jain, Canada Research Chair in Power Electronics, offers significantly higher efficiency than commercially available chips. Applications include mobile devices, electronics, and ultra-efficient solar panels.

Celebrating innovation

The Douglas R. Colton Medal for Research Excellence

Recognizing substantive microsystems or nanotechnology contributions

Dr. Alphonsus Ng was recognized for his new applications of digital microfluidics, in which electrical fields are used to manipulate microscopic droplets of water. This process, which enables researchers to observe and understand the complex workings inside cells, enabled Dr. Ng to develop ground-breaking technologies with global applications in the fields of disease detection and analysis.

TEXPO 2018

Recognizing novel research with industrial relevances

Congratulations to our award winners!

Industrial Collaboration Award

Hardware-Accelerated DNA Sequencing

Zhongpan Wu & Karim Hammad, York University (supervisor Dr. Sebastian Magierowski) **Sponsored by Teledyne DALSA**

Brian L. Barge Award for Microsystems Integration

BRAIN: Bidirectional Rail-to-Rail Artifact-Insensitive Neural-interface

M. Reza Pazhouhandeh, University of Toronto (supervisor Dr. Roman Genov)

Sponsored by CMC Microsystems

Award for Excellence in Nanofabrication

PolyCMUTs: Plastics Transducers for Ultrasound Imaging

Carlos Gerardo, University of British Columbia (supervisor Dr. Edmond Cretu) **Sponsored by Raith America, Inc.**

Micro-Nanosystems Design Award

A 65nm Compact High-Performance Fully Synthesizable Clock Multiplier Based on an Injection Ring Oscillator

Nahla Abouelkheir, University of Ottawa (supervisors Dr. Ralph Mason, Carleton University and Dr. Mustapha C.E. Yagoub, University of Ottawa)

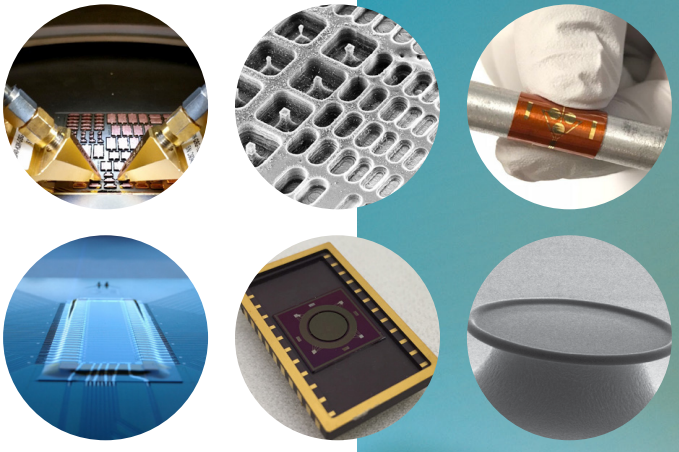
Sponsored by Huawei Technologies Canada

Community involvement

Thank you for your assistance!

Over the past year, hundreds of people and organizations rallied in support of CMC and its role in providing vital R&D infrastructure and services to Canada's National Design Network, and helping our innovators enhance Canada's global competitiveness.

An overwhelming response!



Researchers from across Canada proudly shared images of their innovative design as we celebrated the 500th MNT lab prototype enabled. Canada's university-based MNT labs are an outstanding resource for technology developers and we support our users as they leverage the advanced R&D capabilities that these facilities offer.

Showing our support for the next generation of innovators!

CMC and its staff are long time supporters of the Frontenac, Lennox and Addington Science Fair. This popular annual event provides an opportunity for students in the Kingston, Ontario region to showcase their knowledge, talents and ingenuity in science, engineering, and technology.

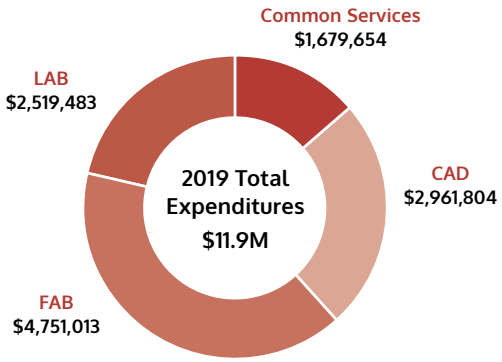
Annual Symposium

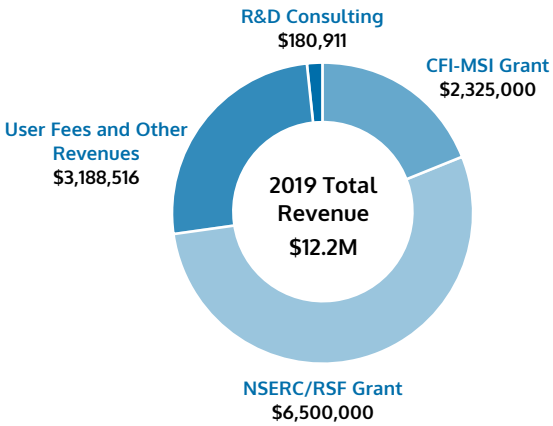
NanoTEC for Smart Communities was this year's theme at Innovation 360, the largest annual gathering of micro-nano innovators from industry and research institutions in Canada. Keynotes and panel discussions addressed: smart vehicles, health, supercluster opportunities, connectivity, and energy.

Financial summary

CMC is able to achieve its mission through support from several financial stakeholders. In 2019, total revenues of $12.2 million came from a variety of sources including federal government grants, user fees, contract management services, and R&D consulting. In 2019, NSERC/RSF funding concluded and CMC is transitioning to CFI's Major Science Initiatives (MSI) program. The current three-year MSI grant ends in 2020 and funding will increase from $2.3 million in 2019 to $7.9 million in year three. CMC also continues to earn contract management revenues by delivering and implementing CFI-funded infrastructure projects (emSYSCAN and ADEPT).

Total expenditures of $11.9 million are significantly higher than prior years as CMC capitalized on the final year of NSERC funding through increased CAD, FAB, and LAB activity. Current year operations resulted in a modest surplus, which will be reinvested in the CNDN.





Statement of Financial Position as at March 31, 2019

Assets	2019	2018
Current Assets	6,749,215	7,437,869
Long-term Assets	502,992	584,236
	$7,252,207	**$8,022,105**

Liabilities & Net Assets	2019	2018
Current Liabilities	1,466,893	2,519,264
Net Assets	5,785,314	5,502,841
	$7,252,207	**$8,022,105**

Statement of Revenue & Expenditure for Year Ended March 31, 2019

Operations	2019	2018
Revenues	12,194,428	11,514,960
Expenditures	11,911,955	10,501,556
	$282,473	**$1,013,404**

www.cmc.ca/Corporate-Reports
for our complete audited financial statements

Let's Connect!

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