

Editorial

Mobilizing Canada to Realize the Microsystems Advantage

The hospital of the 21st century... an imaging device that can detect cancer and pinpoint its exact location in the human body... the next generation of lighter, smaller satellites... tools that protect agricultural land and help farmers save money. Microsystems created in Canada are making these innovations possible.

This issue of IMPACT illustrates how CMC Microsystems is enabling researchers, developers and scientists from diverse disciplines to develop microsystems for application in all industrial sectors.

These dynamic interdisciplinary teams include electrical engineers, computer scientists, physicists, biologists, mechanical engineers and chemists. They are investigating the complex problems and exploring new idea spaces to reap the benefits of enabling microsystems technologies.

Highly qualified people are at the heart of CMC's national microsystems agenda. We are expanding the scope of products and services required by researchers and developers to advance microsystems research, technology development and commercialization. Together, we are helping Canada to realize the microsystems advantage.

Sonya Shorey, Editor,
Senior Manager of Communications

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A 21st Century Hospital

The University of Calgary will use the National Design Network to build high-frequency circuits for a new patient-monitoring system.

“This technology can really help with patient care and CMC Microsystems will play a major and a frequent role when it comes to fabricating and testing low-power circuitry and advanced sensor circuitry. CMC’s contribution is essential for improving the design, and getting a working system into hospitals.”

Dr. Vijay Devabhaktuni
NSERC/iCORE Post-Doctoral Fellow
University of Calgary

It’s being called the Medical Ward of the 21st century. A new teaching unit at Foothills Medical Centre in Calgary, under the direction of Dr. John Conly, is testing novel approaches to health care delivery, research, education and technology. In 2004, the team began field testing a remote sensing system to monitor patients’ vital signs as they move throughout the hospital.

“The technology, called *Ad Hoc Self-Organizing Wireless Sensor Networks*, monitors everything from moisture levels in vineyards to temperature in habitats. We want to develop as many prototypes with CMC as possible so that we can test them in a hospital environment,” says Dr. Vijay Devabhaktuni, an NSERC/iCORE Post-Doctoral Fellow. He works with Dr. James Haslett, the TRILabs/iCORE/NSERC Senior Industrial Research



Dr. John Conly (right) from Foothills Medical Centre is working with Dr. Vijay Devabhaktuni (centre) and Dr. James Haslett (left) from the University of Calgary to develop a new patient monitoring system, using resources provided by CMC.



An electronic circuit called a “mote” (circular object in middle) connects to biosensors (mounted on circular object on right) to continuously monitor a patient’s vital signs in real time. The sensed information is transmitted over radio to a base-station (object on left) that connects to a doctor’s PC.

Chair in Wireless Science and Technology. The wireless sensor was constructed with a first generation commercial circuit called a “mote” for the remote sensing system. About the size of a Canadian dollar coin, the mote connects to biosensors that continuously monitor temperature, heart rate, blood oxygenation and pulse. An embedded transceiver wirelessly transmits data to a base station linked to PCs in a nursing station, or even handheld PDAs.

Power consumption is a key issue with such a monitoring system. PhD student Ken Townsend is building a low-power transceiver system that will eventually extend the system’s battery life by weeks or even months. He is working with: Dr. John Rogers (Carleton University), Dr. Kris Iniewski (University of Alberta), and Dr. Foster Dai (Auburn University, Alabama). Master’s student Steven Zhai, jointly supervised by Drs. Haslett, Sebastian Magierowski and Ed Nowicki, is integrating biosensors that monitor blood oxygenation and heart rate.

The technology could eventually be used in hospitals across Canada. *cmc*



Advancing Satellite Technology: MEMS in Space

The University of Waterloo and COM DEV International Ltd. are working together with critical support from CMC Microsystems to build MEMS components and subsystems for a new generation of smaller, lighter and better satellites and wireless devices.

“CMC has proven to be an invaluable resource to Canadian industry for two decades. It is an organization that has consistently delivered high return on investment to the aerospace electronics industry and many sectors that drive the Canadian economy.”

Dr. Raafat Mansour
NSERC/COM DEV Industrial Research Chair on RF Engineering
University of Waterloo

COM DEV expects to hit the market later this decade with its first MEMS-based subsystems for the satellite and wireless markets. The Cambridge, Ontario-based company is working closely with Dr. Raafat Mansour and 15 graduate students in the Centre for Integrated RF Engineering at the University of Waterloo to develop new MEMS-based Radio Frequency (RF) filters and switches.

“Partnering with a university allows us to experiment together and better leverage our



Dr. Mansour (front row, centre) joins members of his research team from the University of Waterloo and engineers from COM DEV working in collaboration on MEMS-based subsystems for the satellite and wireless markets.

investment in longer-term research,” says Dr. Ming Yu, COM DEV’s Director of R&D. COM DEV, the largest Canadian-based designer and manufacturer of space hardware subsystems, has invested \$1.2 million to sponsor the NSERC/COM DEV Industrial Research Chair on RF Engineering, held by Dr. Mansour.

“Having access to our new lab and to the design, fabrication and testing services offered by CMC means I can perform the same

high level of research as those at COM DEV,” says Dr. Mansour, who worked at the company for 14 years. “Students who are trained using this infrastructure are as skilled as any engineer in industry.”

Dr. Yu is hoping many of those students will later join COM DEV. “In order for us to stay competitive, it’s important to have a steady inflow of bright ideas and experienced engineers like those enabled by CMC.” *cmc*

CMC Microsystems recognizes the outstanding contribution of its investors. Established in 1984, CMC is a not-for-profit corporation funded by Science and Engineering Research Canada (NSERC), matched by industrial contributions of technology, services and cash. CMC also manages major grants from the Canada Foundation for Innovation (CFI) and the Ontario Innovation Trust (OIT) through Queen’s University, to deliver research infrastructure for system-on-chip investigations at Canadian universities; along with additional funds from the province of Quebec and the Manitoba Research and Innovations Fund to enable the testing of high-performance micro-chip designs through the National Microelectronics and Photonics Testing Collaboratory.



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Canada Foundation for Innovation
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A More Complete Picture of Human Life

A team of electrical engineers and medical physicists is developing an all-in-one imaging device that can detect cancer and pinpoint its exact location in the body.



*Dr. Réjean Fontaine displays the technology for his unique dual-modality scanner that will be used by researchers in oncology, cardiology, neurology, genetics and drug development.
PHOTO: Université de Sherbrooke*

Hidden from view, but embedded inside one of the world's most advanced imaging systems is a tiny microchip that was designed and manufactured with the help of CMC Microsystems.

Working with Dr. Roger Lecomte, a nuclear medical physicist at Université de Sherbrooke's Clinical Research Centre and colleagues at the Brookhaven National Laboratory in New York, Dr. Réjean Fontaine used tools and technologies provided by CMC to solve a critical integration problem. The team wanted to simultaneously acquire Positron Emission Tomography (PET) molecular images and Computer Tomography (CT) anatomical images. By using the same detector and electronic chain to detect the high-energy PET annihilation radiation and the low-energy CT

X-rays, the team is creating a system that images the in vivo biological activity and the anatomy all at once.

"To combine the two imaging modalities, we needed to develop and manufacture some dedicated integrated circuits for the front end, and that is where CMC helped us," says Dr. Fontaine, a biomedical microelectronics engineer at Sherbrooke. "We're the only research team in the world working on a PET/CT scanner that uses the same electronics for both devices."

This unique dual-modality scanner will be used by researchers in oncology, cardiology, neurology, genetics and drug development. Sherbrooke has already spun-off Advanced Molecular Imaging (AMI) Inc. to market the device within the next two years. *cmc*

"When we attend conferences outside of Canada, researchers tell us how fortunate we are to have CMC. CMC made it possible for us to design at 0.18 micron for the PET/CT scanner project. Other research teams across the world say they can't do that because it's too expensive."

Dr. Réjean Fontaine
Université de Sherbrooke



*Dr. Roger Lecomte (left) and Dr. Réjean Fontaine (right) used products and services delivered by CMC to design and manufacture a key microchip for a new imaging scanner.
PHOTO: Université de Sherbrooke*

Controlling Weeds – Saving Farmland – Boosting the Agricultural Industry

CMC Microsystems is helping researchers to design new tools that will help protect agricultural land from the ravages of leafy spurge and other weeds.

“This technology offers tremendous potential for many applications – from remote sensing of the environment to the identification of counterfeit money or art. It could even be used to increase security in airports, by scanning the retina of the eye to accurately identify passengers.”

Mr. Peter Davis-Imhof
Research Manager
University of Lethbridge

Leafy spurge infests more than 2.7 million acres of land per year in southern Canada and the northern United States. In Manitoba alone, the rate of infestation has reached alarming levels, costing the provincial government about \$19 million annually.



Researchers at the University of Lethbridge are working with technologies provided by CMC Microsystems to develop an imaging system that can monitor the spread of leafy spurge. Left to right: Dr. Peter Davis-Imhof, Dr. David Naylor and student Richard Querel.



Leafy spurge contaminates grazing areas, contributes to a loss of plant diversity and wildlife habitat, and significantly reduces the value of the land. The level of infestation has become a serious concern in Manitoba.

Research enabled by CMC Microsystems could help to combat this growing threat to the agricultural industry.

Dr. David Naylor and Mr. Peter Davis-Imhof of the Physics Department at the University of Lethbridge are working together with Agriculture and Agri-Food Canada (AAFC) on the development of a new type of imaging system that could be used monitor the spread of leafy spurge over large geographical areas. This imaging Fourier transform spectrometer (FTS) could be installed in airplanes to enable the assessment of leafy spurge growth and the resulting damage to the land.

CMC is providing the team with field-programmable gate array (FPGA) technology, helping to reduce the time required for development as well as the cost of production.

“Dr. Rob Bouchier of AAFC requires a cost-effective and efficient technology that could eventually be turned into an airborne system.

Today, monitoring leafy spurge is very labour-intensive work. It requires many people to walk through fields and count plants. It would be far more efficient to take a hyper-spectral image of an area, to acquire a broad overview of the abundance of leafy spurge,” says Mr. Davis-Imhof.

The team is aiming to develop a compact FTS system with enough computing power to process thousands of very high-resolution spectral images, and then turn the raw data into useful information that can help researchers on the ground.

“This is really an untapped area of remote sensing. Hyper-spectral imaging with FTS systems has barely been explored by the research community,” says Mr. Davis-Imhof. “Having access to the FPGA technology provided by CMC became more critical when we started working with thousands of spectra at a time. We could never afford this equipment otherwise.” *cmc*

Accelerating DNA Matches

Computer scientists at Memorial University are tapping into the System-on-Chip Research Network (SOCRN) to build special-purpose computers for complex pattern matching.

“With this project, we have people with a theoretical interest in computer science finding an application in the hardware domain for something that has potential applications in computational biology, and potentially medicine and linguistics over the longer term.”

Dr. Paul Gillard
Department of Computer Science
Memorial University of Newfoundland

Computer scientists Dr. Todd Wareham and Dr. Paul Gillard are combining the flexibility of software with the performance speed of hardware to more quickly pinpoint DNA matches. The technology – a field-programmable gate array (FPGA) hardware accelerator – could speed the discovery of new drugs, improve our understanding of linguistics and even help national security agencies.

Comparing DNA or protein sequences is a fundamental task in molecular biology, and an increasingly complex one. Being able to do it quickly provides the researcher with competitive advantage. As not every lab can afford a supercomputer, these Memorial researchers are designing specialized microchips that will transform a standard PC into a high-performance computer capable of simultaneously comparing thousands or even millions of genetic sequences.

“If you’re a drug company interested in doing these DNA matches, you could have hundreds of these chips working in parallel,” says Dr. Gillard.

Using a System-Level Prototyping Station delivered through the SOCRN managed by CMC Microsystems, the team is able to translate algorithms for pattern matching



Memorial researchers are using the System-on-Chip Research Network to design microchips that will accelerate comparisons of DNA sequences.

into hardware. “This is a unique opportunity for one of my students to use these tools to develop novel applications on the hardware side,” says Dr. Wareham. “It has also opened a new door for multidisciplinary research here at Memorial.” *cmc*



Dr. Todd Wareham (right), Dr. Paul Gillard (centre) and David Churchill, undergraduate student (left) of Memorial University are working on a technology that could speed the discovery of new drugs, improve our understanding of linguistics and even help national security agencies.

Noise Busters

CMC Microsystems helps scientists design quieter cars

Researchers at Simon Fraser University are developing intelligent systems and sensors that make vehicles quieter. The technology could become a hot selling feature in future automobiles.

More powerful engines and lighter construction materials are having an unintended side-effect on vehicles – too much noise. The automobile industry is counting on university researchers to find solutions that cut noise levels without driving up manufacturing costs. Those solutions could be ready within five years as a result of a national research project, where Dr. Ash Parameswaran and his research team at Simon Fraser University (SFU) are using tools and technologies provided by CMC to design and build miniature sensors and actuators that will help create a quieter ride.

The SFU research team brings unique microsystems expertise to a collaborative automotive project led by the Université de Sherbrooke with funding from industry partners and AUTO21, a federal Network of Centres of Excellence based at the University of Windsor. SFU's goal is to reduce structure-borne noise – noise that is transmitted from the road and tires, to the suspension system and into the cabin of the vehicle.

“We have to design a smart suspension system, one that uses electronics and intelligence to somehow avoid having the noise transmitted,” explains Dr. Ash Parameswaran, Director of SFU's Institute of Micromachine and Microfabrication Research. To design this new MEMS (microelectromechanical system) device, Dr. Parameswaran is relying on off-the-shelf products and computing infrastructure provided by CMC.

The researcher says, “CMC will help me to play a significant role in the manufacturing and testing of the design, from making integrated circuit chips, to assembling small-scale circuits and having them provide us with the technology to make the device. CMC also has established relationships with potential investors who may be interested in this technology. If we weren't doing this research in Canada with the help of CMC and AUTO21, it would be much more difficult to commercialize this innovation.”

The microsystems technology being developed by this SFU research team will not be limited to automobiles. Dr. Parameswaran says it can also be used to reduce noise in trains, planes and ships, offering improved modes of travel for all Canadians. *cmc*



Nakul Verma (left), Matthew Ward (centre left), Dr. Ash Parameswaran (centre), and Michael Sjoerdsma (right) at Simon Fraser University are using microsystems tools and technologies provided by CMC to design and build miniature sensors and actuators that will help create quieter cars.

SFU's Research Team
Dr. Ash Parameswaran
Michael Sjoerdsma
Nakul Verma
Matthew Ward

Industry Partners
Sensor Technology Ltd.
Siemens Canada Ltd.
Soft dB Inc.
Xilinx Inc.
Vibro-Acoustic Sciences Inc.