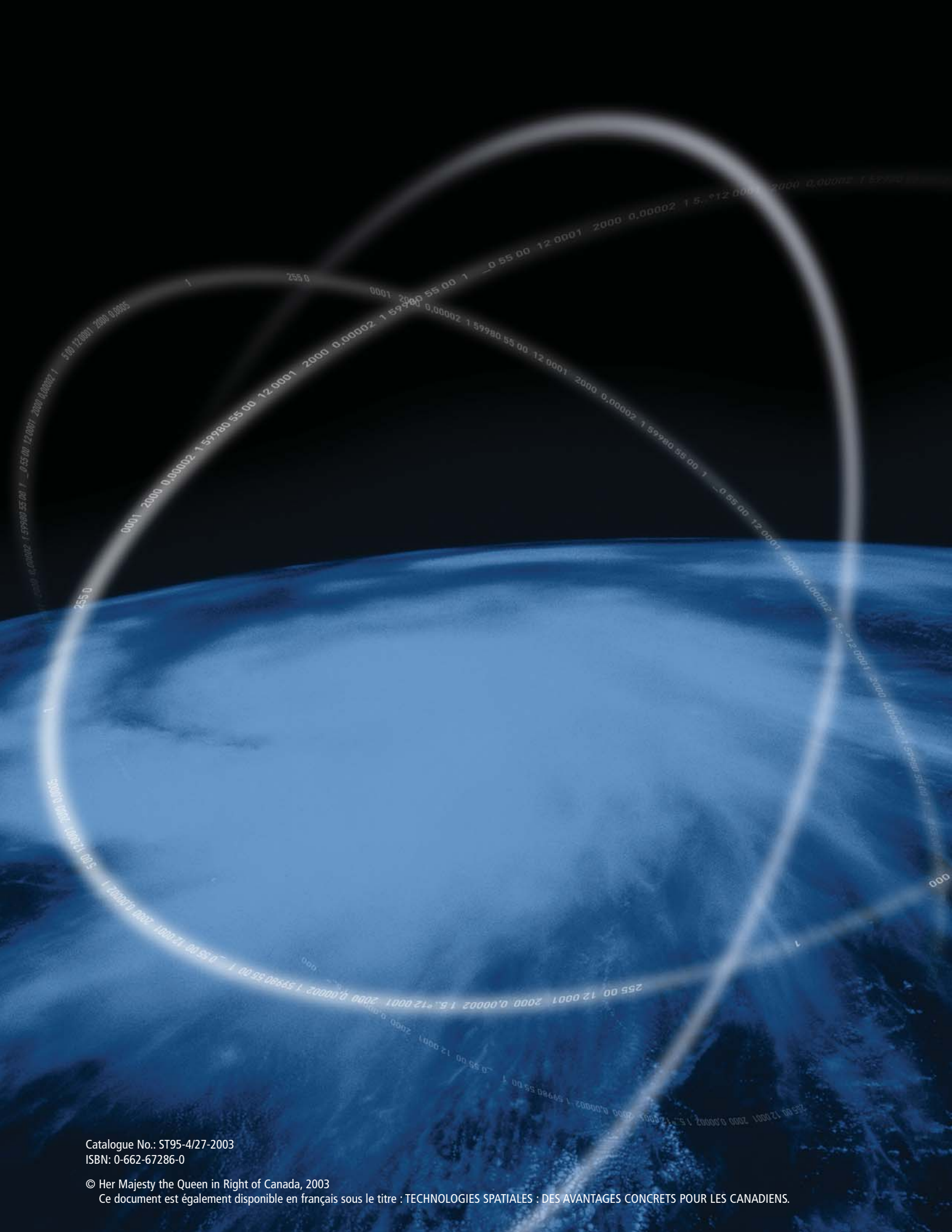
Canadian Space Agency | Agence spatiale canadienne

CSA ASC

BRINGING SPACE TECHNOLOGIES TO CANADIANS

Technological innovations/Innovations technologique

Canada



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A WORD FROM THE PRESIDENT

More than four decades have passed since Canada became the third country to launch a satellite into space. Much has changed since that time. In the past, we focused on areas such as mobile satellite technology. Today, Canada is a recognized global leader in niche markets such as satellite communications, Earth observation and space robotics. Increasingly, Canadian ideas, expertise and innovations in these areas are shaping the world's future.

One thing has not changed since the launch of Alouette-1 in 1962—our firm commitment to use space-based research to benefit Canadians in their daily lives. It is, in fact, much more than a goal. As the success stories in this publication make abundantly clear, it is an ongoing reality.

Equally clear is the fact that our achievements in space are directly linked to our accomplishments here on Earth. We have come to understand that if Canada's space program is to reach new heights, it will be fostered through collaborative relationships between different levels of government, the private sector, with academic researchers and scientists as well as with other space agencies.

The Canadian Space Agency is keenly aware of how a strong foundation of partnership and trust can help us extend the benefits of space-based technologies and applications. To that end, we have established an advisory council made up of key representatives from industry, academia and government. Council members are helping us identify new opportunities to expand the scope and depth of our initiatives. Their input will also help us build an increasingly competitive, export-oriented Canadian space sector.

The future holds great promise, as well as enormous challenges, for Canada's space program. One day, perhaps in the not-too-distant future, we may realise our dream of reaching and exploring Mars. When that day comes, we will once again expand our knowledge of Earth and our place in the universe. And that knowledge and understanding, in-turn, will continue to expand our ability to deliver benefits to Canadians and humanity.

Dr. Marc Garneau

President, Canadian Space Agency

A WORD FROM
THE DIRECTOR GENERAL

The development of space technologies plays an important and vital role in the continuing success of the Canadian space program and the Canadian space industry. The technology development sponsored by the Canadian Space Agency (CSA) has enabled industry to remain internationally competitive and to maintain a leadership position in several niche areas.

Some of the success stories presented here illustrate how the relationship between the CSA and Canada's space industry generates benefits for Canadians. Through these success stories we are acknowledging the exceptional contributions of our growing list of industrial partners. They have played a critical role, not only through the performance of contracted research and development, but also through the contribution of funds, equipment, facilities, know-how and effort towards the development of new technologies.

At the Canadian Space Agency we will continue to support development of new technologies to assure a bright future for our industry, and our space program for the benefit of all Canadians.

Dr. Virendra Jha

Director General, Space Technologies

INTRODUCTION

Using a satellite telecentre, a doctor in a remote area of Labrador consults a specialist in Montreal. As a result, a desperately ill young girl gets the treatment she needs without leaving her home town.

Robotics developed by a Canadian company to maintain and repair satellites in space are now giving surgeons the ability to perform medical operations once considered impossible.

These are just a few examples of space technology being applied on Earth. In today's world, using space technology we can manage our food production more effectively, monitor our environment with increased vigilance and help international rescue teams speed to where they are needed most at disaster sites. These are some of the many ways that space technology save lives and enhances the quality of life on Earth.

Once considered the final frontier, space is increasingly the first place we look to meet the challenges that confront us today. The following stories make it clear that Canada's space industry, through the Canadian Space Agency's technology development activities, is applying the potential of space technologies to improve the lives of all Canadians.

ECONOMIC BENEFITS

EMS SATCOM EQUIPS CORPORATE AIRCRAFT

Fueled by the support of the Canadian Space Agency (CSA), a young Canadian company is blazing a trail in the competitive world of satellite communications. The result? An increasingly impressive line of innovative products developed and manufactured in Canada.

SATCOM is an Ottawa-based division of EMS Technologies of Atlanta, a leading designer and manufacturer of wireless satellite and electronics solutions. EMS Technologies SATCOM, recognized globally for its expertise in exceptionally light and highly reliable antenna systems, has designed and produced mechanically steered antenna products, and now produces full satellite communications systems.

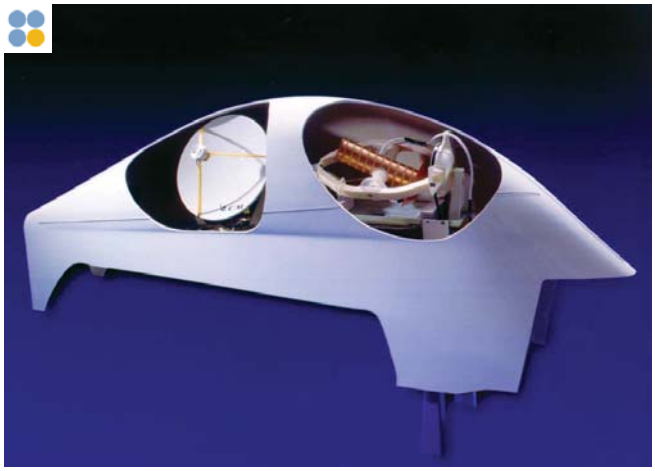

photo: EMS TECHNOLOGIES (SATCOM Radomes)

EMS Technologies SATCOM is Honeywell's supplier of Aeronautical Ku-band antennas for satellite TV and Direct PC for use on corporate aircraft. Working with Harris/LiveTV, SATCOM developed the first and only satellite TV system to be deployed on commercial airlines. In addition, military and corporate aircraft, using the company's aeronautical high-speed data terminal, can access e-mail and the Internet around the world. On the ground, SATCOM and EMS products are also being used to effectively track and schedule truck fleet operations.

Only a few years ago, SATCOM was little more than a fledgling business. Today, SATCOM generates revenues of almost $70 million a year, enjoys a solid international reputation, and contributes to the economy of several cities and provinces. Its products are widely used around the world.

In large part, SATCOM's success is due to its unflagging efforts to develop the lightest and most reliable products. It is also due in part to the support received through the CSA's International Mobile Satellite Communications Program (IMSCP) administered by the Communications Research Centre (CRC). By assuming a level of risk SATCOM itself could not afford, IMSCP enabled the company to develop and launch a number of successful satellite communication products.

Today, EMS Technologies SATCOM is well positioned to continue its ascent in aeronautical satellite communications. The company continues to grow, allowing it to attract the skilled engineers, managers and business development professionals it needs to design further successful satellite communication products.

Company: *EMS Technologies SATCOM (Ontario)*

Project: *International Mobile Satellite Communications Program (IMSCP)*

Applications: *Aeronautical Satellite Communications*

SATELLITE NAVIGATION SYSTEMS—WE'D BE LOST WITHOUT THEM

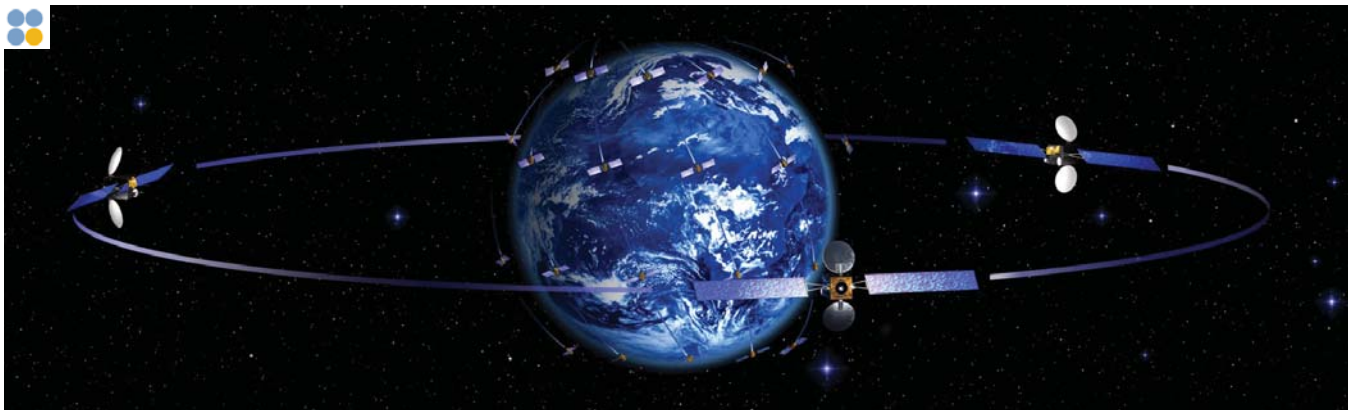

photo: ESA (Galileo)

Satellite navigation receivers, using the Global Positioning System (GPS), give businesses the ability to track, control and manage anything that moves! They help us find oil, guide shipping, land aircraft, synchronize cell phone systems, and provide time references for banking transactions. They tell hikers, bikers and mountaineers where they are and where they're going. They show us the way to our favourite golf holes and lead us back to our secret fishing holes.

In recent years, smaller and less-expensive receivers have introduced the advantages of GPS to an ever-expanding list of commercial and private users. Today, GPS is used around the world for positioning, tracking, mapping and timing.

In large part, Global Navigation Satellite Systems (GNSS) - (the generic term for the US GPS, the Russian GLONASS and upcoming European Galileo systems) owe their growing popularity to their exceptional accuracy. Maintaining that accuracy, however, is no easy task. Factors such as the satellite's orbit, clock drift and signal delays (due to the atmosphere and ionosphere) can cause significant errors in signals sent by a global satellite navigation system. A number of systems have been developed to overcome these factors.

Leading the way in the development of these systems is the Canadian company, NovAtel. In fact, technology developed by NovAtel is at the core of the world's national satellite-based augmentation networks, which improve the accuracy and reliability of the signal for all users. Today, over 90% of ground reference receivers—used to maintain the accuracy of GPS—are supplied by NovAtel.

Now, through its cooperative agreement with the Canadian Space Agency, the European Space Agency has asked NovAtel to contribute to the development of the European Union's state-of-the-art GNSS. Specifically, NovAtel will develop requirements for the system's Galileo Ground Reference Receiver (GRR). It will also create a software model of the receiver to confirm and verify the system's performance specifications and create a top-level structural design for the GRR.

When complete, Galileo will be the first satellite positioning and navigation system specifically designed for civil purposes. With NovAtel's input, it will also be the most efficient and advanced system in existence.

photo: NOVATEL (Ground Reference Receiver)

Company: *NovAtel Inc. (Alberta)*

Project: *Galileo-European GNSS*

Applications: *Ground Reference Receivers*

SELLING ITS SAILING EXPERTISE

photo: ENFOTEC (ICENAV Workstation)

After developing a navigation system to guide ships through the ice-covered waters of the Canadian Arctic and Gulf of St. Lawrence, a small Canadian company from Ottawa, Ontario, decided to plot a similar course for the Antarctic. With the support of the Canadian Space Agency (CSA), Enfotec is sailing home with new business opportunities and a host of contracts.

Enfotec developed its innovative ice navigation system, called IceNav, in the mid-1990s. The system's success prompted the company to investigate how useful it might be to assist ships in Antarctic waters. At the time, ships operating in the Antarctic had virtually no access to information on the area's ice conditions.

Enfotec's plan was simple: it would combine its knowledge of transmitting high-volume data to ships—developed for the IceNav system—with the all-weather imaging capabilities and onboard data storage of the CSA satellite, RADARSAT-1.

The new ice navigation system unveiled at an Antarctic operators' conference in England sparked immediate interest. Both Japanese and British operators agreed on the spot to participate in Enfotec's project. They also agreed to contribute significant resources to the program. As a result, Enfotec installed the system aboard the British Antarctic Survey (BAS) vessel Bransfield in England and on the Japanese Naval icebreaker Shirase, one of the largest non-nuclear icebreakers in the world.

Tests conducted in the Antarctic proved successful: the Japanese and British partners elected to become full commercial IceNav (and RADARSAT) customers. Enfotec's IceNav system has since been installed on the Australian Antarctic Division's flagship vessel, Aurora Australis, and the New Zealand research vessel, Tangoroa. Seismic survey vessels like the Geo Arctic and the Polar Duke are also installing the system and other Antarctic operators are considering the IceNav system.

With the support of the CSA, Enfotec has charted a course whose ultimate destination is success.

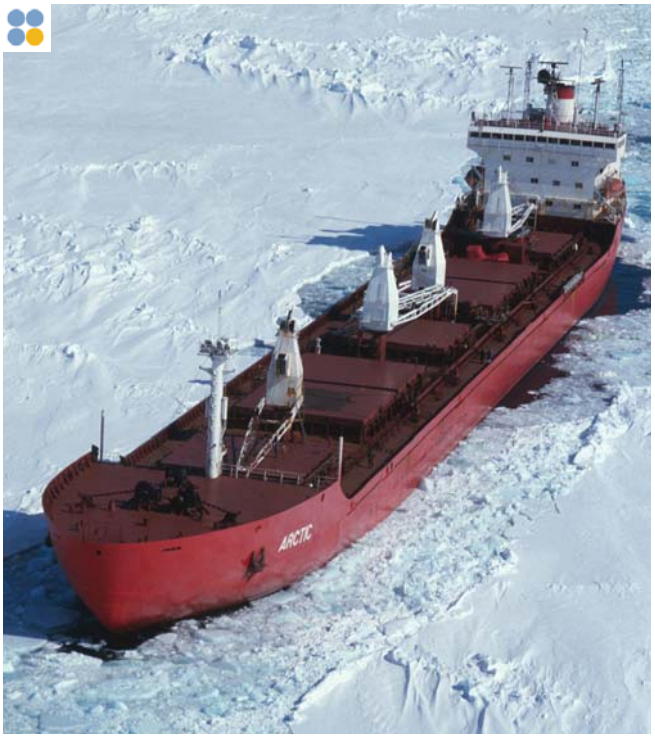

photo: ENFOTEC

Company: *Enfotec (Ontario)*

Project: *ICENAV*

Applications: *Synthetic Aperture Radar / Ice Navigation System*

SUCCESS IS IN THE CARDS

A single card, developed and produced by a small high-tech Canadian company, is revolutionizing the way space agencies control satellites and their on-board systems. The Q4-Card, the most advanced in a family of smart control cards created by Xiphos Technologies Inc. (XTI), was developed in collaboration with the Canadian Space Agency (CSA).

For its size—the card easily fits into the palm of a hand—the "Q-Card" delivers some exceptionally large benefits. By drastically reducing the amount of wiring in a satellite, the Q-Card increases efficiency while lowering overall weight by as much as 10 per cent, which in turn reduces the cost of the satellite.

The Q-Card is exceptionally reliable, whether alone or in high-speed networks such as SpaceWire being developed by the European Space Agency. If a card should fail or be removed from the network, its functions automatically transfer to another card. This ensures that the satellite's control and interface systems remain fully operational at all times.

The card also offers a number of benefits from a programming perspective. Because the card provides a simple, standardized interface between a satellite's subsystems, integrators develop their own systems without worrying about the issue of compatibility. This leads to more efficient design of ground stations, test equipment and on-board control strategies.

The enormous potential of the Q-Card has not gone unnoticed. SpaceQuest, a U.S. company that builds micro-satellites, selected the Q-Card for its most recent satellite. The Q-Card's exceptional capabilities and easy applicability have also attracted the interest of the U.S. Defence Advanced Research Projects Agency (DARPA) and the Northern Centre for Advanced Technology, for their safety and security critical applications.

Meanwhile, the CSA has used the Q-Card as part of an on-orbit MSS (Mobile Servicing System) astronaut training simulator recently delivered to the International Space Station (ISS) and plans to use the card for its Advanced Thermal Environment (ATEN) ISS payload. It is also considering the Q-Card to support the onboard network interface for four missions it has planned with the European Space Agency.

The Q4-Card—more evidence that good things come in small packages.

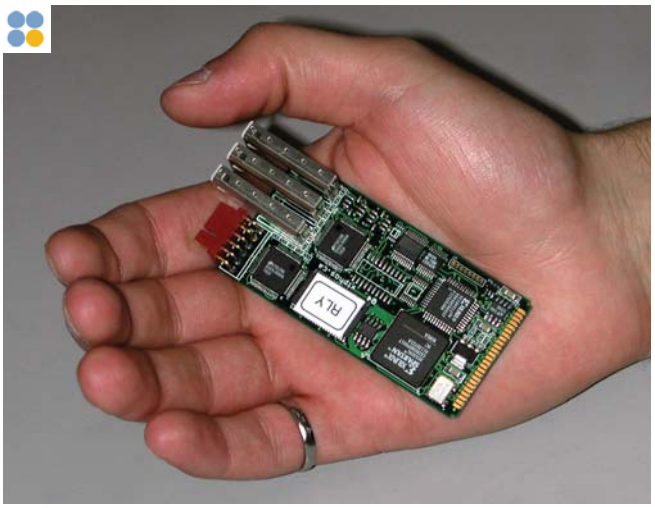

photo: XIPHOS (Q4-Card)

Company: *Xiphos Technologies Inc. (Quebec)*

Project: *Q4-Card*

Applications: *Micro-electronics / Miniaturization*

UNDERSTANDING THE ENVIRONMENT AND CONTRIBUTING TO SUSTAINABLE DEVELOPMENT

A SILVER LINING

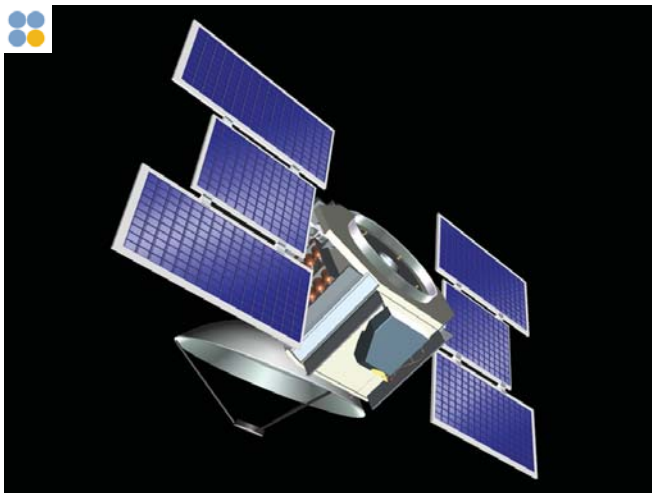

photo: NASA (CloudSat)

Clouds do more than just provide shade. When they obscure our view of the sun and stars, clouds also affect our climate. The question is, how much?

Scientists know that clouds far from Earth help warm the planet, while those close to Earth cool the planet. No matter where they are, clouds absorb heat—meaning they can transport and distribute heat throughout the atmosphere. This is a key driver of the Earth's climate and weather.

Unfortunately, existing space-based systems can only sense the uppermost layer of clouds. They can neither reliably detect the presence of multiple cloud layers nor can they determine cloud water and ice content. This will change with the launch of the environmental satellite, CloudSat. Data collected by CloudSat will increase our understanding of clouds and the role they play in our weather. This knowledge—when built into our weather prediction models—will improve long-term weather and climate predictions.

CloudSat uses radar to measure the vertical structure of clouds. As it probes the Earth's cloud cover, the satellite provides information about the thickness of the cloud layer, the altitudes of the base and top layers, and how much ice and water the clouds contain. It also measures how light is absorbed between the top and the bottom of the atmosphere. This "optical thickness" depends heavily on the presence and nature of aerosols in the atmosphere.

A critical component of the radar system used by CloudSat is a specialized vacuum electron device called an Extended Interaction Klystron (EIK). Similar to the magnetrons used in microwave ovens, klystrons generate radio waves such as those transmitted by CloudSat's radar. The only company in the world that produces the special type of klystron required for CloudSat's radar (i.e. the EIK) is Canada's Communications and Power Industries Canada Inc. (CPI), located in Georgetown, Ontario.

The technology behind this special klystron was developed in Canada for use in millimetre wave radar systems, communications systems and high energy scientific applications. Adapting and redesigning the EIK for use aboard CloudSat required a significant investment by CPI and the Canadian Space Agency. It also required extensive collaboration with the European Space Agency, the Jet Propulsion Laboratory and other NASA centres.

In the end, CPI met the challenge. The company's work on the klystron has made Canada a very desirable partner, not only for CloudSat, but also for a similar joint Japanese-European mission called EarthCARE (Earth Clouds Aerosols and Radiation Explorer).

Thanks to CPI, the forecast for Canada's role in understanding our climate is sunny indeed.

photo: CPI (CloudSat EIK)

Company: *CPI Canada (Ontario)*

Project: *Klystron for CloudSat Radar*

Applications: *Cloud Monitoring*

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Canada

CANADIAN EXPERTISE CONTRIBUTES TO ENVISAT SUCCESS

For more than a decade the Canadian Space Agency (CSA) and the European Space Agency (ESA) have used satellites to monitor the Earth's environment. The two agencies have worked together, sharing knowledge and expertise to ensure that scientists have the data needed to predict changes in our climate and environment.

Most recently, the CSA participated in the development of ESA's ENVISAT, the world's most advanced Earth observation satellite. Several Canadian companies, supported by the CSA, worked on the development of ENVISAT and the technological expertise that these companies contributed to the program has brought them international recognition. But the benefit of ENVISAT for Canadians only begins there: ENIVISAT provides more accurate information about the Earth's atmosphere, oceans, land and ice than previously available.

Information provided by ENVISAT—along with data provided by CSA's RADARSAT-1 and RADARSAT-2 (when launched in 2004)—is enhancing Canadian knowledge in the area of Earth Observation (EO). Through the CSA's participation, the Canadian EO community has access to ENVISAT data to develop the skills and services they require to compete internationally.

Sensors aboard ENVISAT—built with the help of Canadian expertise—are providing valuable information to Canada's environmental and remote sensing community.

For example, the Advanced Synthetic Aperture Radar antenna, developed with the expertise of EMS Technologies, enables ENVISAT to gather data capturing ice freeze-up and break-up dates of large lakes that Laval University will use for monitoring and modeling lake ice activities.

Another one of ten special instruments onboard ENVISAT, the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS), developed with subsystems and expertise provided by ABB Bomem and COM DEV, measures the concentration of various atmospheric constituents, which will help Canadian scientists better map industrial pollutants and greenhouse gases to shed new light on the atmosphere.

Two other Canadian companies MacDonald, Dettwiler and Associates and MPB Technologies contributed significantly to ENVISAT's data transmission, acquisition and processing subsystems, enabling users to receive accurate data reliably and rapidly.

ENVISAT, an international partnership that has tapped Canadian technical leadership to successfully develop the world's most powerful tool for monitoring our planet, is providing an unprecedented opportunity for Canadian researchers and companies to access data from ten of the world's most sophisticated satellite sensors-A success benefiting Canada's environment and improving the quality of life for all Canadians.

photo: ESA (ENVISAT MERIS - United Kingdom)

Companies: *ABB Bomem Inc. (Quebec), COM DEV Space (Ontario), EMS Space & Technology (Quebec), MacDonald, Dettwiler and Associates (British Columbia), MPB Technologies (Quebec)*

Project: *ENVISAT Environmental Satellite*

Applications: *Earth Observation / Technology Expertise*

PRESERVING THE WORLD'S FISHERIES

Over-fishing, habitat destruction and pollution all represent long-term threats to the world's fisheries and aquatic resources. In Asia, home to half of the world's population, the impact of uncontrolled development and population growth makes a serious situation worse.

The fishery resources of the Mekong River watershed in Southeast Asia are under extreme pressure. Given this system's importance to food security, the decline of fish populations is particularly troubling for Cambodia, which relies heavily on the area's fishery resources.

In collaboration with the Mekong River Commission (MRC), Vancouver-based Hatfield Consultants Ltd., supported by the Canadian Space Agency (CSA), conducted a pilot project to identify and monitor fishery habitats in the area. Recording and studying changes and impact to fisheries and wetland habitats over an extended period is essential in the effort to conserve aquatic resources.

Key to the success of the project is the ability of CSA's RADARSAT-1 satellite to collect radar images day or night and through cloud cover and rain. Persistent cloud cover and seasonal monsoons often prevent the acquisition and use of other types of remote sensing data in Southeast Asian countries. Hatfield collected data from the dry, mid-flood, flooding and post-flooding period to define fisheries and aquatic habitats in the Tonle Sap Great Lake and Mekong River watershed areas in Cambodia.

The Hatfield Group's expertise in using RADARSAT imagery for environmental applications was also called upon to support the Vietnamese government and the United Nations Disaster Management Unit to monitor the effects of flooding in the lower Mekong River basin in Vietnam. Hatfield used RADARSAT data collected during 1996 and 1998 flooding to create flood severity maps and a GIS (Geographic Information Systems) database for ongoing flood management.

The company also provided training to the MRC on how to interpret, analyze and use RADARSAT data and the other tools developed for the region.

While millions depend on the area's annual wet season flood cycle for irrigation, fisheries production and soil deposition, the floods also have a dark side. Every year, they claim lives and destroy infrastructure. In 2000, for example, flooding affected four million people and caused more than $400 million in damage. The MRC has established a Flood Management Program to help improve collection and distribution of flood information in the Mekong basin countries, including better access to RADARSAT and other remote sensing data.

With support from the CSA, Hatfield has established its expertise in Southeast Asia and has developed an ongoing relationship with local organizations, such as the MRC, to provide support in environmental management and monitoring. Hatfield has given developing nations the tools urgently needed to better monitor their environment, and to protect the delicate ecosystems that are an integral part of their nations' survival.

photo: HATFIELD (Mekong River Watershed)

Company: *Hatfield Consultants Ltd. (British Columbia)*

Project: *Monitoring the Mekong River Watershed*

Applications: *Fisheries & Wetland Monitoring / Synthetic Aperture Radar*

WATER DIVINING FROM SPACE

Few things contribute more to a country's quality of life than easy access to drinking water. In developing countries, a lack of drinking water can seriously impair social and economic development.

In Africa, the most suitable source of drinking water is groundwater. That's because it requires little or no treatment—an important consideration in countries where economic conditions are frequently precarious.

Unfortunately, pinpointing groundwater sources in Africa is difficult using current methods based on aerial photographs and outdated maps. Significant unnecessary expenses are incurred due to the large number of unsuccessful well drillings. The need for better tools is urgent in countries such as Burkina Faso where more than 1,000 wells have been drilled over a five-year period.

TECSULT International Ltd, a Canadian company with significant experience in hydrogeology, in collaboration with the Canadian Space Agency (CSA) and the Canada Centre for Remote Sensing (CCRS), addressed this challenge and developed a methodology that makes it easier to locate groundwater. This new methodology involves using RADARSAT-1 images, preferably acquired in dry season, after enhancing various features of them and transferring them into a geographic information system (GIS) to analyze natural linear features called lineaments.

Two areas in western Africa were selected for the study: one in Mali and the other in neighbouring Burkina Faso. The geology of both regions is bedrock, where groundwater resources are limited to faults and fractures. The RADARSAT-1 images revealed topographic variations and from these TECSULT mapped natural linear features that represented the surface expression of deeper geological structures that were promising sites for water drilling.

The final results of the identified lineaments and the groundwater potential maps in the two countries showed that TECSULT's new technology was better and cheaper than current exploration techniques.

Stimulated by the success of this initial investment, TECSULT included elements of the project in several proposals presented to countries such as the Ivory Coast, Mali, Cameroon, Burkina Faso and Brazil. The methods developed proved to be highly successful, helping the company win bids in the Ivory Coast and Cameroon, despite significant competition from well-known European and American companies.

photo: TECSULT (Groundwater Drilling-Mali)

Company: *Tecsult (Quebec)*

Project: *Synthetic Aperture Radar Groundwater Mapping*

Applications: *Site Selection for Groundwater Drilling*

QUALITY OF LIFE

BRINGING SPACE TECHNOLOGIES TO CANADIANS •

CONNECTING CANADIANS IN NEED

A young boy in the remote Newfoundland community of Nain is unable to shake a persistent ear infection. His doctor, without the resources to pinpoint the problem, must consult an ear, nose and throat specialist. Unfortunately, the nearest specialist is over a thousand kilometres away in St. John's.

Five years ago, that young boy and his family would have had no other choice but to make the long and expensive trip to St. John's. Today, thanks to Telesat Canada's Remote Communities Services Telecentre, or RCST, the doctor in Nain can simply transmit images of the young boy's ears to the specialist for diagnosis, and take the necessary action. The savings in time, money and a family's emotional state are enormous.

In collaboration with the Canadian Space Agency (CSA) and the European Space Agency, Telesat initiated, in 1998, a project to develop a shared-use satellite-based facility (telecentre) that can deliver improved health care services to remote communities in Newfoundland and Labrador. The RCST concept was developed using Anik E, Telesat's broadband satellite platform, to link rural communities with major urban centres in Canada. These telecentres in isolated communities employed satellite-enabled high-speed Internet access, video-conferencing and digital imaging to deliver tele-learning and tele-health services. Doctors in remote communities were able to send medical information and images to specialists anywhere in the country.

The RCST concept proved so successful that Telesat and the CSA immediately extended the development activities to two other projects. The first, called the Integrated Emergency Medicine Network, or IEMN, uses the RCST concept to link emergency personnel at disaster sites and in land or airborne ambulances with medical experts in major urban centres. The second initiative, known as Marine Interactive Satellite Technologies, or MIST, uses this same concept to dramatically improve emergency medical response to marine vessels travelling in Canadian waters.

These three initiatives were assessed by community focus groups and given a very high rating. However, the major indicator of success has been the extent to which the RCST model is being used to expand service on a provincial and national level. Telesat has since partnered with several federal and provincial government departments and agencies, regional health boards, community organizations, universities and other companies to develop larger scale regional networks and perform comprehensive high-speed multi-media trials for new communications applications and services for all of Canada's rural and remote communities, including those of First Nations.

Telesat and the CSA together have set the wheels in motion to bridge the gap between urban and rural, land and water, and are continuing to work together to deliver essential services to Canadians in need.

Company: *Telesat Canada (Ontario)*

Project: *Remote Communities Services Telecentre (RCST)*

Applications: *Tele-services / Telecommunications*

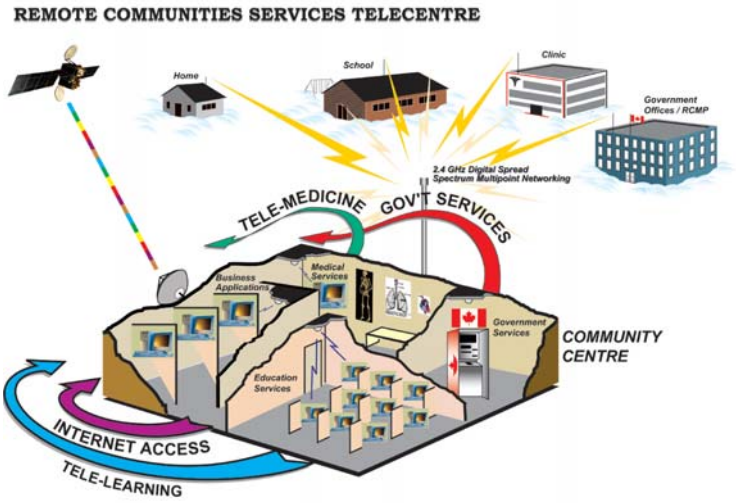

photo: TELESAT

PATIENTS GAIN FROM BONE LOSS EXPERIMENTS

photo: CSA (OSTEO)

A Canadian company is striving to solve one of the most daunting challenges to space exploration—the effects of weightlessness on the human body.

Astronauts who spend prolonged periods of time in space lose bone density and tissue 10 times faster than muscular dystrophy and osteoporosis patients on Earth. In some cases, astronauts have developed symptoms similar to advanced osteoporosis, a debilitating condition that causes structural degeneration of bone tissue. While the cause of osteoporosis is unknown, it affects more than 1.4 million Canadians over the age of 50.

The accelerated tissue degeneration resulting from the near-weightlessness environment of space is perceived by scientists not only as a serious challenge, but also as an ideal laboratory in which to study the mechanics of osteoporosis and the effectiveness of potential treatments.

To exploit this "ideal lab environment ", Millenium Biologix, a small company located in Kingston, Ontario possessing a unique blend of leading-edge technology for bone loss research and systems engineering expertise, in partnership with the Canadian Space Agency (CSA), developed the OSTEO (Osteoporosis Experiments in Orbit) System. OSTEO is a mini-lab created specifically to study accelerated bone disease in space. Among its applications, it enables researchers to study bone cell samples—grown on an artificial and uniform bone substitute—while on-orbit. With U.S. Senator John Glenn operating OSTEO on a space mission in 1998, the international research community gained important new scientific information about bone and tissue degeneration.

OSTEO's initial success has led to the development of more advanced space systems such as OSTEO-2 and STEM (System for Tissue Engineering) that have attracted the interest of space agencies around the world. Many have included these systems in their plans for future research missions targeting the problems of astronaut bone loss, osteoporosis, and other musculo-skeletal diseases.

In the meantime, Millenium is using its unique range of cell culture and tissue engineering systems to support further research on Earth and in space, and to provide advanced treatments for patients around the world and for astronauts assigned to long duration space missions.

The company believes its Advanced Clinical Tissue Engineering Systems (ACTES) that evolved from the OSTEO concept will someday enable regional health care facilities to regenerate a patients' own tissues. It's just one more example of how pushing back the boundaries of space is advancing the quality of life for people here on Earth.

Company: *Millenium Biologix Inc. (Ontario)*

Project: *Osteoporosis Experiments in Orbit (OSTEO)*

Applications: *Osteoporosis Research / Space Life Sciences Missions*

ROBOTS EXTEND A HEALING HAND

The technology behind the success of Canadarm and Canadarm2 is extending its reach into the field of medicine. The result—a new generation of surgical robots and systems—promises to revolutionize health care delivery for generations to come.

Using robotic arms, surgeons can employ minimally invasive tools such as laser scalpels, with exceptional accuracy. The robotic arms eliminate the surgeon's natural hand tremors, resulting in surgery so precise it cannot be duplicated by the human hand. For patients, the results are remarkable. Smaller instruments and greater precision mean smaller incisions. As a result, recovery is often measured in days instead of weeks and the risk of complications is greatly reduced.

Behind this dramatic marriage of space technology and medical innovation is MD Robotics (maker of the world-renowned Canadarm) and two of Canada's leading medical research centres: the Seaman Family MR (Magnetic Resonance) Centre in Calgary and CSTAR (Canadian Surgical Technologies & Advanced Robotics) in London, Ontario.

At the Seaman Family MR Centre, researchers are developing a MR-compatible robotic system for neurosurgery called NeuroArm. NeuroArm is designed to perform a wide range of functions—from needle insertion, suturing and cauterizing to cutting, manipulation of a retractor, and suction and irrigation. NeuroArm will be the first robot in the world to be image-guided, to have a sense of touch, to work with MRI machines, and to be equipped with neurosurgical tools.

NeuroArm will be positioned inside the operating room and guided by a surgeon from outside the operating room. Digital 3D images transmitted to a workstation will enable the surgeon to guide the robot while looking inside the human brain. Using NeuroArm, doctors will be able to perform surgeries once considered impossible, and also improve the success rate of existing procedures.

CSTAR is Canada's national centre for developing and testing the next generation of minimally invasive surgical technologies and techniques. A world leader in medical robotics, it pioneered the world's first robotic, closed-chest, single coronary artery bypass on a beating heart in 1999. CSTAR is a collaborative effort of the London Health Sciences Centre and the Lawson Health Research Institute. Early in 2003, CSTAR used robotics to perform a pyeloplasty, a procedure to correct blockages in the ureter or in the drainage system of the kidney.

The alliance of MDR with two of Canada's pre-eminent medical research centres promises to eliminate a number of medicine's traditional geographical barriers, so that improved health care and life-saving interventions will soon be available to people in remote locations on Earth, and to astronauts in space.

For MDR, already a leader in the development of space robotics, this means a similar role in the area of medical robotics. And that means better health services for us all.

photo: MDR (Surgical Workstation)

Company: *MD Robotics (Ontario)*

Project: *Medical Robotics*

Applications: *Robotic Surgery / Tele-surgery*

THAT MAGIC TOUCH

An innovative, pressure-sensing technology—developed to give robotic limbs on the International Space Station a keener sense of touch—is also making its presence felt in distinctly down-to-earth applications such as music, health and graphic arts.

Developed by Canpolar East, in cooperation with the Canadian Space Agency (CSA), KINOTEX gives robotic limbs the sensitivity to perform tasks requiring human dexterity. Without a human sense of touch, the robot's limbs could collide when working in close proximity to one another. Similarly, if an astronaut accidentally misjudged size, distance or a visual clue, a robotic limb could inadvertently crush an object in its grasp.

KINOTEX overcomes this challenge by enabling the robotic limb to halt a motion before any damage occurs.

Often referred to as "smart skin", KINOTEX is really a network of fibre optic threads, each thinner than a human hair, sandwiched between layers of foam. Move the foam and a computer interprets the results with uncanny sensitivity. KINOTEX has proven so effective it may eventually cover entire robotic limbs—just like skin—to provide the tactile feedback that astronauts require in space.

Here on Earth, KINOTEX is already giving us a new way to control toys, tools, instruments and computers. For example, some laptop computers now use a KINOTEX touch pad in place of a mouse. You control the pointer simply by running your finger over the pad. The pad interprets and reacts to the touch and placement of each finger.

A California company recently turned the touch pad into a mixing board for musicians, and suppliers of videogame controllers are looking at the KINOTEX pad to replace joysticks and game pads. Other possibilities include mattresses that detect and respond to restlessness, carpets that recognize you when you enter a room and couches that turn on the TV set automatically when you sit down.

KINOTEX also has the potential to revolutionize health care products. Tactex Controls has obtained a license from Canpolar East to incorporate KINOTEX as sensors for beds and chairs to help prevent falls, and for medical training accessories to enhance the early detection of breast cancer.

Increasingly, it appears that the cooperation that led to the development of this especially smart skin is proving to be a really smart move.

photo: NASA (CANADARM Handshake in Space)

Company: *Canpolar East Inc. (Newfoundland and Labrador)*

Project: *KINOTEX*

Applications: *Smart-skin / Tactile Feedback*

TECHNOLOGY DEVELOPMENT AND DIFFUSION

CANADIAN TERRESTRIAL TECHNOLOGY SPINNING OFF INTO SPACE

A world leading terrestrial technology may become the next world leading space technology emanating from Canada.

Optech, a world leader in laser radar (lidar) technology, already dominates the terrestrial markets in direct to digital laser imaging. Now, with the support of the Canadian Space Agency (CSA) and a Strategic Partnership with MD Robotics, Optech is offering the international space community several highly innovative products.

Optech's first invitation to space came from NASA's Jet Propulsion Lab (JPL), which engaged Optech in 1998 to manufacture a prototype laser sensor that could help land a spacecraft on a comet. The JPL project revealed a space market for Optech's unique technology and grew into a CSA-supported effort known as LAPS (Lidar-based Autonomous Planetary-landing System). LAPS combines Optech's lidar technology with on-board guidance, navigation and control software, developed by Sherbrooke University, to provide an improved method to autonomously and safely land spacecraft on remote planetary surfaces. The need for such a system was made dramatically clear in 1999 with the crash of NASA's Mars Lander, and future mission requirements for landing near hazardous terrain will make LAPS a significant risk reduction technology.

Optech's lidar technology also possesses the critical range and accuracy to rendezvous and dock with satellites in distress. Optech and MD Robotics have recently co-developed a concept called RELAVIS (Rendezvous Laser Vision System) that could become a must-have for systems performing on-orbit satellite maintenance and servicing, expected to be one of the most lucrative future commercial space markets.

Another innovative idea builds on Optech's expertise with lidar systems for atmospheric science and environmental monitoring. The CSA has supported Optech in the development of a space-based remote-sensing instrument called ORACLE, to measure and monitor constituents of the Earth's troposphere and stratosphere. ORACLE would utilize a technique called Differential Absorption Lidar (DIAL) to provide vital information about the many environmental issues, such as greenhouse gases, global warming, depleted ozone layer and atmospheric pollutants, that concerns everyone on Earth.

The successful results of the ORACLE project are now being carried forward into proposals for a technology demonstration mission. They have also resulted in Optech being selected by the European Space Agency to develop a mission concept for the ambitious WALES (Water vApour Lidar Experiment in Space) program. The WALES mission will provide accurate global profiles of atmospheric water-vapour content that are essential to global atmospheric models.

Optech's ambitious research and development, in combination with CSA's support, reinforces a key fact: Canadian companies with big ideas are building Canada's reputation as a major force in space exploration.

photo: NASA (Mars Reconnaissance Orbiter)

Company: *Optech Inc. (Ontario)*

Project: *Lidar-based Autonomous Planetary-landing System (LAPS), Differential Absorption Lidar (DIAL)*

Applications: *Lidar / Space Servicing, Planetary-landing; Atmospheric Studies*

SERVICING SATELLITES IN SPACE

Demonstrating the capabilities of refueling, reconfiguring and repairing satellites in space is a daunting task. When Boeing decided to take on the challenge, it put together an international team of the leading space companies. MD Robotics (MDR), recognized around the world for its expertise in space robotics, was one of those companies.

Based in Brampton, Ontario, MDR developed and built the Canadarm, and more recently, developed the robotics for the Canadian Space Agency's Mobile Servicing System (MSS), a sophisticated robotic system, critical to the assembly,

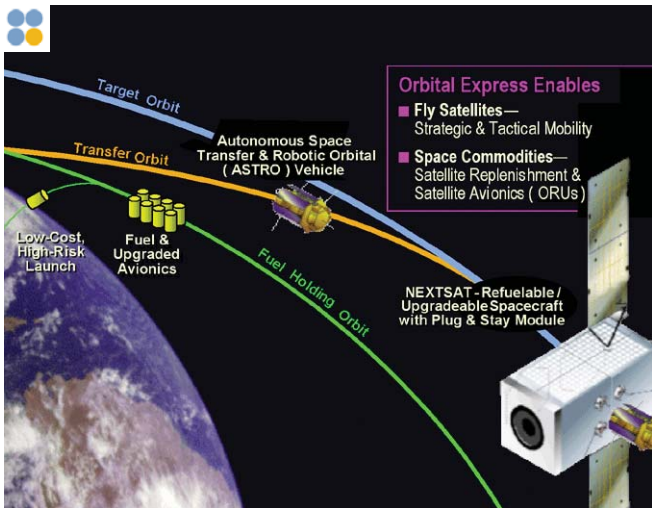

photo: DARPA (Orbital Express)

maintenance and servicing of the International Space Station (ISS). MDR is also supplying the control station, called the Robotic Work Station that enables astronauts to operate the MSS from within the Space Station. MDR, with the collaboration of the CSA, is continually pushing the state of the art by developing cutting-edge technologies necessary for future space robotic systems.

MDR's expertise and experience will be essential to the success of the Orbital Express Advanced Technology Demonstration, an ambitious program to demonstrate satellite-servicing on-orbit, in which robotics provided by MDR will be used to capture and service satellites. A specialized application and infrastructure developed by MDR will monitor and control the robotic operations.

The routine, autonomous servicing of satellites that Orbital Express hopes to achieve has long been a top priority for the military and the civilian space industries. Such a capability, experts agree, would enhance satellite utility, allowing their performance to be adjusted or optimized as necessary.

While satellites are now limited by their on-board fuel supplies, in the future, a robotic supply ship will shuttle back and forth between the satellite and an on-orbit fuel dump to replenish the satellite's fuel supply. The Orbital Express program is initially focused on creating concepts for this unique satellite servicing system.

In the future, MD Robotics and the Boeing team will be working to make those concepts a reality.

photo: MDR (Satellite Servicing)

Company: *MD Robotics (Ontario)*

Project: *Orbital Express*

Applications: *Space Robotics / Satellite Servicing*

SPACE VISION WITH A NEW DIMENSION

In the late 1990s, Neptec, a Canadian company, introduced a revolutionary system to assist in the assembly of the International Space Station. Neptec's innovative Space Vision System (SVS) uses images from a single conventional video camera to help astronauts precisely position and orient the city bus sized elements of the space station as they piece together the largest structure ever built in orbit.

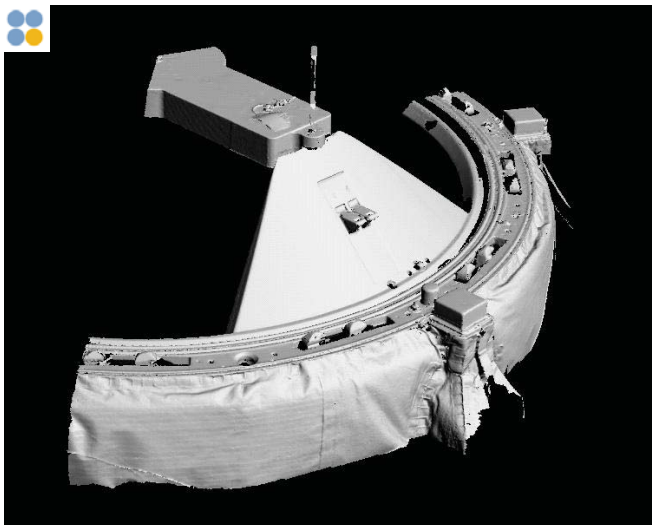

photo: NEPTEC (LCS 3D Image)

In the harsh working environment of space, where there is no up or down and distance is always difficult to determine, the SVS represented a significant breakthrough allowing astronauts to overcome these limitations. The SVS has been so successful that it is now standard equipment aboard the Space Shuttle and the Space Station.

When NASA later wanted to improve the SVS by making it immune to the effects of the rapidly changing lighting conditions in space, Neptec's success with the SVS was pivotal.

In late 1999, NASA offered Neptec the opportunity to develop the required improvements of SVS for a flight demonstration on shuttle flight STS-105.

By building upon research done by the Canadian Space Agency (CSA) and the National Research Council (NRC), and with financial support from the CSA and Technology Partnerships Canada (TPC), Neptec designed, developed and delivered a Laser Camera System (LCS) in less than 16 months.

The NASA tests confirmed that the LCS does more than simply increase the efficiency of the Space Vision System. As a 3D camera, it can take three dimensional pictures with millimetre accuracies that can be used to build models of the photographed objects.

Today, this new third dimension in vision technology is at home both on Earth and in space. Versions of LCS are also being developed to perform high fidelity inspection in space and to improve automated measurements in sectors such as mining, manufacturing and agriculture.

photo: NEPTEC (LCS)

Company: *Neptec (Ontario)*

Project: *Laser Camera System (LCS)*

Applications: *Space Vision Systems / 3D Imaging*

TURNING SCIENCE FICTION INTO FACT

Science fiction writers and filmmakers beware: one of your favourite subjects—intelligent spaceships and robots—is rapidly becoming science fact, thanks to the Canadian-based company, EMS Technologies.

Well-known for developing the computers and processors used in the Canadarm, the Earth observation satellite RADARSAT-1, and the Mobile Servicing System on-board the International Space Station, EMS Technologies has created a revolutionary new generation of on-board space processors.

photo: EMS TECHNOLOGIES (ESP)

Working with the Canadian Space Agency (CSA), EMS used recent breakthroughs, such as radiation-hardened integrated circuits, to develop a family of Enhanced Space Processors (ESPs). These ESPs function effectively from low orbits all the way to geostationary (extremely high) orbits and are ideal for planetary and deep space probes.

What separates the EMS family of processors from similar products is that an entire processing unit, as well as several standard support modules, are crammed onto a single chip. This technology, fittingly referred to as a "System on a Chip," significantly reduces the number of components and interconnections required for the processor. This makes EMS Technologies' ESPs more compact, less expensive and more resistant to failure than its competitors. In keeping with its commitment to constantly push the envelope in space technologies, EMS also incorporated several space system designer-friendly features into its family of processors.

Though relatively new to the market, the ESP family of processors is already attracting widespread interest. In fact, several programs have selected ESPs for their space-borne systems.

Dutch Space of the Netherlands will use an ESP in its ConeXpress satellite program. This is part of an innovative proposal to the European Space Agency to provide frequent and regular low-cost access for communication demonstration missions. NPO PM, one of Russia's pre-eminent satellite manufacturers, has signalled its intention to use an ESP-based on-board computer for its next generation of GEO satellites. A Swedish telecommunications satellite builder has announced plans to employ the ESP. The CSA will use the ESP for several of its science and remote sensing missions.

Through advancements like the Enhanced Space Processors, EMS Technologies is sending a clear message to science fiction writers—what you can only dream up today, we will make reality tomorrow!

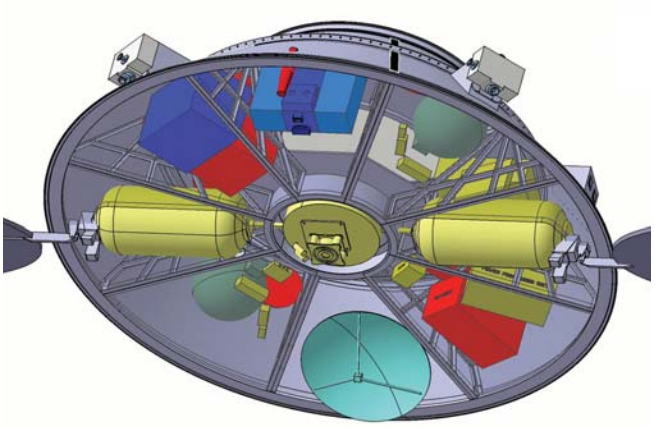

photo: ESA (ConeXpress)

Company: *EMS Technologies (Ontario)*

Project: *Enhanced Space Processors (ESP)*

Applications: *Micro-electronics / Miniaturization; Satellite Computers*

WORLD-CLASS RESEARCH

BRINGING SPACE TECHNOLOGIES TO CANADIANS •

ASTRONAUTS PRACTICE IN SPACE

Imagine playing the most complicated video game ever created. Then imagine being asked to play it at peak efficiency—without practicing for several months.

In a way, that was exactly what was originally asked of astronauts operating Canadarm2 aboard the International Space Station (ISS). Imagine also that the cost of an error could be over $50 million.

Like that imaginary video game, operating a 12-metre crane-like object through a TV monitor in space requires exceptional manual and visual dexterity, and while astronauts undergo rigorous training before venturing into space, they've been unable to practice these particular skills after arriving on the Space Station.

Since the astronauts on ISS will stay in orbit for three or more months, there was an urgent need to develop an on-orbit trainer for astronauts. Unfortunately, the technology required to produce a portable, self-sustained training unit—as well as the computing power to provide the simulation accuracy required—simply wasn't available.

Until now, that is.

A team of Russian and Canadian space researchers and engineers has successfully pushed back the technology envelope and developed an on-site trainer for the International Space Station called the SMP (System for Maintaining and Monitoring Performance) On-Orbit Mobile Servicing System (MSS) Astronaut Training System that was launched on-board the Soyuz Progress Transport on February 2, 2003. Canada played a pivotal role in two significant breakthroughs that helped make the on-site trainer possible.

The first is a highly efficient simulation software tool – SYMOFROS, developed by the Canadian Space Agency (CSA). The other is a smart electronics card, developed by a small Canadian company called Xiphos in collaboration with the CSA. The card easily interfaces hand-controllers to portable computers. When SYMOFROS and the smart card were combined with Russian expertise in on-board system integration, the final hurdle to the development of an on-orbit trainer was overcome.

The SMP On-Orbit MSS Astronaut Training System consists of a small laptop computer and two hand-controls. Training and analysis modules incorporated in the system allow astronauts to practice, among other things, capturing free-flying objects such as small satellites, which is the most difficult task that a Canadarm2 operator may be required to perform.

Practice, it seems, whether in space or on a video game, makes perfect.

photo: RSA (Expedition 7 Commander, Yuri Malenchenko on SMP)

Company: *Canadian Space Agency (CSA)*

Project: *System for Maintaining and Monitoring Performance (SMP)*

Applications: *Astronaut On-board Training Simulator*

FINDING SPACE FOR INFORMATION FROM SPACE

As our ability to collect data from space increases, so must our ability to store, categorize and disseminate that information. This is especially important for Canadians. Canada relies extensively on data collected by sensors onboard Earth observation satellites because of our geography and dependence on natural resources.

A new sensor technology, called hyperspectral imaging, promises to dramatically improve our ability to collect data from space. By simultaneously acquiring hundreds of images at different wavelengths (colours), the hyperspectral imager can provide exceptionally accurate information on vegetation, ground conditions and water. Neither the human eye nor current sensors can detect what the hyperspectral imager sees from space.

However, managing the huge flow of data provided by hyperspectral imaging satellites is proving to be difficult. The hundreds of images generated must be stored and/or transmitted first to the ground, and then on to users. Existing storage and telecommunication technologies are simply inadequate to handle that much data.

The Canadian Space Agency (CSA)—recognizing the value of the data acquired by the hyperspectral imager—set about to overcome this obstacle. CSA researchers pinned their hopes on a technique called Bandwidth Compression, which reduces the size of the data by a factor of twenty without losing any useful information from the original image.

After six years of research, the publication of more than 20 scientific articles, and the filing of three patents, CSA researchers emerged with a highly innovative technique called Vector Quantization (VQ) Multi-dimensional Satellite Data Compression. Through this process, images taken by the hyperspectral imager are compressed transmitted to Earth, and then reconstructed (or de-compressed). Not only does this new technique have five to ten times fewer errors than currently available competing technologies, but it produces images that can be processed thirty to forty times faster than the original data.

It didn't take long for these exceptional results to reach the attention of Ontario-based PCI Geomatics, a world leader in geomatics software. Working with the CSA, PCI Geomatics is incorporating this revolutionary technology into Geomatica, its highly successful product for processing remote sensing images, digital photogrammetry, spatial analysis cartography, and digital visualization.

Thanks to research at the CSA, PCI Geomatics has integrated additional technology within its software that will help enhance its presence in the international marketplace by allowing clients to take advantage of previously unmanageable datasets. The many difficulties once associated with working productively with large hyperspectral data, new commercially available high-resolution images, and other sizeable files can now be more easily overcome by all geomatics professionals.

Championing the development of space knowledge and excellence, the Canadian Space Agency has provided PCI Geomatics with new opportunities in niche markets. It has also enhanced Canada's reputation as a worldwide leader in remote-sensing technology while improving the world's ability to monitor and manage its natural resources.

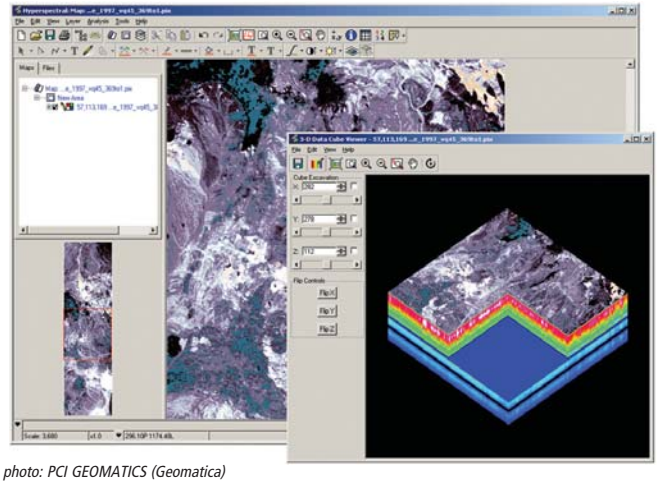

photo: PCI GEOMATICS (Geomatica)

Company: *PCI Geomatics (Ontario)*

Project: *Vector Quantization*

Applications: *Hyperspectral / Multi-dimensional Satellite Data Compression*

THE NEXT BEST THING TO BEING THERE . . .

A ship is commissioned to chart the Baffin Bay seabed. Several scientists—geologists, marine biologists and environmentalists—are invited to take part. One scientist, based in Winnipeg, sees that participating in the study will benefit her research immensely. Unfortunately, her teaching commitments prevent her from taking part in the project.

It is a scientist's worst nightmare.

Today, thanks to the Quester Tangent Corporation, located in Sidney, British Columbia, this nightmare is a thing of the past. Working in partnership with the Canadian Space Agency (CSA), the Communications Research Centre, the Canadian Centre for Marine Communication and the Arctic Research Division of the Department of Fisheries and Oceans (DFO), this Canadian company developed an Internet and satellite-based communication system called the Remotely Operated Data Acquisition System, or RODAS.

Using RODAS, scientists on land can communicate directly, through the Internet, with data acquisition systems on board vessels at sea. RODAS enables them to monitor what is happening up to one kilometre below the ship from anywhere in the world. For scientists in Winnipeg and around the world, it is the next best thing to being there. In fact, the system allows scientists to collect the data they need without committing to spending weeks aboard a research vessel.

Through RODAS and the Internet, scientists and researchers can monitor and control individual sensor systems placed aboard a vessel—as well as the quality of data the systems gather—from their labs and offices. The systems report daily to the scientist, who can then in turn relay instructions back to the system. A ship engaged in marine science activities can increase the number of sensors on-board, enabling it to respond to the needs of researchers around the world.

The success of the RODAS concept is now being considered for several new projects by DFO and its U.S. counterpart, the National Marine Fisheries Service. This concept is also opening a whole new way of mapping the seabed and tracking fish by having Coast Guard or commercial fishing vessels carry sensors as they criss-cross the ocean. Using RODAS, information from different vessels would be sent to a central data bank, providing a single picture for scientists to use in their research.

The future of RODAS does not lie solely in remote mapping of the world's seabeds. This innovative technology is also capable of monitoring and controlling, from the comfort of a lab or office, instruments installed on any type of vehicle or facility situated in the most remote corners of the world.

photo: DFO (CCGS Louis S. St-Laurent)

Company: *Quester Tangent Corporation (British Columbia)*

Project: *Remotely Operated Data Acquisition System (RODAS)*

Applications: *Telecommunications, Tele-research*

WHEN GRAVITY HOLDS BACK SCIENCE

Gravity can complicate the lives of scientists seeking to determine how various materials combine to form stronger and lighter alloys. In the microgravity environment of space, conditions found on Earth, such as sedimentation and convection, that inhibit or slow down complex chemical and physical reactions do not exist, allowing scientists to conduct more complex experiments within shorter time frames.

It's little wonder that scientists covet the near-zero gravity conditions aboard the International Space Station (ISS), which they see as the perfect laboratory in which to learn how physical and chemical processes shape materials. As a result of their work, lighter, stronger and more flexible materials will be available for a growing range of products on Earth.

Essential to the work of these scientists is a furnace to heat materials such as metal alloys and glasses. For the past decade, Queen's University in Kingston, Ontario, with the support of the Canadian Space Agency (CSA), has developed the innovative furnaces required for microgravity conditions. In fact, since the early 1990s—when it introduced a three-zone isothermal furnace named QUELD I (Queen's University Experiments in Liquid Diffusion)—Queen's University and the Canadian company Millenium Biologix Inc. have produced three generations of progressively better furnaces.

QUELD I was used aboard the Space Shuttle for experiments dealing with the phenomenon of liquid diffusion in microgravity. The second-generation furnace, called QUEST, actually combined 15 furnaces into one payload. Also developed at Queen's University, it was placed in the shuttle's payload bay to conduct diffusion and solidification experiments.

The third generation, QUELD II, an improved version developed by Millenium Biologix, made possible the study of 205 samples aboard the Space Station Mir. Experiments were conducted on diffusion, glass formation and the manufacturing of semiconductors. The results of these experiments will help scientists better understand the mechanisms involved in crystal growth and glass formation and how they impact the material's properties. These important findings will help to create new materials here on Earth—materials with unique properties that could lead to widespread applications in electronics, aerospace and other industries.

The latest generation of furnace, the ATEN (Advanced Thermal ENvironment), will be sent to the International Space Station in 2006. ATEN experiments will seek to improve several materials, from semiconductors to ceramics and glass.

Millenium Biologix and Queen's University's successful technological innovations in thermal environments for microgravity experiments on-board Mir and the Space Shuttle have enhanced Canada's reputation in the field of materials science. As scientists look forward to more intensive testing aboard the ISS, it is apparent that Canadian technology will once again play a critical role.

photo: CSA (Queld II)

Company: *Queen's University (Ontario), Millenium Biologix Inc.(Ontario)*

Project: *Queen's University Experiments in Liquid Diffusion (QUELD)*

Applications: *Furnace, Materials / Microgravity Science Missions*

CONTACTS

CONTACTS

A SILVER LINING 14
Project: Klystron for CloudSat Radar
Applications: Cloud Monitoring
Company: CPI Canada
45 River Drive
Georgetown, Ontario
L7G 2J4
(905) 877-0161
www.cpii.com/cmp

ASTRONAUTS PRACTICE IN SPACE. 32
Project: System for Maintaining and Monitoring Performance (SMP)
Applications: Astronaut On-board Training Simulator
Company: Canadian Space Agency (CSA).
6767 route de l'Aéroport
Saint Hubert, Quebec
J3Y 8Y9
(450) 926-4800
www.space.gc.ca

CANADIAN EXPERTISE CONTRIBUTES TO ENVISAT SUCCESS 15
Project: ENVISAT Environmental Satellite
Applications: Earth Observation / Technology Expertise
Company: ABB Bomem Inc.
585 Charest East
Bureau 300
Quebec, Quebec
G1K 9H4
(418) 877-2944
www.abb.com/ca

Company: COM DEV Space
155 Sheldon Drive
Cambridge, Ontario
N1R 7H6
(519) 622-2300
www.comdev.ca

Company: EMS Space & Technology
21025 Trans Canada Highway
Ste-Anne-de-Bellevue, Quebec
H9X 3R2
(514) 457-2150
www.ems-t.com

Company: MacDonald, Dettwiler and Associates
13800 Commerce Parkway
Richmond, British Columbia
V6V 2J3
(604) 278-3411
www.mda.ca

Company: MPB Technologies
147 Hymus Boulevard
Montreal, Quebec
H9R 1E9
(514) 694-8751
www.mpb-technologies.ca

CANADIAN TERRESTRIAL TECHNOLOGY SPINNING OFF INTO SPACE 26
Project: Lidar-based Autonomous Planetary-landing System (LAPS), Differential Absorption Lidar (DIAL)
Applications: Lidar / Space Servicing, Planetary-landing; Atmospheric Studies
Company: Optech Inc.
100 Wildcat Road
Toronto, Ontario
M3J 2Z9
(416) 661-5904
www.optech.on.ca

CONNECTING CANADIANS IN NEED 20
Project: Remote Communities Services Telecentre (RCST)
Applications: Tele-services / Telecommunications
Company: Telesat Canada
1601 Telesat Court
Gloucester, Ontario
K1B 5P4
(613) 748-0123
www.telesat.ca

EMS SATCOM EQUIPS CORPORATE AIRCRAFT. 8
Project: International Mobile Satellite Communications Program (IMSCP)
Applications: Aeronautical Satellite Communications
Company: EMS Technologies SATCOM
1725 Woodward Drive
Ottawa, Ontario
K2C 0P9
(613) 727-1771
1-800-600-9759
www.emssatcom.com

FINDING SPACE FOR INFORMATION FROM SPACE . . 33
Project: Vector Quantization
Applications: Hyperspectral / Multi-dimensional Satellite Data Compression
Company: PCI Geomatics
50 West Wilmot Street
Richmond Hill, Ontario
L4B 1M5
(905) 764-0614
www.pcigeomatics.com

PATIENTS GAIN FROM BONE LOSS EXPERIMENTS. . . 21
Project: Osteoporosis Experiments in Orbit (OSTEO)
Applications: Osteoporosis Research / Space Life Sciences Missions
Company: Millenium Biologix Inc.
785 Midpark Drive
Kingston, Ontario
K7M 7G3
(613) 389-6565
www.millenium-biologix.com

PRESERVING THE WORLD'S FISHERIES 16
Project: Monitoring the Mekong River Watershed
Applications: Fisheries & Wetland Monitoring / Synthetic Aperture Radar
Company: Hatfield Consultants Ltd.
201-1571 Bellevue Avenue
West Vancouver, British Columbia
V7V 1A6
(604) 926-3261
www.hatfieldgroup.com

ROBOTS EXTEND A HEALING HAND. 22
Project: Medical Robotics
Applications: Robotic Surgery / Tele-surgery
Company: MD Robotics
9445 Airport Road
Brampton, Ontario
L6S 4J3
(905) 790-2800
www.mdrobotics.ca

SATELLITE NAVIGATION SYSTEMS—
WE'D BE LOST WITHOUT THEM 9
Project: Galileo-European GNSS
Applications: Ground Reference Receivers
Company: NovAtel Inc.
1120 - 68th Avenue N.E.
Calgary, Alberta
T2E 8S5
(403) 295-4500
www.novatel.com

SELLING ITS SAILING EXPERTISE. 10
Project: ICENAV
Applications: Synthetic Aperture Radar / Ice Navigation System
Company: Enfotec
Suite 206 - 25 Tapiola Crescent
Ottawa, Ontario
K1T 2J7
(613) 248-0189
www.enfotec.com

SERVICING SATELLITES IN SPACE 27
Project: Orbital Express
Applications: Space Robotics / Satellite Servicing
Company: MD Robotics
9445 Airport Road
Brampton, Ontario
L6S 4J3
(905) 790-2800
www.mdrobotics.ca

SPACE VISION WITH A NEW DIMENSION 28
Project: Laser Camera System (LCS)
Applications: Space Vision Systems / 3D Imaging
Company: Neptec
302 Legget Drive
Ottawa, Ontario
K2K 1Y5
(613) 599-7602
www.neptec.com

CONTACTS

Project: Q4-Card
Applications: Micro-electronics / Miniaturization
Company: Xiphos Technologies Inc.
3981 St-Laurent Boulevard
Suite 800
Montreal, Quebec
H2W 1Y5
(514) 848-9640
www.xiphos.ca

Project: KINOTEX
Applications: Smart-skin / Tactile Feedback
Company: Canpolar East Inc.
702 Water Street
St. John's, Newfoundland and Labrador
A1E 1C1
(709) 722-6067
www.canpolar.com

Project: Remotely Operated Data Acquisition System (RODAS)
Applications: Telecommunications, Tele-research
Company: Quester Tangent Corporation
Suite 201 - 9865 West Saanich Road
Sidney, British Columbia
V8L 5Y8
(250) 656-6677
www.questertangent.com

Project: Enhanced Space Processors (ESP)
Applications: Micro-electronics / Miniaturization; Satellite Computers
Company: EMS Space & Technology
21025 Trans Canada Highway
Ste-Anne-de-Bellevue, Quebec
H9X 3R2
(514) 457-2150
www.ems-t.com

Project: Synthetic Aperture Radar Groundwater Mapping
Applications: Site Selection for Groundwater Drilling
Company: Tecsult
85 Sainte-Catherine West
Montreal, Quebec
H2X 3P4
(514) 287-8500
www.tecsult.com

Project: Queen's University Experiments in Liquid Diffusion (QUELD)
Applications: Furnace, Materials / Microgravity Science Missions
Company: Queen's University
99 University Avenue
Kingston, Ontario
K7L 3N6
(613) 533-2000
www.queensu.ca

Company: Millenium Biologix Inc.
785 Midpark Drive
Kingston, Ontario
K7M 7G3
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