Annual Report

2021 🍁 2022



New initiatives in support of globally competitive hardware innovation.

Milestones



More than 400 semiconductor prototypes submitted to fabrication, including a record 158 photonics designs in support of this globally recognized Canadian strength.



66 professors and 1,900 researchers and students were first time users of services.



Industrial and international academic user base grew 45% in one year.

Welcome to our newest members





Sheridan



Entered into 4 strategic agreements with suppliers developing quantum computers so as to offer **qubit programming and design services** to researchers.

Developed new photonics fabrication service with Applied Nanotools Inc. (Alberta) to specifically leverage Canadian strength in this technology. Expansion across Canada, strengthening our national scope. With our team of quantum experts located in Sherbrooke, Quebec and a national distribution with employees newly based in Edmonton, Alberta and Halifax, Nova Scotia, CMC has a closer connection to clients, users and suppliers.

CMC's Virtual Incubator Environment (VIE) program showed nearly 50% growth in its second year – supporting 17 start-ups in Canada.



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Joint letter from the Chair of the Board & CEO

CMC has been making careful strategic decisions about which emerging technologies to focus on. 2021-2022 saw CMC deliver expanded services to grow our five core technologies:

- Microelectronics
- Photonics
- Micro-Electro-Mechanical Systems (MEMS)
- IoT & Edge AI
- Quantum

These are a blend of technologies where CMC has decades of experience, and others where we are consolidating our expertise and establishing our leadership in Canada, and across the world.

Despite a turbulent year in the semiconductor industry, CMC had its best performance in over a decade delivering chips and wafers for more than 400 designs through our global network of manufacturing facilities.



This includes manufacturing of almost 160 photonic designs – double from the previous year, seven superconducting designs – a world first via a multi-project wafer service, and 80 designs manufactured for industrial and academic clients outside of Canada.

This highlights a few points. First, we have an excellent established network of partners and suppliers across the global supply chain. Next, we are servicing areas of the digital economy that are on the bleeding edge of technology. CMC is not waiting for this disruptive shift to happen. We are right there at the front of the curve, ready to help Canada's brightest innovators and train the skilled personnel needed for specialized high-growth areas of the economy to thrive.

This is a testament to CMC's excellence in CAD, FAB, and LAB services, but more importantly, to the strength of the entire Canadian innovation ecosystem. We are proud to be a part of it and look forward to driving growth and helping shape the next generation of innovation excellence in Canada.

Thanks for taking the time to learn more about CMC.



Ian Roane Chair of the Board of Directors CMC Microsystems



Gordon Harling President and Chief Executive Officer CMC Microsystems

Technology and Strategic Direction

CMC's strategic direction aims to maximize impact on Canadian research, innovation and growth of Canada's digital economy.

Foundational **Technologies**

CMC's technology drivers fueling Canada's strategic sectors are underpinned by:



MEMS, Nanofabrication & Integration



Microelectronics







Photonics



Our Guiding Principle Benefits to Canada

Microchip (chip) technologies are critical in Canada's technology ecosystem. Academic and industrial innovators rely on these foundational technologies for applications in Industry 4.0, autonomous vehicles, big data, Internet of Things (IoT), cyber defence/security, 5G network, quantum computing, artificial intelligence (AI) and more.



Microelectronics

Leading-edge microelectronics technology is critical to researchers. The semiconductor industry is moving toward a "silicon to services" model that spans from data centre to mobile edge applications, with AI integrated in every aspect from product development to service delivery.

CMC will enable affordable access through our established Multi-Project Wafer (MPW) model and our deep partnerships with world class suppliers and foundries.

Our channel partnership with GlobalFoundries[®] (GF) is an example of how we allow Canadian innovators to compete in this space.

Photonics

Photonics is a systems-enabling technology widely used in modern functionality ranging from data transmission to sensing for the data centre and telecom industry.

The trend toward higher levels of integration naturally favours the adoption of silicon photonics. CMC will enable more technology integration with a strong emphasis on putting more photonic functionality onto each chip, integrating photonics with other technologies, such as microelectronics. CMC services include fabrication access to silicon photonics platforms for chip-level monolithic integration, methodologies for scalable integrated photonics design, and training in the design, fabrication and testing of photonic integrated circuits.



SELECTED MICROELECTRONICS R&D PROJECTS



✓ ThinkRF – RF design



SELECTED PHOTONICS R&D PROJECTS

- ✓ IBM polymer connector
- ⊘ AMF toolkit design
- Post MEMS processing for photonics
- ⊘ Optical Logic Gate

MEMS, Nanofabrication and Integration

Microelectromechanical systems (MEMS) and sensors are gaining popularity across the entire advanced technology ecosystem. Improvements in accuracy, reliability and miniaturization have seen MEMS devices integrated into applications from wearables and IoT-connected devices right through to Industry 4.0 applications in the automotive sector.

Two MEMS foundries, Teledyne MEMS and Applied Nanotools (ANT), and centres for pilot fabrication, packaging, and system development are located in Canada. By leveraging our relationships within this rich ecosystem, we lower barriers for Canadian innovators to excel in this sector, which shows no signs of slowing down.

SELECTED MEMS, NANOFABRICATION AND INTEGRATION R&D PROJECTS

- Ø Interposer MPW
- Selectronic Sensor Platforms (ESP) for
 - Microfluidic integration
 - 3D printed package
 - COVID-19 sensor
- ✓ Protopak 3D packages

IoT & Edge AI

The rise of the Internet of Things (IoT), artificial intelligence (AI) and machine learning (ML), and 5G have driven demand for power-efficient, secure computing at the network edge. Applications such as wearables, biomedical monitoring, autonomous driving and precision agriculture are producing an unprecedented amount of data from sensors. This growth in data, together with the exponential increase in AI/ML complexity, are spurring a need for new computing architectures and system integration technologies.



- RISC-V DNA sequencing accelerator
- RISC-V hardware accelerator for machine learning
- ✓ CORE-V SoC
- ✓ IoT Swiftmote sensor platform
- Atlas 800 server deployment
- Atlas 200 dev kit deployment
- Oeeplite AI optimizer

Quantum

Interest in quantum computing is exploding, powered by significant increases in investment and technological breakthroughs. Industrial applications are almost limitless, with the pharmaceutical and financial services industries being early adopters.

CMC's strategy is to democratize access to state-ofthe-art quantum hardware and software technologies.

CMC's new Quantum Computing as a Service now allows Canadian researchers to access IBM's and Xanadu's state-of-the-art quantum computers, supported by our team of quantum programming experts.

On the hardware side, we are lowering barriers by providing access to quantum MPW services. We are proud to have offered the world's first MPW run to fabricate superconducting devices. This is a crucial step to accelerate innovation in this emerging space. SELECTED QUANTUM R&D PROJECTS

- IBM Quantum academic projects (13)
- Quantum computing for transcriptome analysis and functional imaging
- IBM Quantum training of Artificial Neural Networks
- \bigcirc MPW for superconducting circuits
- Quantum entanglement between photonic integrated circuits

Success Stories

A Quantum Leap in Cybersecurity

Mathematician Anne Broadbent, cryptographer Carlisle Adams and software engineering student Sherry Wang, of the University of Ottawa, joined forces to protect password authentication in a quantum age.

Websites have a file that holds cryptographically protected fingerprints of passwords for all users who login. This file is the target for attackers and cybercriminals.

"Quantum computers are an experimental technology and careful configuration is needed to avoid and mitigate errors. CMC provided excellent advice and helped us extract useful results."

- Dr. Anne Broadbent, PhD

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If attackers have access to quantum computers, quantum copy protection could prevent them from being able to duplicate these valuable files.

As a founding member of the IBM Quantum Hub at Université de Sherbrooke's Institut quantique, CMC provided access to IBM's most advanced quantum computing systems. CMC quantum programmers then refined methodology to test the team's approach to quantum copy-protectionan approach preventing adversaries from making copies of existing quantum software.

Board of Directors

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Officers of the Corporation

David Lynch Vice-President, Technology Peter A. Stokes Secretary Marie Thiele Treasurer

Thanks to Our Funders!

Major Partners





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

Major Research Facility: Canada's National Design Network

Québec 🕈 🛣



CFI Innovation Fund Infrastructure Projects

ADEPT - Advanced Design Leading to Manufacturing in Micro-Nano Technologies

Provincial Funding Partners

Government of Alberta Government of British Columbia Government of Manitoba Government of New Brunswick Government of Newfoundland and Labrador Government of Nova Scotia Government of Ontario

"CMC has decades of experience and expertise working with researchers and institutions across the country. By bringing together industry and research leaders, we can accelerate IoT growth in Canada."

Michel Langelier, President and CEO of AloT Canada

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By the Numbers

A Growing Research Community

A national network of 10,000 academic participants and 1,000 companies developing innovations in micro-nanotechnologies.

Collaborative Initiatives



Developing Semiconductor Skills Needed in Canada





Success Stories

Sensors Headed to the Moon

Behraad Bahreyni's quest for the moon began with a project that took him in the opposite direction – the depths of the Atlantic Ocean.

"My group uses virtually every service CMC provides. We receive all sorts of CAD tools for designing and testing equipment. We send students to training courses by CMC. We submit chip designs for the foundry services and do parts of fabrication through CMC. We then test these devices using the equipment borrowed from CMC. This is a great institution, and we are really grateful." - Dr. Behraad Bahreyni

In 2018, Ultra Electronics Maritime Systems in Halifax asked the Simon Fraser University engineer for help: The company wanted a better way to detect underwater threats. They asked if it would be possible to replace hydrophones– microphones that detect sound waves under



water – with accelerometers that could detect the forces produced by sonar signals.

That success inspired the team to look for new applications for the more sensitive accelerometer on land – and now in space.

In May, the Canadian Space Agency chose the team to provide miniaturized instruments for a rover that will conduct high-resolution studies of the lunar subsurface in the polar region of the Moon.

The team is also training eight postgraduate researchers to strengthen Canada's talent pool in technologies that can be used in space.

In 2021-2022 CMC Delivered:

✓ 17 training courses including four highly-specialized, intensive CMC Basecamp[™] training courses delivered to almost 350 participants.

WORLD FIRST training on the entire Design-Fabricate-Test cycle of superconducting devices used in quantum computer hardware



In partnership with the NSERC CREATE programs of Quantum BC and QSciTech, 25 trainees implemented their own superconducting designs.



Participants tested their chips at their home institution or used cryogenic equipment at the Quantum FabLab at L'Institut quantique de l'Université de Sherbrooke.



Trainees interacted with experts from Canada and used CMCprovided design tools to submit designs for fabrication by STAR Cryoelectronics.

- ✓ Active Silicon Photonics Fabrication Course
- Passive Silicon Photonics Fabrication Course
- Analog/Mixed-Signal Design Methodology and FinFET Layout Training

These courses provide a unique combination of theory and lab work and a trainee experiences the entire design/fabrication/test cycle of their very own microchip.



Industrial Impact

Geared for Growth: Path to Commercialization for Academic Research



Success Stories

Using Microfluidics to Help Breast Cancer Survivors Heal and Recover

"Thanks to CMC's CADpass, we have access to COMSOL, SOLIDWORKS and Altium that we use on a daily basis to improve our microfluidic systems." - Dr. Carolyn Ren



Dr. Carolyn Ren (left) and Run Ze Gao (right)

Dr. Carolyn Ren and Run Ze Gao have developed a wearable, next generation pneumatic massage sleeve for patients with breast cancer-related lymphedema, which is caused by accumulation of fluid in the arm. The condition is often chronic and affects more than 50 per cent of breast cancer survivors who had lymph nodes removed or damaged in their breast cancer treatment. Ren and Gao's goal was to develop a lighter, portable, cheaper and more effective active pneumatic massage sleeve that the patients would be comfortable wearing and could use on the go.

To commercialize the prototype, Gao and Ren founded a start-up, Air Microfluidic Systems. They won \$50,000 in the Falcons' Fortunes pitch competition for cancer innovations hosted by FACIT, the gateway to the cancer research pipeline in Ontario.

Serving Industrial and International Customers

31 Industrial Users 50% Growth from Previous Year



41 International Academic Users 40% Growth from Previous Year

More than 70 designs from over 25 organizations were fabricated in 2021-22. CMC's prototyping services attract industrial and international customers, helping to make MPW runs more affordable and frequent for Canadians.

17 early-stage Canadian start-ups used CMC's Virtual Incubator Environment (VIE) to access design tools for their R&D projects. There are now eight CAD tool suppliers taking part in the program to make their tools accessible to entrepreneurs.





Six U.S. universities and industry clients used Cadence design tools hosted in the CMC cloud as part of CMC's arrangement as a Cadence Passport Partner.



Attracting global interest from users in: Australia, Brazil, China, Denmark, England, Germany, Hong Kong, India, Ireland, Italy, Japan, Mexico, Netherlands, Russia, Taiwan, Turkey, UAE, Uruguay, and the U.S.A.

Capability to Keep Researchers at the Leading-Edge

CAD

High-performance Computer Aided Design (CAD) tools and environments for successful design from over 20 vendors

- 35 CAD tool suites available via desktop or through CMC Cloud
- √ 7,445 users
- 310 user guides, design flows, and training materials
- ✓ 20 training courses and events
- ✓ 15 webinars

FAB

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

- 🎸 65 technology runs through eight foundries worldwide
- 410 designs fabricated
 - Almost 160 photonic designs double from the previous year
 - Over 140 microelectronics designs manufactured in advanced semiconductor technologies
 - Over 80 designs fabricated or post-processed in laboratories
 - Over 40 MEMS and microfluidics designs

LAB

Device validation to system demonstration

- 680 programmable development systems
- 80 pieces of test equipment for rent
- Online support system with more than 2,200 cases closed annually
- ✓ RISC-V processor design & prototyping
- Sensor Platform (ESP)
- SwiftMote Sensor Platform (wireless sensor)
- 8 PetaFLOP Atlas 800 AI training server installed at the University of Waterloo to accelerate research projects

A Value Chain for Key Economic Sectors

Global Partners

CMC's advanced technology supply chain enables internationally competitive research and innovation.



A Thriving Advanced Technology Supply Chain in Canada

CMC is Building Capability in Canada and is Proud to Play a Vital Role in the Thriving Canadian Ecosystem

>50%

of supply chain vendors are Canadian firms.

A National Supply Chain of >50 Organizations, for example:

CAD

- Crosslight Software
- O Design Workshop Technologies
- Javelin Technologies (Solidworks)
- ✓ Nanoacademic Technologies
- 🛇 OptiWave Systems

FAB

- 3IT.Nano, Université de Sherbrooke
- Achray Photonics
- Applied NanoTools
- C2MI MiQro Innovation Collaborative Centre
- 🗹 Celestica
- Oream Photonics

- 🚫 INO National Optics Institute
- National Research Council Canada (NRC-CPFC)
- SiEPICfab, UBC
- 🧭 Teledyne DALSA
- ✓ Teledyne MEMS

LAB

- 🧭 DeepLite
- C2MI MiQro Innovation Collaborative Centre
- CMR Summit Technologies

- ✓ PINQ²
- 🗹 Solaxis
- 🕢 ThinkRF

Working with International Peers to Advance the **Global Potential of Micro-Nanotechnology**

- 🔗 ANFF Australian National Fabrication Facility, Australia
- CMP Circuits Multi-Projets, France
- C EUROPRACTICE, European Consortium
- Fraunhofer Institute for Integrated Circuits IIS, Germany
- 🔮 IDEC Integrated Circuit Design Education Centre, South Korea
- 🧭 imec Interuniversity Microelectronics Centre, Belgium
- STFC Science & Technology Facilities Council, United Kingdom
- SRI Taiwan Semiconductor Research Institute, (formally CIC), Taiwan
- Tyndall National Institute (Ireland)
- The MOSIS Service, United States

Success Stories

VDEC - VLSI Design and Education Center, Japan

Powering a Greener Future

Dr. Meghan Beattie, a member of Dr. Karin Hinzer's SUNLAB (University of Ottawa) researched the development of state-of-the-art photovoltaic devices, which convert light into electricity, using innovative semiconductor materials and device design.

The first project of her thesis involved ultra-high efficiency multi-junction solar cells. These solar cells are used to generate electricity from sunlight in space but are too expensive for terrestrial use. Instead, most terrestrial solar power installations rely on silicon solar cells, which are less efficient but much more affordable. Dr. Beattie studied a new material, porous germanium, and discovered that it could significantly reduce manufacturing costs for multi-junction cells, expanding the potential market for this renewable energy technology.

Dr. Beattie also studied photonic power systems, where power is transmitted as light rather than through electrical cables. This mode of power

transmission is electrically isolated, which is ideal for powering sensitive electronic devices. In her thesis, she designed photovoltaic devices that would increase the feasible photonic power transmission distance by a factor of ten over what can be achieved using most commercially available photovoltaic technology.

Through CMC, Dr. Beattie was able to access industry standard TCAD Sentaurus software by Synopsys Inc., which is specifically designed for modelling semiconductor devices such as photovoltaic cells. This allowed her to examine the inner workings of photovoltaic devices in more detail than could be achieved through experiment alone and to explore device designs far beyond those that she studied in the lab. These simulations are key to Dr. Beattie's research, which can lead to a greener future.

Facilitating Ecosystem Development Through Membership in Strategically Aligned Organizations

- ✓ AloT Canada
- C2MI MiQro Innovation Collaborative Centre
- ✓ CANARIE
- CENGN Centre of Excellence in Next Generation Networks
- 🕑 D&R Design & Reuse
- EPIC European Photonics Industry Consortium
- GSA Global Semiconductor Alliance
- ✓ ISEQ (Quebec's Electronic Systems Industry)
- 🗹 Life Sciences Ontario
- 🧭 NanoCanada
- 🗹 NanoOntario
- ✓ OpenHardware Group

- Optica (formerly OIDA)
- ✓ Optonique
- Photons Canada (Canadian Photonic Industry Consortium)
- ✓ PRIMA Quebec
- Ø RISC-V International[®]
- 🕢 Semi
- SPIE
- **V** TECHNATION Canada
- CCMM Chamber of Commerce of Metropolitan Montreal
- Greater Kingston Chamber of Commerce
- Kanata North Business Association (and Kanata North Technology Hub350)
- 🗹 Ottawa Board of Trade

"Our strategic partnership with CMC gives us access to multi-product and single-product wafer fabrication and energizes our commitment to Canadian and North American silicon manufacturing."

Andrew Skafel, President and CEO, Edgewater Wireless Systems Inc.

Celebrating Innovation

Towards an Energy Efficient Future – at the Atomic Level



Taleana Huff won the 2021 CMC Microsystems Douglas R. Colton Medal for Research Excellence for work that lays the foundation for computers and mobile phones that use 100 times less energy.

For her Master's degree and her PhD, Taleana Huff worked with Robert Wolkow, iCORE Chair in Atom Scale Information at the University of Alberta. She focused on what they came to call "Atomic White-Out," an error correction method for fabricating and patterning quantum dots. The technique gave Huff and the team the ability to successfully build atomic circuits. She was able to construct binary atomic wires and logic gates.

She and her colleagues encoded the binary 0's and 1's of computer language in the spatial position of single electrons in quantum dot pairs, instead of in conventional transistors. Pairs can be electrostatically "linked" together to build full computer circuits, says Huff. They called this approach Binary Atomic Silicon Logic (BASiL).

"The advantage of BASiL over traditional transistors is that they can operate 100 times faster, use 100 times less energy, and are incredibly tiny."

- Dr. Taleana Huff

Quantum Silicon Incorporated, a Canadian company based in Edmonton, is working to bring the patented technology to market.



Celebrating Innovation (continued)

TEXPO 2022

Graduate student competition recognizing novel research with industrial relevance.

Congratulations to our award winners!



Brian L. Barge Microsystems Integration Award

William Lemaire

Université de Sherbrooke Supervisor: Dr. Réjean Fontaine Infrared-Powered Artificial Retina based on a 65- nm CMOS stimulator ASIC





Award for Microsystems Innovation by Women

Sheida Gohardehi University of Waterloo Supervisor: Dr. Manoj Sachdev Dual-Driver Pixel Circuit and Associated Drivers for Low-Power OLEDoS Microdisplays



Award for Excellence in Microsystems Fabrication

Amirhossein Omidvar

University of British Colombia

Supervisor: Dr. Edmond Cretu

FlexCMUT, a Flexible Polymer-based Micromachined Ultrasound Array for Conformal Imaging



Award for Excellence in Microsystems CAD Tools and Design Methodology

Roberto Silva

University of Toronto

Supervisor: Dr. Roman Genov

Coded-Exposure-Pixel (CEP) Camera for Scene-Adaptive Single-Shot HDR and 3D Imaging at Standard Video Rate

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Financial Summary

CMC delivers on its mission through the support of several financial stakeholders. In 2021-22, total revenues of \$15.1 million came from a variety of sources, including federal and provincial government grants, user fees, industrial sponsorship, contract management services, and R&D consulting. The most significant source continues to be CFI's Major Sciences Initiatives (MSI) program. Compared to the prior year significant revenue growth came from Province of Quebec funding, non-subscriber fabrication and contract R&D. Total expenditures of \$14.5 million increased from the prior year as CMC continues to expand fabrication services and R&D activity.

Statement of Financial Position as of March 31, 2022

Assets	2022	2021
Current Assets	8,857,028	8,718,970
Long-term Assets	\$9,088,568	\$9,040,647
	2022	2021
Liabilities & Net Assets	2022	2021
Liabilities & Net Assets Liabilities	2022 3,697,783	2021 4,266,903
Liabilities & Net Assets Liabilities Net Assets	2022 3,697,783 5,390,785	2021 4,266,903 4,773,744

Statement of Revenue and Expenditure for Year Ended March 31, 2022

Operations	2022	2021
Revenues	15,069,633	12,910,019
Expenditures	14,452,592	13,223,582
	\$617,041	(\$313,563)



www.CMC.ca/Corporate-Reports

for our complete audited financial statements



Kingston I Montreal I Ottawa I Sherbrooke



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