
Research powered by people

National
Research
Council of
Canada

Annual Report
2021-2022

NRC-CNRC



National Research
Council Canada

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recherches Canada

Canada

Every day, teams of researchers, engineers, business experts, technical officers and advisors, and other dedicated professionals make ground-breaking science and innovation possible across the National Research Council of Canada (NRC). This annual report celebrates the people who power our research, and highlights how their contributions are helping address the greatest issues of our time, from the ongoing pandemic to climate change and the digital revolution.

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On the cover | Principal Research Scientist **Priti Wanjara** leads a team at the NRC’s Aerospace Research Centre that is generating exciting breakthroughs in metal alloy additive manufacturing (3D printing) of critical airplane engine components—innovations that are increasing industrial adoption of additive technologies across Canada and beyond. Priti is also a champion of workplace equity, diversity and inclusion, playing a vital role in a mentorship program for women across the NRC.

“When I started my career, there were very few female role models for me to emulate,” she says. “What motivates me most is helping people: being a positive influence and inspiring students and early career researchers to reach levels of success beyond their expectations.”



There is a saying

that “a ship takes many hands to sail.” In our case at the NRC, it is more than 4,000 pairs of hands—people at 14 research centres and facilities across the country, and also on the premises of NRC Industrial Research Assistance Program clients—who engage in or enable some of the most advanced science and technology development in the world. They include award-winning researchers and engineers, industrial technology advisors, technical officers and computer scientists, contracting and procurement teams, lawyers, IP specialists, facility managers, human resources professionals, IT and communications specialists, and many other dedicated professionals.

Every single member of the NRC team, some of whom are highlighted in the pages of this report, played an important role in supporting our ongoing response to the COVID-19 pandemic in 2021–2022, while tackling other critical issues and opportunities—from climate change to the digital revolution, and its new frontiers of artificial intelligence and quantum technology. Mitch Davies was at the helm for part of the year while I was at the Public Health Agency of Canada, and I thank him for his leadership during that time.

Among the achievements of the year, the people of the NRC completed the construction of the new Biologics Manufacturing Centre in record time to strengthen Canada’s ability to produce vaccines here at home. We had teams drive the publication of updated national construction codes and standards for climate resilience. We launched new Challenge programs, including one to address challenges and opportunities in Canada’s North. Our very own Dr. Paul Corkum won the 2022 Wolf Prize in Physics: one of the most significant scientific awards.

What stands out about the people of the NRC is the extent to which they are truly “mission-driven,” dedicated to serving the public good. This is an organization of individuals who want to make a difference. Three particular individuals I want to single out in this message are Dr. Roger Scott-Douglas, Dr. Dan Wayner and Dr. Michel Dumoulin. All are experienced executives—and in the case of Dan and Michel, long-term NRC researchers—who have or will be retiring in the near term, after each serving more than 30 years with the NRC or in the public service. Yet as some colleagues retire, others have joined the NRC executive team, including Dr. Lakshmi Krishnan, Dr. Ibrahim Yimer, Dr. Joel Martin and Dr. Jean-François Houle, each bringing new perspectives and experiences.

As we begin the development of a new strategic plan for the next 5 years, the mission-focused orientation of the NRC team will drive our work in 2022–2023 and beyond. Budget 2022 makes it clear that the NRC has a strong role to play in building a more sustainable future for Canada. With our new funding, we will focus on areas such as low-carbon construction techniques and advancing Canada’s strategic interests in critical minerals. We will be part of the government-wide effort to reduce plastic waste and, in everything we do, we will collaborate even more closely with universities, industry, Indigenous communities and other partners across the country and around the world.

It is easy to think of government organizations as impersonal institutions. In reality, they are about people—and the NRC is home to the very best.

To all employees of the NRC, no matter your role or where you are located, thank you for everything you do. Without you, there is no NRC.

About the NRC

Our research spans 14 research centres across 5 divisions, with facilities in 24 locations across Canada, and the Industrial Research Assistance Program (NRC IRAP) that reaches over 8,000 client firms each year.

Our research centres

Life Sciences

Aquatic and Crop Resource Development
Human Health Therapeutics
Medical Devices

Emerging Technologies

Advanced Electronics and Photonics
Herzberg Astronomy and Astrophysics
Metrology
Nanotechnology
Security and Disruptive Technologies

Digital Technologies

Digital Technologies

Transportation and Manufacturing

Aerospace
Automotive and Surface Transportation

Engineering

Construction
Energy, Mining and Environment
Ocean, Coastal and River Engineering

Our vision

A better Canada and world through excellence in research and innovation.

Our mission

To have an impact by advancing knowledge, applying leading-edge technologies and working with other innovators to find creative, relevant and sustainable solutions to Canada's current and future economic, social and environmental challenges.

Our values

Integrity

Behaving at all times ethically, honestly and objectively; being impartial and transparent with our colleagues, collaborators, stakeholders, clients and the people of Canada; and exercising sound stewardship of our resources.

Excellence

Pursuing excellence in all that we do: in our research and innovation, in our collaborations, in execution of our programs, in our support to firms and in our delivery of our common corporate services.

Respect

Valuing and respecting the knowledge, expertise and diversity of our colleagues, our workplace, our collaborators, our stakeholders and our clients to have an impact on Canada and the world.

Creativity

Harnessing our imagination, passion for excellence, scientific exploration, technology and innovation to generate new knowledge, new technologies, new business processes and new collaborations for a better NRC and a better world.

| Scientific achievements | |
|-------------------------|---|
| 1,187 | Peer reviewed publications ¹ 52 publications per 100 scientists/engineers |
| 270 | Patent applications |
| 1,850+ | Active patents |
| \$169.8M | Total revenues |
| 9 | Challenge programs ² |
| 5 | Supercluster support programs ³ |

| People | |
|--------|---|
| 4,286 | Total NRC full-time equivalents 2,228 scientists, engineers and technicians 262 IRAP Industrial Technology Advisors |
| 487 | Student, postdoctoral fellowship and research associate opportunities |

¹ Calendar year 2021
² Pandemic Response, Materials for Clean Fuels, High-throughput and Secure Networks, Artificial Intelligence for Design, Disruptive Technology Solutions for Cell and Gene Therapy, Aging in Place, Internet of Things: Quantum Sensors, Arctic and Northern, Applied Quantum Computing
³ Advanced Manufacturing, Artificial Intelligence for Logistics, Digital Health and Geospatial Analytics, Ocean, Sustainable Protein Production
⁴ Annual Client Satisfaction Survey
⁵ Collaborative Science, Technology and Innovation Program

| Clients | | |
|-----------------------------|--------------------------------------|---|
| 1,114 | 339 | 93% |
| R&D projects for clients | Technology business consultations | Clients say NRC helped them achieve results ⁴ |

| Facilities | | |
|------------|-------|----------------------|
| 182 | 24 | 126 |
| Buildings | Sites | Major R&D facilities |

| Financials (unaudited results) | |
|--------------------------------|---|
| \$169.8M | Total revenues |
| \$1,436.3M | Total expenditures |
| \$31.9M | Grants & contributions for CSTIP ⁵ |
| \$590.8M | Grants & contributions expenditures |

| Industrial Research Assistance Program (NRC IRAP) | | |
|---|--------------|---------------------------|
| 9,078 | 3,657 | 5,421 |
| Total clients | Firms funded | Advisory services only |
| 32% Revenue growth of client firms | | |
| 18% Employee growth of client firms | | |



Research is always ultimately about people and their needs



Benoit Thériault

Benoit
Thériault

Research Officer
Automotive and Surface Transportation

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A new hub for advanced manufacturing

3D printing could unlock more sustainable production

When **Benoit Thériault** was asked to move more than 2,400 kilometres from Saguenay, Quebec, to Winnipeg to be part of the team at the NRC's brand-new advanced manufacturing facility, he didn't think twice. "Commissioning some of the largest and most advanced 3D printers in the world is an incredible opportunity that doesn't happen often in a lifetime."

Construction of the facility, which is home to specialized scientific equipment for materials and manufacturing research, wrapped up in January 2022. Benoit, a research officer with the NRC's Automotive and Surface Transportation Research Centre and self-described "engineer at heart," says he is excited for the facility to serve as a regional hub for integrating and demonstrating advanced technologies that stand to make Canadian manufacturing more sustainable.

"While the technical side is inherently interesting, research is always ultimately about people and their needs," says Benoit. "Everything we are doing at the NRC is to help move society forward and better the lives of everyone."

Benoit's research focuses on additive manufacturing (also known as 3D printing) of metals. He is aiming to develop a better understanding of different 3D printing processes so they can be used more widely across Canada's manufacturing sector, helping respond to supply chain disruptions and reducing environmental impacts through more domestic production. Benoit is also looking at how to adapt the technology to use metal alloys that are currently impossible to print on an industrial scale.

News

Innovating together

3D printing is just one way to improve metal fabrication. The METALTec industrial R&D group brings together companies, public funding partners, universities and NRC teams to share the costs of new research for transportation equipment manufacturing, such as a project to make vehicle metal alloys more resistant to corrosion.

Last year, METALTec became the largest group of its kind within the NRC, reaching 32 industrial members, 9 sponsors and 8 academic collaborators. Through the NRC's Advanced Manufacturing program, 5 industrial R&D groups helped more than 100 collaborators address critical Industry 4.0 challenges in 2021–2022.

R&D to support the transition to a low-carbon economy

Clean energy technologies can help Canada achieve net-zero emissions by 2050, but many of them don't yet exist. **Jennifer Littlejohns** from the Energy, Mining and Environment Research Centre is the director of the Advanced Clean Energy program, which is accelerating the development of new low-carbon fuels, clean hydrogen and battery energy storage technologies.

"I'm motivated by the pressing issue of climate change mitigation and making a better future for my kids," she says.

The program, one of many in our suite of low-carbon initiatives, currently has more than 60 active projects involving government, industry and academic partners. It generated over 35 publications last year and a number of intellectual property (IP) assets.

Blue ocean, green vessels

Marine Performance and Evaluation Team Lead **Allison Kennedy** and her colleagues in the Ocean, Coastal and River Engineering Research Centre analyzed 10 months of vessel operational data from BC Ferries to understand how a new low-friction hull coating affected power and fuel consumption.

“We are developing data products and tools that will help Canada operate vessels in a cleaner and more environmentally friendly way, while also building Canadian competencies in a high-interest research area.” · Allison Kennedy





Nedjma Belrechid

This effort will be enhanced by previously completed work with Environment and Climate Change Canada, the Pacific Climate Impact Consortium and code experts across the country to develop forward-looking data on the impacts of climate change for building and infrastructure design. The results of this work, part of the NRC’s Climate Resilient Buildings and Core Public Infrastructure initiative funded by Infrastructure Canada, are now readily available and are expected to inform future code changes for more climate-resilient construction.



Mélanie Payant

Sustainability on land and at sea

Making Canada’s communities more energy efficient and climate-resilient

Mitigating the impacts of climate change is an urgent priority for communities across Canada. Reducing energy consumption and related emissions is one crucial way to do that. In March 2022, dozens of team members across the NRC’s Construction Research Centre culminated more than 5 years of work to support the development and publication of Canada’s updated National Model Codes, including new provisions focused on improving energy efficiency in buildings and housing.

Nearly 400 updates were made to the National Model Codes, which include the National Building Code of Canada, National Fire Code of Canada, National Plumbing Code of Canada and National Energy Code of Canada for Buildings—nearly 5,000 pages combined. This monumental task took place through a consensus-based process led by the Canadian Commission on Building and Fire Codes (CCBFC).

Technical advisors on the NRC’s Codes Canada team, which is based in the Construction Research Centre, provided technical and administrative support to the CCBFC and its standing committees, coordinating the provision of evidence-based research to inform codes development. As part of that work, NRC researchers collaborated with Natural Resources Canada to inform the development of new tiers for energy performance compliance in the codes. Those new tiers will help regulating jurisdictions adopt progressively greater energy efficiency requirements in the construction of new buildings and homes.

Production and marketing specialists on the Codes Canada team then handled the editing, translation, production and publication of the electronic codes, as well as coordination with the NRC’s print and distribution team to deliver the printed manuals. Once adopted or adapted by the provinces and territories, the revised codes will inform the planning, design and construction of new buildings.

News

Shoring up Canada’s coastal defences

To improve coastal resiliency against increasingly frequent superstorms, last year our Ocean, Coastal and River Engineering Research Centre built and tested physical models of “living breakwaters”: reef-like barriers that could protect waterfront communities from flooding while creating a welcoming habitat for marine life. We are also exploring hybrid and nature-based solutions, looking at how wetland plants can offer protection against waves, currents and flooding.

In addition, we are working with the Department of National Defence (DND) and the Canadian Coast Guard to improve ship and submarine performance, to better defend Canadian coastlines. This is part of our collaboration agreement with the DND, which we renewed in 2021 for an additional 25 years.

Food sustainability: Growing berries in Nunavut

Researchers from the Aquatic and Crop Resource Development Research Centre are collaborating with partners in Canada’s North to enable year-round production of fruits and vegetables not readily available in isolated and remote communities. In 2021–2022, after testing 4 strawberry cultivars in a research “pod” in Saskatoon, the best-performing ones were shipped to Gjoa Haven, Nunavut, where community members successfully grew strawberries for 7 months in an identical pod powered by renewable energy and environmental control technologies.



75 years of aerospace innovation

The NRC's Flight Research Laboratory celebrated its 75th anniversary in 2021. Since 1946, its teams have used wind tunnels, electrodynamic shakers, engine-icing test centres, hyperspectral imaging systems and other technologies to build safer and better airplanes.





Patrick Zdunich



Cuong Nguyen

Research in the skies and stars

Advancing sustainable aviation technologies

Patrick Zdunich knew from a very young age that he wanted to be an aeronautical engineer. Today, as technical lead for the Hybrid Electric Aircraft Testbed (HEAT) project, he is part of the multidisciplinary NRC team behind the February 2022 test flight of a hybrid electric aircraft—a major step forward on the path to green aviation.

“Aviation is one of the most difficult activities to make sustainable because of the massive power and energy requirements of flight,” says Patrick. “The last real step change in flight was the jet engine. Low-emissions aviation is the next, and I want to help Canada build its position in the sector by playing an important role in its development and deployment.”

Patrick is not alone at the NRC’s Aerospace Research Centre in wanting to revolutionize aviation. His colleague, **Cuong Nguyen**, is project lead on the Winter Precipitation Type Research Multi-scale Experiment (WINTRE-MIX), a joint U.S.–Canada study of how clouds and near-freezing precipitation are changing due to climate change. Data collection was completed in early 2022 using ground-based and airborne radar systems and in situ sensors, with Cuong serving as radar scientist aboard all WINTRE-MIX flights.

“I was not in Canada to witness the impact of the 1998 ice storm, but the goal of WINTRE-MIX is to better predict such events,” Cuong says. The project’s findings will advance the understanding of extreme winter weather, which affects everything from transportation to power generation.

It takes many roles to conduct the work of the Aerospace Research Centre, including test pilots like **Reagh Sherwood**, who flew the planes used for both HEAT and WINTRE-MIX. A former pilot with the Royal Canadian Air Force, he says testing new technologies demands high-level knowledge about every system on board an aircraft and how they interact with each other.

“Thankfully the HEAT team brought in the flight testers early,” says Reagh. “We were able to contribute to the design to simplify the operations and ensure the flight vehicle could be operated safely while still gathering the required data.”

News

A look into the heart of the galaxy

Published in January 2022, the most detailed image of supernova remnants and radio-emitting magnetized threads at the core of our Milky Way galaxy was produced by the MeerKAT radio telescope in South Africa, built in part with technology from the NRC’s Herzberg Astronomy and Astrophysics Research Centre.

Uncovering the secrets of the universe

The James Webb Space Telescope—the most powerful ever built—was launched in December 2021 with Canadian-made scientific instruments and guidance sensors on board. NRC scientists such as **Chris Willott**, an astronomer in the Herzberg Astronomy and Astrophysics Research Centre, will also play an important role in processing the data collected by the telescope.


“Webb will show us the conditions in the earliest galaxies that formed in the universe,” says Chris. “I expect the first few months of science operations will provide a flood of new revelations and surprises we have not yet imagined.”

An aerial photograph of a dense evergreen forest, likely spruce or fir, with a white rectangular text box in the upper left corner. The trees are vibrant green, and the canopy is thick. Some bare, grey branches are visible in the upper right quadrant.

Protecting the forest to see the stars

After a 2014 wildfire broke out less than 2 kilometres west of the NRC's Dominion Radio Astrophysical Observatory in British Columbia, a team led by Site Operations Supervisor **Kory Phillips** has been working with forest management specialists and local First Nations to identify ways of protecting this important facility and the surrounding environment from wildfire risk. In collaboration with our partners, last year we finalized a wildfire treatment plan that will reduce the amount of fire fuel in the area and, ultimately, the risk and impact of any new wildfires.





Quantum states are so sensitive, they can detect and measure things well beyond the known limits of classical physics

Aimee K. Gunther

Aimee K.
Gunther

Deputy Director, Internet of Things:
Quantum Sensors Challenge program

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A leap into Canada's quantum future

As deputy director of the NRC's new Internet of Things: Quantum Sensors Challenge program, **Aimee K. Gunther** is making it possible for academics and companies to access the technical and financial support they need to harness the extreme sensitivity of quantum systems so they can develop sensors far more precise than any that exist today.

Q: How will quantum sensors be used?

AG: Because quantum states are so sensitive, they can detect and measure things well beyond the known limits of classical physics. That will have applications across many fields, from the environment and natural resources to health care and defence. For example, in mining, you could detect mineral deposits deep underground without having to drill or dig.

Q: Why is this program important?

AG: Quantum sensing is the nearest-term quantum technology that will be commercially available, likely within the next 5 years. Fortunately, Canada is in a good position to develop it, thanks to our strong talent base and early head start on quantum research investments.

Q: What do you enjoy most about your role in shaping and leading this program?

AG: When I worked in the lab, I built quantum experiments with my hands. I still build with my hands, except now it's collaborations and policy, and I feel that I'm having much more of an impact than I would have had if I continued as a researcher. In March 2022, we hosted a workshop with the quantum sensing start-up community, focused on commercialization. It was likely one of the first Canadian gatherings of this industry, which is exciting.

News

Accelerating AI adoption

In November 2021, the Digital Technologies Research Centre launched a new AI Accelerator service, providing AI and data analytics solutions and advice to departments and agencies throughout the federal government.

A global leader in photonics

Budget 2021 provided \$90 million over 5 years for the NRC to retool and modernize the Canadian Photonics Fabrication Centre (part of the Advanced Electronics and Photonics Research Centre), to help Canada remain a leader in testing and developing fibre-optic modules, advanced semiconductors, quantum photonics and other cutting-edge telecommunications technologies.

Mirrors and magnets

Last year, scientists in the Nanotechnology Research Centre revealed an innovative new deformable mirror system for telescopes and ground-to-space communications that uses precisely assembled super magnets to consume less power without compromising image quality.

The Internet of Things: Quantum Sensors Challenge program is aligned with the Government of Canada's goal of amplifying Canada's strength in quantum research and growing quantum-ready technologies and companies. The NRC began developing an Applied Quantum Computing Challenge program last year and sought out ideas from companies wanting to collaborate on projects in areas such as quantum algorithms and simulations. Also, the High-throughput and Secure Networks Challenge program has been funding quantum communications research and development since 2019.



This is not just
a project, but
a communal
effort that
will help us
support our
language
learning



Akwiratékha' Martin

Revitalizing Indigenous languages through technology

Kanien'kéha verb conjugation goes digital

When **Anna Kazantseva** came to Canada as an immigrant in 2003, she knew very little about Indigenous cultures. In 2015, she helped create the Indigenous Languages Technology team at the NRC’s Digital Technologies Research Centre, which works closely with Indigenous experts to develop speech- and text-based tools that are contributing to the stabilization and revitalization of Indigenous languages.

“Learning the Kanien'kéha language has been a very moving experience for me,” she says. “I would love to see one day all or at least many of the 50 to 80 Indigenous languages in Canada have the same support and ease of use online and across devices as English and French.”

Anna is a researcher on the **Kawennón:nis** project, an online verb conjugator for the Kanien'kéha (Mohawk) language that is now in beta testing. Also on the team is **Akwiratékha' Martin**, who has been teaching, testing and problem-solving all the “exceptions” to the rules for the accent and pitch patterns (e.g., length, tone) of Kanien'kéha verbs. Akwiratékha', a Kanien'kehá:ka who joined the team 3 years ago, believes easy-to-access online tools like this one are important as they will relieve much of the anxiety experienced by Indigenous language educators, learners and translators due to a lack of resources.

“This is not just a project, but a communal effort that will help us support our language learning,” he says. “Projects like these should have hope and a clear and supported path toward our language stability and confidence. We want to live and thrive one day, instead of always feeling our linguistic decay.”

Indigenous Languages Technology team member **Aidan Pine** built an open-source app that allows the popular word game Wordle to be adapted into other languages. Versions have been created for Gitksan and SENĆOTEN, and others are in development in collaboration with the First Peoples’ Cultural Council.



Anna Kazantseva

For the North, by the North

In 2021, the NRC issued the first call for research proposals under the new Arctic and Northern Challenge program. Arctic and Northern peoples played a key role in identifying the program's focus areas, with research funding and scientific expertise going to Indigenous- and Northern-led initiatives that will address issues related to housing, health, food and water. Arctic and Northern peoples will also participate in the design, governance and dissemination of applied research to improve quality of life and build stronger, more sustainable Northern communities.



We're providing Indigenous youth with more equitable access to career-building opportunities



Karine Lacoste

Engaging Indigenous students in science

After having worked at a national Indigenous organization, **Karine Lacoste** made a personal commitment to reconciliation by helping to build bridges between Indigenous and non-Indigenous people wherever she goes. Now a project manager in the Office of the Vice-President of Engineering, she spearheaded a pilot project last year, alongside 60 other NRC employees, to provide better access to work opportunities at the NRC for Indigenous post-secondary students.

Q: How does this project change the NRC’s approach to recruiting Indigenous students?

KL: We used to rely almost exclusively on co-op portals, but more than half of those postings were unlikely to reach Indigenous students. With this pilot, we are building new relationships with Indigenous student services offices at key universities across Canada. We are also training NRC hiring managers on how to better reach Indigenous students and build the intercultural competencies needed for Indigenous recruitment.

Q: How do you measure success?

KL: Last year we saw an increase in the number of students hired who self-identify as Indigenous. But this project is not about reaching targeted representation numbers. It is about developing more meaningful and trusting relationships with Indigenous students, staff, clients and innovators. It is also about building a welcoming and culturally safe workspace where Indigenous youth will want to come to work, and getting them excited about pursuing graduate studies or R&D careers in STEM.

Q: What do you hope the long-term impact of the project will be?

KL: The more Indigenous youth pursue STEM careers, the stronger the innovation landscape will be in Canada. Providing Indigenous youth with more equitable access to career-building opportunities will not only help empower Indigenous communities, but the NRC will also be better able to serve the innovation needs of all Canadians if we have First Nations, Inuit and Métis students bring their unique perspectives to our research activities.

News

A network to advance Indigenous research aspirations

The newly created Indigenous Engagement Network brings together employees from a variety of disciplines to raise awareness of NRC activities related to Indigenous engagement, training, research, hiring and business support. It also helps build engagement capacity and skills, providing resources and advice to NRC employees intending to initiate Indigenous engagement or research.

For a more diverse and representative workforce

Last year, we launched our new 3-year Workforce and Workplace Equity, Diversity and Inclusion (EDI) Strategy. Its priorities and initiatives will improve the NRC’s ability to hire and support the career development of diverse talent; foster an inclusive, accessible and anti-racist culture; and address and remove policy and system-related barriers preventing diverse talent from participating fully in the workforce.



Signing on to I-STEM

I-STEM is an interdepartmental initiative that aims to increase and expand support for Indigenous priorities in environmental stewardship, research, technology development and knowledge transfer. The NRC joined the I-STEM cluster last year.

In 2021–2022, we contributed to the I-STEM workplan. In addition, by leveraging the collective knowledge of I-STEM members, we have been able to build new resources and tools for staff, and expand our understanding of research ethics with respect to Indigenous peoples.

Employees who have previously engaged with Indigenous communities and research, at all levels within the NRC, also had the opportunity to participate in an immersive learning experience titled “Reframing Research Through Reconciliation.”



What we have been able to accomplish to help our country during such a critical time is an immensely satisfying achievement for everyone involved



Maria Aubrey

Ready for what's next

Building up Canada's biomanufacturing capacity

NRC Vice-President of Strategic Initiatives, **Maria Aubrey**, was given an ambitious task when COVID-19 hit: boost Canada's capacity to produce vaccines by overseeing the design and construction of the new Biologics Manufacturing Centre (BMC) in Montréal.

The project called on all of Maria's project management experience and demanded dedicated, cohesive teamwork. Construction finished in June 2021, just 10 months after breaking ground — unheard of for a facility of the BMC's size.

"You can paralyze yourself if you don't stay focused," Maria says. "We accomplished so much so quickly by making timely decisions at each step and relying on the expertise of our team to see them through."

Maria is also quick to acknowledge partners across government and industry: Public Services and Procurement Canada, the consultants who assembled the team of architects and engineers, the technicians and tradespeople, the suppliers of critical systems and equipment, and many others.

"While I was not born in Canada, I chose to be a Canadian," says Maria. "What we have been able to accomplish to help our country during such a critical time is an immensely satisfying achievement for everyone involved."

Maria's team is now focused on demonstrating the BMC's compliance with good manufacturing practices to obtain a drug establishment licence from Health Canada. At the same time, the team is undertaking technology transfer activities in preparation for the BMC's first production of vaccines for COVID-19. The facility will also support other future public health emergencies, as well as public-interest projects such as producing drugs for rare diseases that are not available on the market.

"We are proud to have been part of this project, which increases the national capacity to deal with future public health challenges, and demonstrates the efficiency of collaborative delivery methods to ensure the project team works toward a common goal: achieving gains in schedules, budgets and overall quality." · Pomerleau Inc. and Laporte Consultants Inc.

News

Supporting the COVID-19 Vaccine Task Force

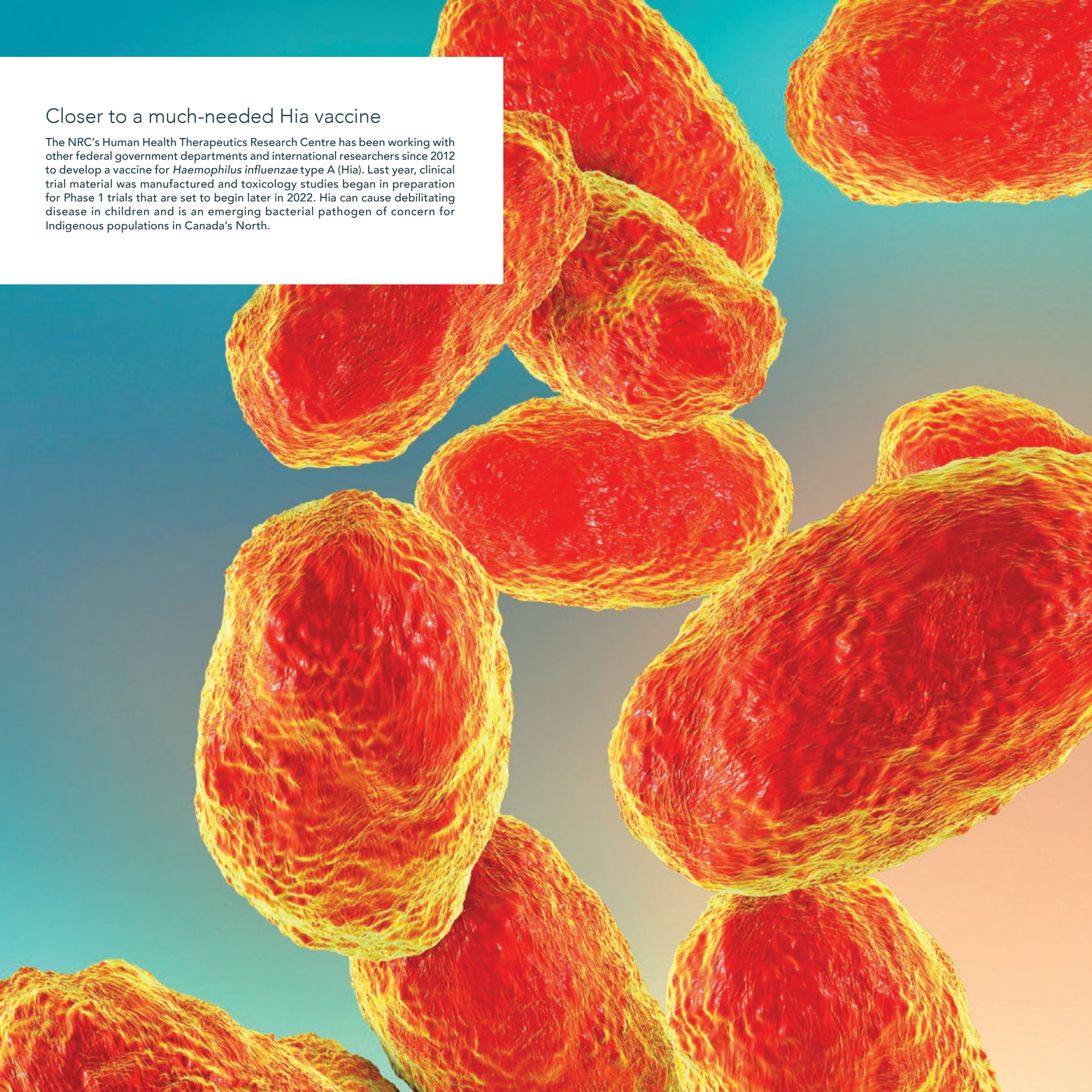
The NRC housed the secretariat to the COVID-19 Vaccine Task Force (VTF) until the end of 2021, supporting its mandate to advise on securing, developing and optimizing vaccines for Canadians. Composed of multidisciplinary experts and industry leaders in the vaccine field, the VTF provided invaluable insight to the Government of Canada.

New testing capabilities for more effective PPE

The NRC partnered with the Canadian Council of Independent Laboratories (CCIL) to help CCIL members test the safety and effectiveness of respirators and surgical face masks. The NRC's Metrology Research Centre developed new capabilities for testing particulate filtration efficiency and provided testing services for PPE and decontamination equipment to both protect Canadians and support the development of an emerging Canadian PPE industry.

Closer to a much-needed Hia vaccine

The NRC's Human Health Therapeutics Research Centre has been working with other federal government departments and international researchers since 2012 to develop a vaccine for *Haemophilus influenzae* type A (Hia). Last year, clinical trial material was manufactured and toxicology studies began in preparation for Phase 1 trials that are set to begin later in 2022. Hia can cause debilitating disease in children and is an emerging bacterial pathogen of concern for Indigenous populations in Canada's North.





Nothing
brings more
satisfaction
than the
help and
hope we
will bring
to patients
and their
families

Risini
Weeratna

Senior Research Officer
Human Health Therapeutics

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A driving force behind the first made-in-Canada cancer cell therapy

A new treatment for B-cell leukemia and lymphoma

Risini Weeratna's husband was diagnosed with leukemia more than 25 years ago. He survived thanks to an innovative therapy—an experience that changed the course of Risini's career. "Since then, I have devoted my career to preventing and curing disease."

Risini joined the NRC in 2016 after working at companies such as Pfizer. She is now a senior research officer at the Human Health Therapeutics Research Centre, leading the development of the first Canadian-made chimeric antigen receptor modifier T-cell (CAR-T) therapy for B-cell leukemia and lymphoma.

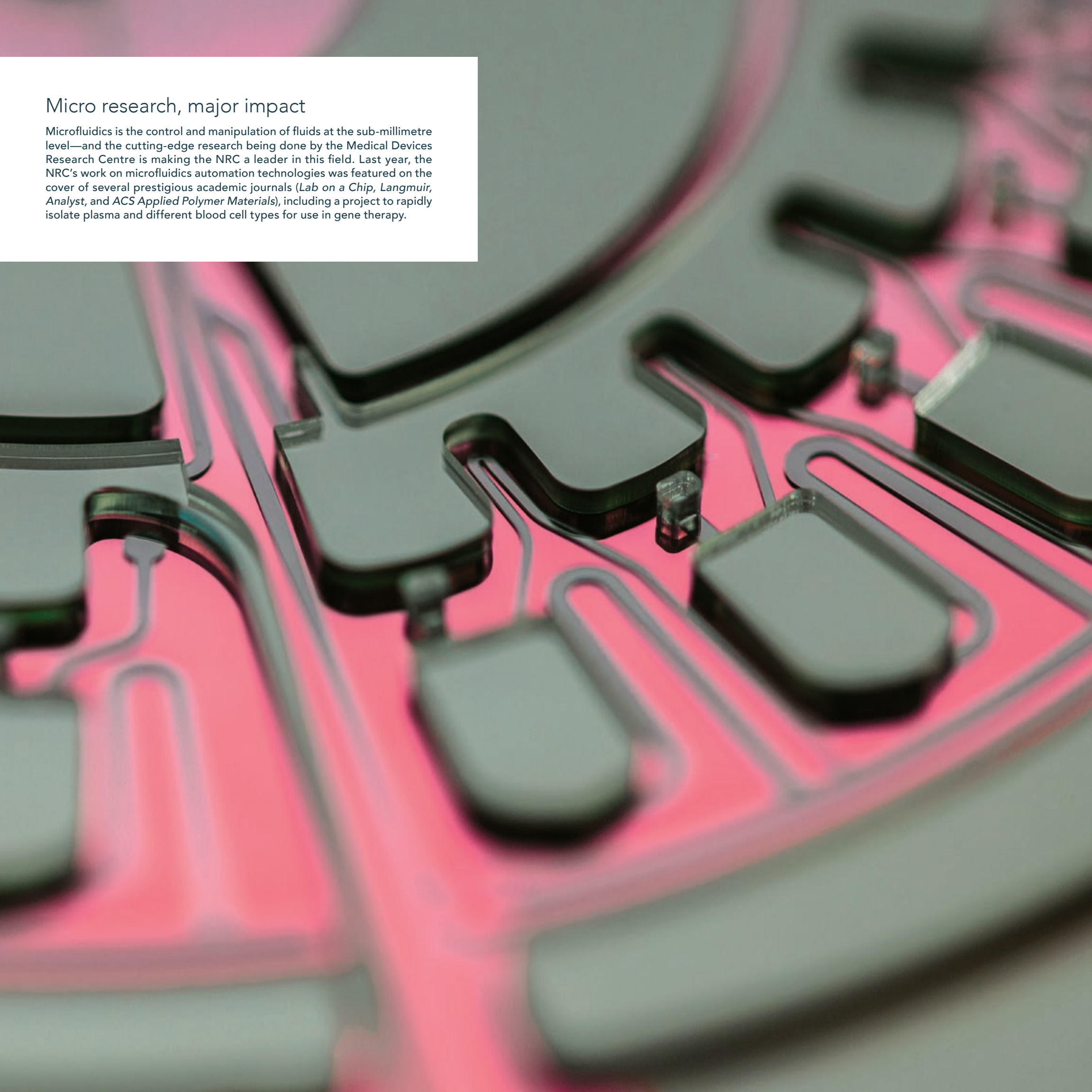
"I always wanted to apply my knowledge to develop cancer immunotherapies that are accessible more broadly across the population," she says. "Nothing brings more satisfaction than the help and hope we will bring to patients and their families."

Risini provides scientific guidance and strategic direction to NRC experts in areas related to immunotherapy, including cell therapy. In 2021–2022, her team selected the antibody building blocks that are the core of the CAR-T therapy and compiled pre-clinical safety and efficacy data for review by Health Canada. They also helped clinical collaborators secure a \$1.7 million grant from the Canadian Institutes of Health Research for phase 1 clinical trials, which are expected to begin in early 2023. If the trials are successful, this therapy will represent a breakthrough in the development of innovative medicines that are made available to all Canadians through the public healthcare system at a fraction of the cost of other currently available CAR-T therapies made by large pharmaceutical companies—with affordability being a top priority for Risini.

While most CAR-T therapies use antibodies derived from mice, the NRC used llama antibodies, which are simpler in structure and more genetically similar to human antibodies—and less likely to be rejected by patients' immune systems.

Micro research, major impact

Microfluidics is the control and manipulation of fluids at the sub-millimetre level—and the cutting-edge research being done by the Medical Devices Research Centre is making the NRC a leader in this field. Last year, the NRC's work on microfluidics automation technologies was featured on the cover of several prestigious academic journals (*Lab on a Chip*, *Langmuir*, *Analyst*, and *ACS Applied Polymer Materials*), including a project to rapidly isolate plasma and different blood cell types for use in gene therapy.



Games are an entirely new medium for delivering mental health support



Catherine
Proulx

Research Officer
Medical Devices

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Changing the game in mental health

More and more Canadians are turning to mobile apps for mental health self-care. **Catherine Proulx**, a researcher in the NRC's Medical Devices Research Centre, is lead developer on *Legend of Evelys*, a role-playing game created in partnership with the Centre for Addiction and Mental Health that went into beta testing last year.

Q: Why a game to promote good mental health?

CP: Games are an entirely new medium for delivering mental health support. They can reach a different audience than the usual public health channels. While we gave our game a lighthearted feel, it's underpinned by evidence-based therapy techniques developed with actual clinicians.

Q: What's the current status of the game?

CP: We have opened it up to a small group of players to assess usability and scalability. We designed it with people of all ages, abilities and gaming experience in mind, and worked really hard to make it inclusive.

Q: As lead investigator and main software architect, what's your role?

CP: I am hands-on with software development and also the link between all the people involved—testers, artists, legal experts and clinicians—guiding them toward one consistent vision.

Q: What motivates your work?

CP: Play is one of the fundamental human drivers, and we now have technology that puts play in the palm of everyone's hands. It's rewarding to explore how we can use that to make people's lives better, and I get to do that while fulfilling a childhood dream of making games.

A wellness strategy for a post-pandemic world

In 2021–2022, the NRC launched a new 3-year Wellness Strategy to ensure the mental health supports available to employees reflect the realities of today's workplace. Aligned with government-wide priorities on mental health and well-being, the strategy aims to equip employees and managers to better support workplace wellness, and improve the psychological health of all people at the NRC.

It's exciting to use a product that has made its way through my office



Véronique Desjardins

Véronique
Desjardins

Regional Contribution
Agreement Officer,
Industrial Research
Assistance Program

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Navigating the funding landscape

How IRAP RCAOs support Canadian innovators

As the pandemic entered its second year, it was more crucial than ever for small and medium-sized Canadian companies to get financial assistance to bring new technologies to market. The 30 regional contribution officers (RCAOs) like **Véronique Desjardins** at the NRC's Industrial Research Assistance Program (IRAP) were there to support them.

Véronique has been an RCAO for 14 years, guiding NRC IRAP clients through reimbursement processes to ensure they get sufficient, timely financing for their projects while respecting financial rules and regulations.

"I love talking to entrepreneurs," says Véronique. "I've seen projects that were just starting out and are now firmly entrenched in everyday life. It's exciting to use a product that has made its way through my office."

During the pandemic, the RCAO team worked extra hard to ensure clients were not unfairly penalized for also receiving financial assistance from other government programs. Their support complements the technical and business advice provided by NRC IRAP's industrial technology advisors (ITAs).

"What's important to me is rigour," says Véronique. "I want all Canadians' money to be well spent and allocated to the best ventures in the Canadian economy."

News

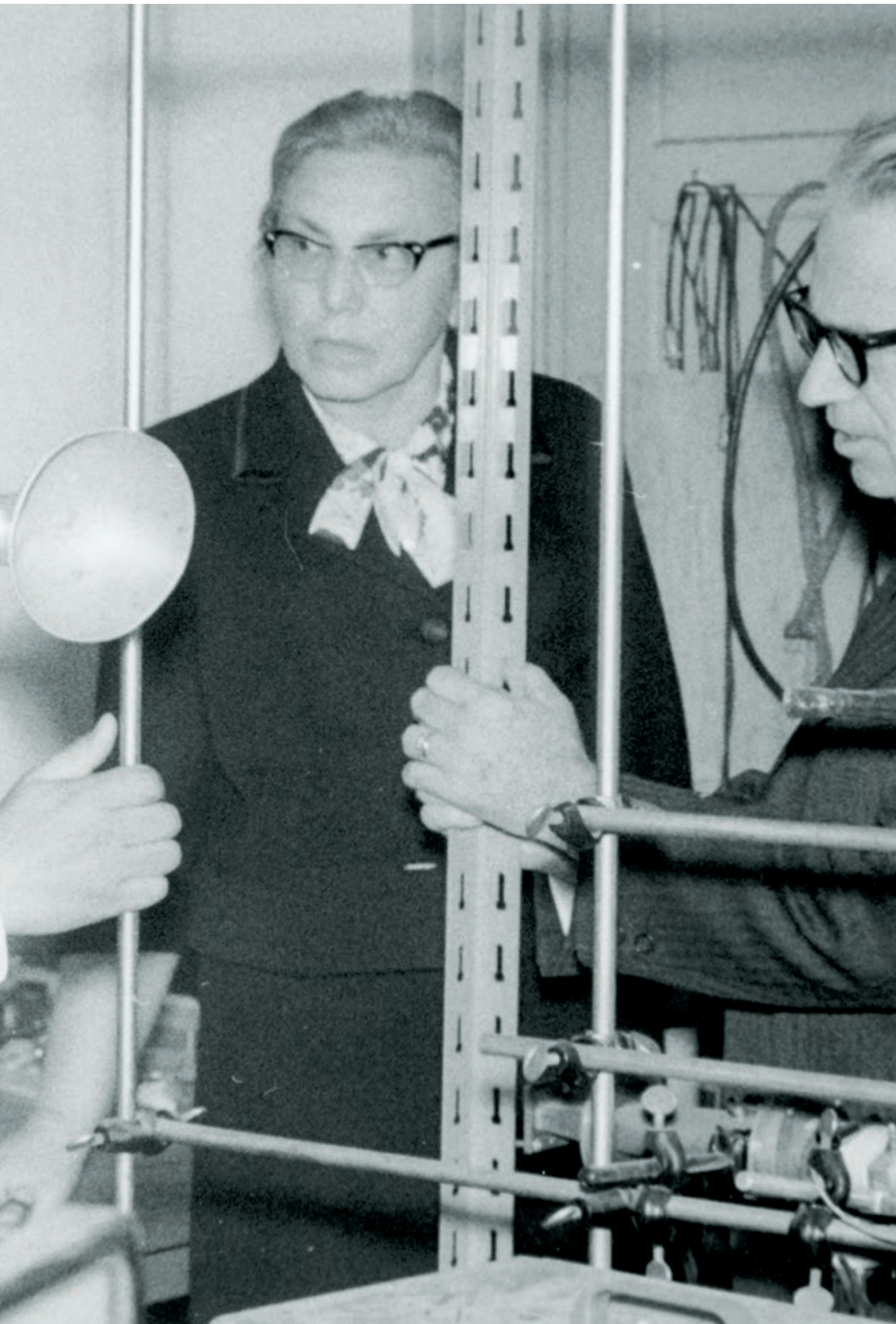
Building a more diverse workforce

NRC IRAP has expanded its efforts to help small and medium-sized companies become more inclusive by developing tools they can use to assess, prepare and implement equity, diversity and inclusion (EDI) plans. Internally, NRC IRAP has increased its focus on attracting and retaining a more diverse workforce, leveraging modern recruiting tools while refining its organizational design to meet evolving program delivery requirements.

75 years of NRC IRAP

NRC IRAP has proudly supported and enabled Canadian innovation since 1947. The program marked its 75th anniversary on January 18, 2022, kicking off a year-long celebration of its evolution into a leader in Canada's innovation space. The anniversary also provides an opportunity to honour employees past and present who have been instrumental in the success of NRC IRAP and its clients.





Luise and Gerhard Herzberg

Bridging borders

Joint Canada–Germany symposium recognizes women in science

Each February, the NRC holds a symposium celebrating the achievements of women in science, technology, engineering and mathematics (STEM) throughout the federal government. In 2022, we went beyond Canada's borders to recognize women worldwide with a virtual symposium co-hosted with the German Federal Ministry of Education and Research.

More than 1,100 participants registered for the symposium, which for the first time was held across 2 days. In addition to workshops and panel discussions on the importance of international collaboration and the role of mentoring in developing the next generation of women researchers, the symposium featured remarks from Ina Schieferdecker, Germany's Director General for Research for Technological Sovereignty and Innovation; and Agnes Herzberg, daughter of legendary German-Canadian scientist Gerhard Herzberg.

To mark the 50th anniversary of Gerhard's Nobel Prize in Chemistry, the NRC announced a new postdoctoral fellowship honouring Herzberg and his wife, Luise. The fellowship will be awarded annually to a woman PhD graduate demonstrating excellence in research.

News

A half-century of cooperation with Germany

In 2021, the NRC extended its formal agreements with the German Aerospace Center and the Bavarian Research Alliance for another 7 years. Since the 1971 signing of the Canada-Germany Science and Technology Agreement, the 2 countries have partnered on more than 1,000 joint research projects on everything from space technologies and fuel cells to photonics and ocean science.

A decade of Eureka moments

2022 marked the 10th anniversary of the NRC's membership in the Eureka network, which brings together companies, universities and other innovators from 45 countries to work on market-driven industrial research and development. As Canada's national contact point for Eureka, the NRC helps accelerate Canada's involvement in transnational research projects.

Dr. Luise Herzberg was an accomplished mechanical engineer and astrophysicist in her own right. She joined the NRC in 1948 as a volunteer research associate and spent the final 12 years of her career with the then Radio Physics Laboratory.

Awards and honours

Several NRC researchers, scientists and other professionals were recognized throughout the year for the excellence of their work and career-long contributions to their respective fields.

Dr. Paul Corkum named co-winner of Wolf Prize in Physics

Dr. Paul Corkum, Principal Research Officer at the NRC, is the co-recipient of the prestigious international Wolf Prize in Physics for 2022. A pioneer in the development of attosecond science, he is best known for developing the tools for producing the shortest human-made flashes of light—attosecond pulses lasting just one billionth of a billionth of a second—which are used to study the motion of electrons in molecules and atoms.

Individual awards and recognitions

Dr. Éric Baril • Honorary Member, InnovÉE

Dr. Phil De Luna • Member, Royal Society of Canada's College of New Scholars, Artists and Scientists

Dr. Zhenguo Lu • Fellow, Optica (formerly known as the Optical Society of America)

Dr. Alan McConnachie • Member, Royal Society of Canada's College of New Scholars, Artists and Scientists

Dr. Ralph Paroli • William T. Cavanaugh Memorial Award, ASTM International

Dr. Homin Shin • Scientist of the Year, Korean Federation of Science and Technology Societies

Dr. Roman Szumski • Friend of Thai Science Award, Office of Higher Education, Science, Research and Innovation, Royal Thai Embassy (Washington, D.C.)

Dr. Ye Tao – Fellow, Canadian Academy of Engineering

Dr. Li-Lin Tay • Finalist, 2021 Fitzpatrick Institute for Photonics Virtual Symposium Poster Session

Anuja Tripathi • Best Woman Performer in Research & Development, GISR Foundation

Dr. Priti Wanjara • Fellow, Canadian Academy of Engineering and Fellow, Canadian Aeronautics and Space Institute

Dr. Chunsheng Yang • Fellow, Canadian Academy of Engineering

Dr. Lu Yang • Fellow, Royal Society of Chemistry

Team awards and recognitions

Automotive and Surface Transportation Research Centre Powder Forming Team (Cindy Charbonneau, Louis-Philippe Lefebvre, Roger Pelletier) • Metal Additive Manufacturing Outstanding Technical Paper Award, 2021 Additive Manufacturing with Powder Metallurgy Conference, Metal Powder Industries Federation and American Powder Metallurgy Institute International

Biologics Manufacturing Centre Procurement Team • Unsung Heroes Award, Canadian Institute for Procurement and Materiel Management

Ocean, Coastal and River Engineering Research Centre (Jeffrey Brown, Dr. Robert Frederking, Dr. Jungyong Wang) • Captain Joseph H. Linnard Prize, American Bureau of Shipping

Metrology Research Centre (Greg Smallwood, Richard Green, Triantafillos Koukoulas, Thierry Lavoie, Andrew Oldershaw) and NRC IRAP (Maria Negulescu), as part of Health Canada's Respirator Guidance and Certification Development Team • Excellence in Regulatory Cooperation and Collaboration Award, Community of Federal Regulators

Automotive and Surface Transportation Research Centre, Security and Disruptive Technologies Research Centre, and e2ip Technologies • Innovation Prize (Partnerships), l'Association pour le développement de la recherche et de l'innovation du Québec

Leadership

Senior Executive Committee Composition in 2021–2022



Iain Stewart
President



David Lisk
VP Industrial Research
Assistance Program
(IRAP)



Éric Baril
VP Transportation
and Manufacturing
(Acting)



Jean-François Houle
VP Engineering



Lakshmi Krishnan
VP Life Sciences



Geneviève Tanguay
VP Emerging
Technologies



Maria Aubrey
VP Strategic Initiatives
and Biologics
Manufacturing Centre



François Cordeau
VP Business and
Professional Services



Michel Dumoulin
Special Advisor
to the President



Emily Harrison
VP Human Resources;
Equity, Diversity and
Inclusion Champion



Dale MacMillan
VP Corporate
Services and Chief
Financial Officer



Joel Martin
Chief Digital
Research Officer



Shannon Quinn
Secretary General



Dan Wayner
Departmental Science
Advisor and Chief
Science Officer

Leadership

Council members

Composition in 2021–2022



Douglas W. Muzyka
Chair of the NRC Council,
Former Senior Vice-
President and Chief
Science and Technology
Officer, E.I. DuPont de
Nemours and Company,
Indian River, NS



Karen Bakker
Professor and Canada
Research Chair, University
of British Columbia,
Vancouver, BC



Norma Beauchamp
Former President and
Chief Executive Officer,
Cystic Fibrosis Canada,
Toronto, ON



Susan Blum
Associate Vice-President,
Research and Innovation,
Saskatchewan Polytechnic,
Saskatoon, SK



Neil Bose
Vice-President
(Research), Memorial
University, St. John's, NL



Carolyn Cross
Founder, Chairman
and Chief Executive
Officer of Ondine
Biomedical Inc.,
Vancouver, BC



Aled Edwards
CEO of the Structural
Genomics Consortium,
Toronto, ON



Ray Hoemsen
President and
Managing Director of
Hoemsen & Associates,
Winnipeg, MB



Mohamed Lachemi
President and Vice-
Chancellor, Toronto
Metropolitan University,
Mississauga, ON



Steven Murphy
President and Vice-
Chancellor, Ontario Tech
University, Oshawa, ON



Pierre Rivard
Executive Chairman
and Co-Founder,
TUGLIQ Energy Corp.,
Toronto, ON



Iain Stewart
President, National
Research Council of
Canada, Ottawa, ON

