NRC·CNRC

From ***Discovery*** *to* ***Innovation…***

Science at work for Canada

A Proud Past – A Vital Future

1916 1930 1950 1970 1990 2001

ENVIRONMENT • HEALTH • TRANSPORTATION • NUCLEAR ENERGY • FOOD SAFETY • CONSTRUCTION • BIOTECHNOLOGY • ASTRONOMY • AEROSPACE • INFORMATION TECHNOLOGY • NATIONAL SECURITY • ADVANCED MATERIALS • OCEAN TECHNOLOGY • FUEL CELLS

Ninety years of Canadian achievement

National Research Council Canada
Conseil national de recherches Canada

Canada

Since 1916, NRC has been dedicated to using science and technology to help protect and improve the lives of Canadians, and strengthen our national economy. Here are some of our past accomplishments through the decades.

1916

NRC ESTABLISHED

Since the beginning — June 6, 1916 — when the National Research Council Canada (NRC) was known as the Honorary Advisory Council on Scientific and Industrial Research, NRC has been committed to strengthening the Canadian economy and improving the lives of Canadians through science and industrial research.

1920s

CONCRETE AND CEMENT SCIENCE STAND STRONG

For over eight decades, NRC research on concrete and cement has ensured the safety of Canada's infrastructure — helping prevent sewers, roads, bridges and buildings from quickly deteriorating in the harsh Canadian climate.

In 1920, NRC was asked to find out why concrete structures, such as sewers and public buildings, were crumbling in western Canada. After tracing the problem to sulphate waters that degrade concrete, researchers developed a sulphate-resisting cement and a curing treatment to protect fresh concrete against corrosion.

NRC's work has led to the development of new test methods and materials that can be added to concrete to prevent failures and premature deterioration.

More recently, NRC has created a new concrete with electrically conductive properties that has potential applications ranging from the heating of houses to the de-icing of bridges, roads and runways.

1930s

STREAMLINING THE LOCOMOTIVE

In the 1930s, NRC engineering helped to launch a new generation of streamlined locomotives. The new design grew out of a project to improve the efficiency of locomotives and prevent smoke from obscuring the engineer's view.

Engineers used NRC's new wind tunnel to test existing locomotive models for Canadian National Railways (CNR), and experiment with alternate designs, resulting in a sleeker, more aerodynamic shape.

By 1936, CNR unveiled its NRC-designed locomotive series. Its chief rival, Canadian Pacific Railway (CPR), soon had a similar locomotive in production. In 1939, the new CNR and CPR locomotive designs were both chosen to pull the Royal Train during a Canadian tour by King George VI. Later that year, the NRC-inspired CNR locomotive was featured at the World's Fair in New York City.

1940s

AT THE FOREFRONT OF ATOMIC ENERGY RESEARCH

It was a top secret military project: Under the cover of war, NRC developed nuclear research into a scientific marvel that launched Canada onto the world stage in energy, health care and technology.

In 1941, NRC built Canada's first nuclear reactor prototype and, in 1947, unveiled the National Research eXperimental (NRX) reactor — the most powerful nuclear reactor in the world.

Housed at the massive Chalk River Laboratories, NRX and its successor, the National Research Universal (NRU) reactor, became a top training ground in nuclear science, engineering and technology.

Scientists produced new medical isotopes that are still used today to diagnose and treat cancer and other serious illnesses in more than 20 million patients around the world each year.

In 1952, Atomic Energy of Canada Ltd. spun off from NRC. There, scientists designed and tested the CANDU reactor — the world's most efficient nuclear power system.

NRC still uses the Chalk River Labs through the Canadian Neutron Beam Centre, where researchers apply neutron scattering to study everything from steel to ice.

RADAR — "THE NIGHT WATCHMAN"

During the Second World War, NRC was the centre of Canadian contributions to radar technology. In fact, Canada installed the first operating radar system in North America — a coastal defence system near Halifax called the "Night Watchman", with NRC's help.

In the late 1930s, NRC began to explore the possibility of detecting aircraft by electrical means. Meanwhile, the British had devised high-powered compact radar designs for an anti-aircraft system. The secret technology was brought to North America in 1940, and NRC used the plans to develop the GL Mark III C anti-aircraft radar system. Although it did not see action in Britain, this system was installed in Australia, South Africa, Russia and Canada.

This success soon led to further radar design and production work. By 1945, NRC had developed about 30 different types of radar for various military purposes that helped the allies win the war.

A NEW ERA IN ELECTRONIC MUSIC

The funky electronic sounds that have enlivened popular music since the 1970s owe their origins to NRC — inventor of the world's first synthesizer in 1945, the "electronic sackbut."

NRC's original electronic sackbut, a keyboard the size of a small electric organ, produced only one note at a time, but a performer could control that sound in a number of ways. It played the theme music for "Mr. Wizard", a science program that aired for two decades on U.S. television. Eventually, the instrument evolved to feature a touch-sensitive keyboard that allowed a musician to change the volume and pitch of a note by altering a key's vertical pressure or making a sideways motion.

Another NRC musical innovation was the variable speed, multi-track tape recorder. A pioneer of computer music programs in the 1970s, NRC also contributed to the development of electronic music studios.

1950s

ENGINEERING A BETTER QUALITY OF LIFE

Created to assist injured war veterans, an NRC invention has helped thousands of paralyzed people around the world regain a sense of mobility. NRC designed the world's first practical electric wheelchair for quadriplegics, and it quickly drew international attention. The prototype, considered one of the most significant artifacts in Canadian innovation history, is now on display at the Smithsonian Institution in Washington, D.C.

The NRC model was more reliable, maneuverable and versatile than any previous motorized wheelchairs. It featured independent drives on each of the main wheels, so the chair could pivot easily, as well as a sophisticated control switch with eight different positions that resembles the modern "joystick".

Moving at a speed of roughly four kilometres per hour, the prototype wheelchair could operate in close quarters and on relatively steep ramps. It had a maximum operating range of about 30 kilometres, which made it practical for use both indoors and outdoors.

Through this project, NRC helped launch the new field of rehabilitation engineering.

LIFE-SAVING TECHNOLOGY

For decades, NRC has worked at the very heart of biomedical engineering. Inventions include the world's first cardiac pacemaker, and also the first pacemaker to be powered by the human body.

When doctors wondered how to safely restart a heart that stops during surgery, NRC researchers found that a gentle electrical stimulus would do the trick. The stimulus could also speed up or slow down an irregular heart beat.

In 1950, NRC unveiled the first model pacemaker: a radio-sized unit that used vacuum tubes to generate electric pulses and ran on a standard household current. While it worked well, it was too big to be immediately practical. But with steady advances in transistors and batteries, pacemakers got smaller and by 1957, in Sweden, the first unit was successfully implanted in a person's chest.

NRC researchers didn't miss a beat and soon created the world's first "biological pacemaker" charged by the body's own energy. This device could run uninterrupted for about a decade.

Today, the cardiac pacemaker is an essential element of modern medicine for people with diseased or injured hearts.

CREATING CANOLA — "PRAIRIE GOLD"

The bountiful fields of bright yellow canola that blanket the Prairies are a testament to NRC research. Today, canola is a staple ingredient in cooking oil, mayonnaise, cosmetics and dozens of other products. Considered the world's only made-in-Canada crop, canola contributes more than $6 billion per year to the economy — including $2 billion worth of exports.

In the 1950s, crop researchers took steps to reduce Prairie farmers dependence on wheat. Over the next several decades, they helped transform rapeseed — a minor crop used as an industrial lubricant — into a nutritional, edible oil. By the mid-1970s, two million hectares of the new plants, christened canola (**CAN**adian **O**il **L**ow **A**cid), were grown in Canada.

Depending on the year, canola is the second most valuable crop (behind wheat) harvested on Canadian farms. Today, Canada remains the global centre for canola science, growing more than 5.2 million hectares of the wonder plant.

1960s

SAVING SURVIVORS BY FINDING FALLEN AIRCRAFT

Decades ago, wilderness airplane crashes usually ended in tragedy. Finding survivors in remote areas meant hunting for visible signs of life in a vast landscape of near-identical features. Many victims died of starvation or exposure to the elements before they could be found. But a life-saving NRC invention — the crash position indicator — has removed the guesswork from search and rescue work, by quickly pointing the way to downed aircraft.

The device has been installed on millions of aircraft around the world. This crash-proof, waterproof, fire-resistant radio beacon is designed to tumble clear of a fallen aircraft, automatically turn itself on, and then beam out a homing signal. NRC licensed its technology to a Canadian company and the device was then combined with a flight recorder that monitors an aircraft's systems and operations. The "black box" is now a permanent fixture on heavy aircraft around the world.

KEEPING CANADA ON TIME

As Canada's official time keeper, NRC uses atomic clocks to keep Canada on time and in sync with the rest of the world. Maintaining time standards is essential to keep global economies, navigation and communication running smoothly.

In the late 1950s, NRC entered the atomic age of timekeeping when it completed one of the world's first atomic clocks. Then, in 1975, NRC built the first cesium clock that could run continuously and not require calibration with an external clock.

The accuracy and stability of atomic clocks is important since our communication and navigation systems rely on precise time measurements. Aircraft and ships rely on global positioning systems that use time signals broadcast from atomic clocks on board satellites orbiting the earth.

Also, increasingly complex science requires high levels of accuracy. Radio and television broadcasters have to coordinate their programming schedules to a standard time so audiences can tune into their favourite programs. And, telecommunications systems rely on precise timing to operate switches that route signals through networks like the Internet.

Although we might not think about it, atomic clocks play a big role in many aspects of our daily lives.

More than 90 YEARS of remarkable research and memorable contributions to Canada

Decade by Decade

1916

NRC Established

1920s

Paving the Way to Stronger Concrete
In the 1920s, NRC scientists developed corrosion-resistant concrete able to stand up to Canada's harsh climate, and launched a field of research that continues to ensure the safety and durability of Canada's buildings and bridges today.

1930s

Streamlining the Locomotive
In the 1930s, NRC redesigned the shape of the steam locomotive, transforming it from a smoky safety hazard into a sleek, streamlined vehicle fit for royalty.

1940s

Revolutionizing Music
By combining scientific knowledge and a passion for music, an NRC physicist created the world's first electronic synthesizer in 1945 — an instrument still used in much of today's popular music.

Protecting WWII Troops
During the Second World War, NRC scientists advanced radar technology, built Canada's first nuclear reactor, and developed an ATV tracking system among many other valuable contributions with long-lasting effects.

1950s

Creating Canola
NRC researchers and agriculture scientists in Saskatoon, Winnipeg and Ottawa helped build a billion-dollar canola industry by breeding a nutritious made-in-Canada supercrop.

Engineering a Better Quality of Life
Through innovations like the electric wheelchair and the artificial pacemaker, NRC research has improved the quality of life of countless Canadians.

1960s

Setting Clocks Precisely
For decades, NRC has been a leader in creating and developing atomic clocks that keep Canada and the world running on time.

Finding Fallen Aircraft Quickly
The crash position indicator was designed by an NRC engineer to help search and rescue teams find crashed aircraft faster, saving the lives of survivors and rescuers alike.

1970s

Foiling Counterfeiters
NRC scientists helped foil the efforts of counterfeiters by creating the special optical thin-film coatings that are used as security features on Canadian currency, ID cards and driver's licenses.

Pioneering Computer Animation
NRC developed key-frame animation software that inspired a generation of computer animators around the world and changed the face of cinematic art.

1980s

Sniffing Out Terrorism
A bomb sniffer designed at NRC to chemically sniff out hidden explosives has been used around the world in the fight against international terrorism.

Launching Canada's Space Program
During the "space fever" of the early 1980s, NRC launched Canadarm and the Canadian Astronaut Program, giant steps in the development of Canadian space science.

1990s

Preserving the Environment
NRC researchers developed Biobrite™, an enzyme that dramatically decreases organochlorine discharges from pulp bleaching while saving mills hundreds of thousands of dollars each year.

Safeguarding Children's Health
Three decades of NRC research resulted in an infant meningitis vaccine that will protect the lives of children around the world.

Helping Olympians Compete
NRC helps Canada's speed skaters, skiers, skeleton teams and other Olympic athletes reach the top of their sport by testing and improving their aerodynamics, equipment and clothing.

2000s

Digitally Preserving Historic Treasures
First developed at NRC in the mid-1980s, virtualizing reality technology renders stunning movie effects, and has been used to create extremely high resolution 3D digital records of the Mona Lisa and other historic treasures.

And the future promises more discovery and innovation by NRC

1970s

WHERE IT ALL STARTED — ANIMATION IN NRC LABS

Behind the big screen magic of *The Lord of the Rings* and *Harry Potter* movies lies a technology that has changed the face of cinematic art. In fact, NRC animation pioneers have been honoured with an Academy Award in the technical achievement category for their contribution to the animation industry.

The scientists designed an animation package that could generate complete animated sequences based on key frames, whereby an artist sketched frames showing only the main points of action. The computer then calculated the in-between frames, reducing the tedious manual work traditionally involved in animation.

The first computer-animated film was an experimental project done in collaboration with the National Film Board of Canada. This led to "Hunger" (*La Faim*), which in 1974 became the first computer-animated movie to be nominated for an Academy Award. NRC also contributed animation sequences to the groundbreaking documentary series called "Ascent of Man", featured on the BBC.

NRC's work inspired a generation of animators and paved the way for sophisticated computer animation in blockbuster films.

THIN-FILM TECHNOLOGY HELPS FOIL COUNTERFEITERS

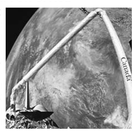
Aside from their distinctive design, each of Canada's decorative bank notes is embedded with a reflective strip that changes colour when tilted, cannot be reproduced through normal printing or photographic processes, and is impossible to peel off. Today, these optical security devices — developed and patented by NRC — are also seen on passports, cheques and ID cards all over the world.

In 1968, the Bank of Canada approached NRC to help prevent counterfeiters from using super-resolution printers to produce fake currency. From 1989 onwards, the Bank of Canada began introducing new notes featuring an optical security patch on the front of each bill. An immediate drop in counterfeiting followed each new currency release.

As NRC technology evolved, so did the level of security protection built into Canadian bank notes. In the second generation of optical security devices, the colour-changing strip was built right into the bank note paper itself, in the form of a thin, coated plastic thread.

1980s

ENGINEERING A ROBOT ARM FOR SPACE



In November 1981, Canada's most famous robot — "Canadarm" — made its bold international debut. With "Canada" prominently emblazoned, Canadarm's introduction in space has been called the most visible and dramatic demonstration ever of Canadian technology on a global stage. NRC named the revolutionary robotic arm and led its design, development and construction — overseeing a Canadian industrial team — for NASA's space shuttle program.

Almost a decade in development, Canadarm was created to help astronauts launch and recover satellites and other payloads, and to assist in space walks. It was engineered to withstand the extreme space environment: intense cold, heat and radiation — and keep working perfectly. Designed for microgravity, Canadarm can grab, lift and maneuver more than 30,000 kilograms using less electricity than a kettle.

In 2001, Canadarm2 — a larger, more sophisticated robot arm — was installed on the International Space Station. The new arm has two "hands" so it can latch onto the space station while grasping objects or "walking" from place to place like an inchworm. Operators use an NRC-designed space vision system to keep track of the position, orientation and movement of payloads.

LAUNCHING THE CANADIAN ASTRONAUT PROGRAM

Just before sunrise on October 5, 1984, an NRC space team put its mark in Canada's history books. The launch of Space Shuttle Mission 41-G was a special moment for millions. Within 8 minutes of lift-off, Marc Garneau was circling the Earth aboard *Challenger*, becoming the first Canadian to travel into space.

Only eight months earlier, NRC had recruited Garneau and five other Canadian astronauts to begin training and prepare a set of experiments for space flight.

The unprecedented national job competition generated headlines across the country. Over 4,000 people applied for this "chance in a lifetime", including engineers, scientists, doctors, computer experts, pilots, and teachers. After a rigorous evaluation process, six were selected based on their academic backgrounds, professional experience, health, and communication skills.

Eventually, five of NRC's original six astronauts flew on shuttle missions and took Canadian experiments into orbit. In 1989, NRC's astronaut team, space technology and space science activities became the core of the new Canadian Space Agency.

BOMBSNIFFERS BATTLE TERRORIST THREATS

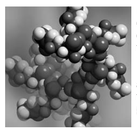
Long before crime-fighting wizardry captured the pubic's eye, the Canadian Mounties possessed one of the world's best bomb sniffers. NRC built the first device to battle terrorism in the skies.

Canadian aviation security officials, concerned about hijackings and bomb threats in the 1970s, enlisted NRC's help to test the vapours from TNT dynamite — a popular explosive. The result was a suitcase-sized explosives vapour detector called the "NRC Blue Box", which can also detect some plastic explosives. In the 1980s, the RCMP used these devices to protect Queen Elizabeth II, Pope John Paul and U.S. President Ronald Reagan during state visits.

Following aircraft bombings in the '80s, NRC bomb sniffers were installed in all Canadian airports. Meanwhile, NRC developed a faster technique to detect both illicit drug and explosives compounds. Today, the technology is used worldwide.

1990s

WINNING THE WAR AGAINST INFANT MENINGITIS



Infectious disease is the world's greatest child killer, but a meningitis vaccine developed at NRC is saving lives around the world. The vaccine protects against meningitis C — a potentially fatal infection of the lining around the brain and spinal cord. Older vaccines failed to protect infants, but this new one protects all ages.

Meningitis kills up to 10 per cent of its victims within 48 hours, and survivors are often left with serious health problems such as permanent brain damage, hearing loss and learning disabilities. Half of the victims are less than two-and-a-half years of age.

NRC set out to create a vaccine that would work on children's immune systems. The result was a new vaccine that is more reliable and stimulates the production of meningitis antibodies in infants.

Great Britain was the first country to use the vaccine in a mass immunization program. In the first year, the incidence of meningitis C decreased by 75 to 85 per cent. In two years, it was virtually wiped out.

HELPING TO PROTECT THE ENVIRONMENT

For many years, Canada's pulp and paper industry wrestled with a huge problem: pulp bleaching methods use chlorine and generate vast amounts of toxic liquid waste. But in the 1990s, NRC developed an industrial enzyme that greatly reduces both the pollution discharged by pulp mills and the cost of producing pulp. This enzyme, called xylanase, has helped Canadian pulp mills decrease chlorinated waste products by 4,000 tonnes per year, while saving each mill about $500,000 in annual operating costs.

Since natural xylanase falls apart under harsh industrial conditions, NRC researchers tailored a xylanase molecule to work at the higher acidity and temperature levels typical of pulp processing. The hardy enzyme was approved for commercial use in both Canada and the U.S.

SCIENCE IMPROVES CRIME-BUSTING TECHNIQUES

Fingerprinting is one of the oldest tools in forensic science. Thanks to NRC's pioneering research, the RCMP and other police forces around the world can obtain fingerprints now from what once seemed like impossible sources, such as human skin and plastic bags.

When researchers discovered that laser light can make fingerprints fluoresce, NRC designed a portable fingerprint lamp that investigators can bring to crime scenes. The lamp can also identify trace fibres such as hair, which are often critical to evidence gathering.

Other advances include a vacuum fingerprint chamber that uses common super glue (methyl cyanoacrylate) to quickly reveal fingerprints on crime scene objects, and a powerful dye that makes otherwise invisible fingerprints glow. Today, NRC technology keeps Canada at the forefront of forensic innovation.

2000s

THE SCIENCE BEHIND OUR ATHLETES

Behind Canada's top winter athletes are world-class NRC scientists, who can improve everything from bobsled runners to speed-skating suits.

NRC wind tunnels have been used to assess the aerodynamics of sports equipment — such as cycles, sleds, helmets and suits — and the positioning of athletes' shoulders and legs. In preparation for the 2002 Salt Lake City Olympics, Canadian speed skater Catriona LeMay Doan tested six possible suits — and went on to win a gold medal. In light of her success, members of Canada's cross-country ski team also tested their suits at NRC.

NRC has a long track record of working with athletes to boost their performance. In the 1970s and 1980s, Ken Read, Steve Podborski and other members of the famous "Crazy Canucks" downhill skiing team polished their racing styles inside the wind tunnels. For the 1992 Winter Olympics, scientists applied laser techniques to change the surface properties of bobsled runners in order to increase their speed and reduce wear and corrosion.

NRC's influence has even extended to a universal symbol of the Olympics. For the 1988 Calgary Winter Games, "Team NRC" rose to the challenge by designing a special Olympic Torch, including a safe, clean and continuous fuel system for the torch.

DIGITALLY DEFINING HISTORIC TREASURES

For centuries, the Mona Lisa's enigmatic smile has beguiled viewers while the details of da Vinci's masterpiece have intrigued science. Now, NRC researchers have shed new light on some of the painting's enduring mysteries.

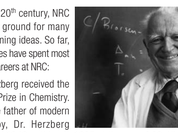
NRC's unique advanced imaging technology is able to record the faintest of details, including fine brush strokes or tool marks on works of art. In 2004, French authorities invited NRC to participate in an extensive high tech examination of the Mona Lisa.

For a few brief hours spread over two days, scientists scanned the painting with a 3D colour laser. The images revealed new details of da Vinci's unparalleled brushstroke technique and uncovered the master's original sketch hidden beneath the layers of paint. Scientists also detected a subtle warp on one side of the underlying wood panel, but no sign of any lifting paint, suggesting that for a lady her age, the Mona Lisa is well preserved. These details will help curators in their ongoing efforts to understand and protect the 500-year-old masterpiece.

Today, NRC's 3D scanner technology is used around the world to create digital models of major artifacts and works of art. NRC has also scanned Michelangelo's *David* sculpture and paintings by Renoir, Tom Thomson and Rembrandt.

Discover more about NRC's proud past, vital future, important research and remarkable teams at www.nrc-cnrc.gc.ca/student-science-tech

NRC and the Nobel Prize



Throughout the 20th century, NRC provided fertile ground for many Nobel Prize-winning ideas. So far, 10 Nobel laureates have spent most or part of their careers at NRC:

- Gerhard Herzberg received the 1971 Nobel Prize in Chemistry. Hailed as the father of modern spectroscopy, Dr. Herzberg joined NRC in 1948, retiring in 1995 at the age of 90. His NRC laboratory became the world centre for molecular spectroscopy.
- John Polanyi and Dudley R. Herschbach shared the 1986 Nobel Prize in Chemistry for developing a new field of chemistry called reaction dynamics. Dr. Herschbach was a visiting NRC researcher in the early 1950s, while Dr. Polanyi was a Postdoctoral Fellow from 1952 to 1954.
- Sir Frederick Banting shared the 1923 Nobel Prize in Physiology or Medicine for the discovery of insulin. A member of NRC's governing council from 1938 to 1941, Dr. Banting helped found the Medical Research Council (now called the Canadian Institutes of Health Research).
- Bertram Brockhouse shared the 1994 Nobel Prize in Physics for developing neutron spectroscopy, and for pioneering contributions toward neutron scattering techniques. Dr. Brockhouse conducted atomic research at Chalk River from 1950 to 1952, and worked at NRC laboratories in Ottawa from 1944 to 1947.

Other NRC alumni who were also Nobel-laureates include: Sir John Cockcroft (1951), Geoffrey Wilkinson (1973), Rudolph Marcus (1992), Sir Harold Kroto (1996) and John Pople (1998).