Eggs-cellence

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New markets

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What's this?

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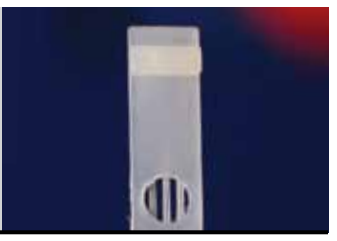
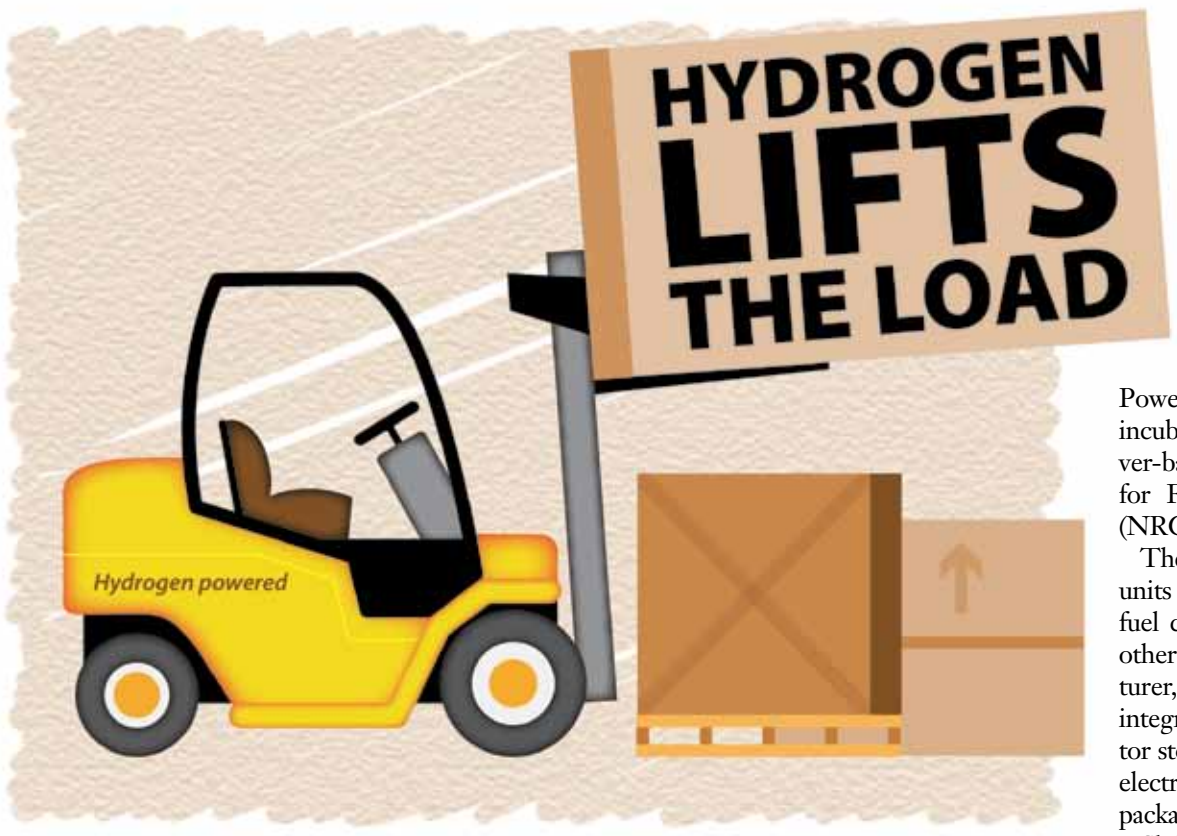


NRC NEWSLINK

ISSN 1913-1607 NATIONAL RESEARCH COUNCIL CANADA SPRING 2009



Fuelling the Plug Power GenDrive™ fuel cell with hydrogen is safe and easy, and takes less than five minutes.

Late in 2008, Plug Power Inc. sold more than 200 GenDrive™ hybrid hydrogen fuel cell packs to Central Grocers Inc., to power forklifts in a giant new central warehouse complex in Illinois.

Based in the U.S., Plug Power gained the technology in 2007 when it acquired a Canadian company, Cellex Power Products, which now builds and sells the technology as Plug Power Canada. Cellex was incubated in the Vancouver-based NRC Institute for Fuel Cell Innovation (NRC-IFCI).

The GenDrive power units consist of hydrogen fuel cells produced by another Canadian manufacturer, Ballard Power Systems, which are integrated with battery or super capacitor storage and sophisticated controller electronics. These components are then packaged for rugged environments.

Sliding straight into the standard lead-acid battery compartments in existing electric forklifts, the power units pack hidden benefits, says Warren Brower, product marketing manager at Plug Power's Latham, New York headquarters. The hydrogen power packs are non-toxic, have zero emissions and last years longer than batteries. They also streamline warehouse operations. A fuel cell takes only two or three minutes to refill with hydrogen once or twice a day, allowing operators to move more material. By comparison, charging and changing lead acid batteries takes hours, and charging rooms eat into profitable warehouse space.

Powering forklifts is a niche market, with a worldwide value of $6-8 billion dollars a year.

"Fuel cells eliminate the need for a great deal of equipment," says Brower. "Our fuel cells go into a lift truck and stay in it."

Continued on page 6

Standardizing the feed

When Charlottetown-based Stirling Products North America Inc. (STI-NA) developed an extraction process for a yeast-based complex sugar product called beta glucan as a natural livestock feed supplement, the company faced a challenge. For its industrial process to extract beta glucan — trade named ProVale™ — Stirling Products had to find ways to test the purity of

Continued on page 6

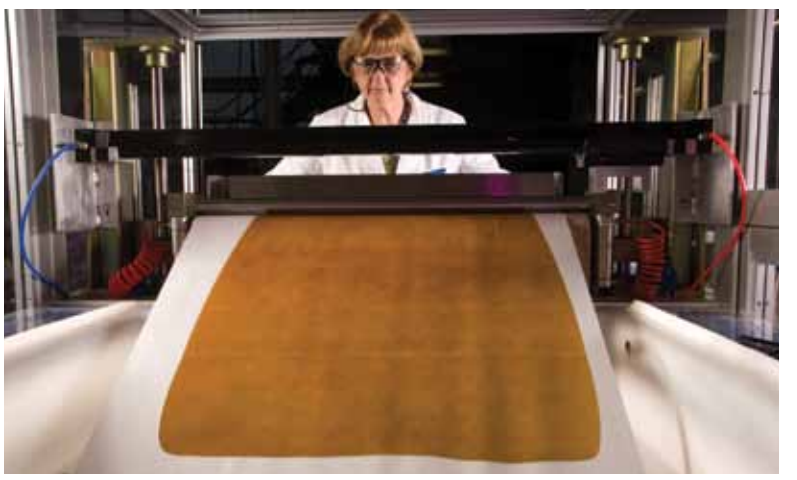
Shane Patelakis inspects a pump at Stirling Products North America Inc.'s pilot plant in Prince Edward Island.

Membrane magic

Vaperma, a Québec City company, is partnering with NRC to manufacture new, more environmentally friendly separation technologies that could yield major energy savings for the petrochemical and other industries. Founded in 2003, the company has quickly become a world leader in industrial dewatering and dehydration systems, and currently produces Siftek™ membrane separators based on polymer gas separation membranes — very thin, selectively porous plastic sheets — that remove water from ethanol at an industrial scale.

Originally based on polymer technology developed at the Université Laval, Vaperma's product for de-watering ethanol makes corn-based ethanol production more economical and environmentally friendly compared with energy-intensive distillation or molecular-sieving processes. Current industrial processes use a lot of energy to heat and cool gases and liquids to extract useful compounds, but membrane separation using specialized polymers accomplish the task with far less.

Dr. Michael Guiver, a polymeric materials researcher at the NRC Institute for Chemical Process and Environmental Technology (NRC-ICPET) in Ottawa says polymeric membranes offer a very efficient way to process ethanol and obtain a pure product with significantly less net energy input. "With our help, Vaperma aims to use their existing hollow fibre membranes as supports to make composite membranes with more potential applications so they can tap new markets," he says.



NRC technical officer Linda Layton casts a sheet of a novel polymeric membrane material for gas permeability testing at NRC-ICPET.

High performance polymers need to be coated as thin layers — less than a micron thick — over "nets" of more robust, cheaper polymers that provide mechanical strength, to form what's called a composite membrane.

"If the polymer in an industrial membrane is very expensive, which specialized high-performance polymers tend to be, then you want to make the filter layer as thin as possible both to reduce costs and gain maximum throughput," says Dr. Guiver.

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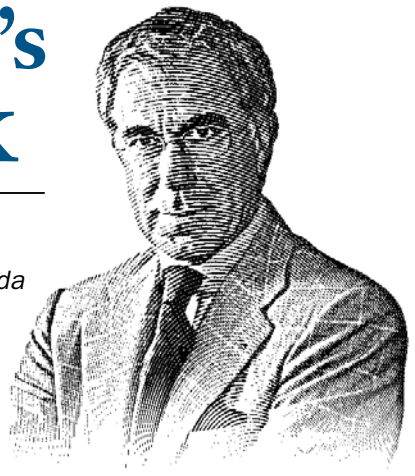
National Research Council Canada Conseil national de recherches Canada

Canada

President's outlook

Dr. Pierre Coulombe
National Research Council Canada



Reversing the trend for Canadian manufacturing

Good news about Canadian manufacturing has been a rare commodity in recent years. Labour productivity and corporate profitability in the manufacturing sector have declined significantly since 2002, and we continue to see plant closures and employee layoffs.

In this environment, many manufacturing firms are suspending their R&D efforts just to survive. But reduced R&D today means less opportunity tomorrow. Despite today's economic realities, we need continuous investment in R&D to help Canada's manufacturing sector thrive globally. We need greater incentives for companies to put money into R&D so they will continue to innovate, even if that innovation does not lead to immediate profitability. We must shorten the timeline for innovations to flow from the lab to the marketplace so that companies see a quicker return on their R&D investment. And we need to see Canada become a world leader in green manufacturing technologies.

The 2009 Federal Budget recognizes these needs. To help protect jobs, the government is providing $7.5 billion in extra support for sectors, regions and communities. This includes support for the auto, forestry and manufacturing sectors, as well as funding for clean energy.

As part of this support, the government is extending the two-year write-off for investments in manufacturing and processing equipment until the end of 2011. This measure will help manufacturers retool and boost their productivity for long-term success.

The broad range of infrastructure projects proposed in the Budget will also benefit manufacturers, as well as businesses that rely on logistics, innovation, clean energy and broadband infrastructure.

The government also recognizes NRC's critical role in stimulating innovation. The Budget granted an extra $200 million over the next two years to the NRC Industrial Research Assistance Program (NRC-IRAP) to help Canadian firms perform R&D. NRC-IRAP provides innovation assistance to an average of 10,000 firms each year, sharing the financial risk with some 2,800 of these R&D projects and pre-commercialization activities.

R&D can't be considered a luxury, not in this economy. We need to use all the resources at hand to help Canadian manufacturers innovate today and compete among the world's best.

NRC has also recently launched a strategy to focus R&D on advanced materials and processing technologies as well as decision-aid systems for manufacturing. One of our top objectives is to help Canadian manufacturers take their share of business in the global supply chain. Another objective is to help our manufacturing industries develop cleaner production processes, and consume less energy and raw materials. Putting NRC's expertise to work on these areas of R&D will generate good economic returns.

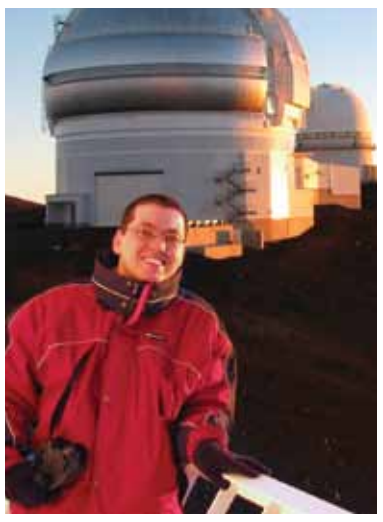
Across Canada, NRC has some 240 industrial technology advisors helping companies take advantage of NRC-IRAP as well as our industry partnership facilities and other technology development centres. From collaborative R&D to industrial research assistance, our door is open for business.

R&D can't be considered a luxury, not in this economy. We need to use all the resources at hand to help Canadian manufacturers innovate today and compete among the world's best. ■

NRC people in the news

Scientist of the Year

On January 21, 2009, Dr. Christian Marois of the NRC Herzberg Institute of Astrophysics was named Scientist of the Year 2008 by Radio-Canada, the French-language service of the Canadian Broadcasting Corporation. This award recognizes his team's achievement in capturing the first-ever images of planets circling a star other than the Sun. The award was shared by the other Canadian members of the team: David Lafrenière (University of Toronto) and René Doyon (Université de Montréal).



Dr. Christian Marois

The team, led by Dr. Marois, used the Gemini North and Keck telescopes on the summit of Mauna Kea in Hawaii to capture infrared images of the planets. These images were then confirmed using advanced instrumentation and image-processing technology, allowing the team to identify three planets larger than Jupiter orbiting a star known as HR 8799. This star, 130 light years from Earth in the constellation of Pegasus, is faintly visible to the naked eye.

So far, Dr. Marois and his colleagues have been recognized for their discovery by Science magazine, the popular website Space.com and Time magazine.

MRI pioneer honoured

On December 30, 2008, Dr. Ian Smith, Director General of the NRC Institute for Biodiagnostics in Winnipeg, was named an Officer of the Order of Canada "for his leadership in the advancement, development and commercialization of Canada's diagnostic technologies, notably magnetic resonance imaging and its applications in the field of health care."

And on January 23, 2009, Dr. Smith was presented with a 2008 Outstanding Achievement Award of the Public Service of Canada. Recognized as the Prime Minister's Award, this is given to "senior public service employees whose careers have been distinguished by a sustained commitment to excellence in the public service and building the public service as a vibrant national institution geared to future needs."

Dr. Smith is a world leader in the field of biodiagnostics and was instrumental in the advancement of a movable MRI system that allowed surgeons to do non-invasive scans before, during and after surgery. He has been a driving force in the development of technologies that reduce the invasiveness of surgical procedures.

The Right Honourable Stephen Harper, Prime Minister of Canada, and Her Excellency the Right Honourable Michaëlle Jean, Governor General of Canada, congratulate Dr. Ian Smith, Director General of NRC-IBD, on being named an Officer of the Order of Canada.

Herzberg Gold Medal winner

Dr. Paul Corkum, an attosecond science researcher at the NRC Steacie Institute for Molecular Sciences and physics professor at the University of Ottawa, is this year's winner of the Gerhard Herzberg Gold Medal for Science and Engineering — Canada's most prestigious science prize.

NRC President Dr. Pierre Coulombe (left) and the Honourable Gary Goodyear, Minister of State for Science and Technology (right) congratulate Gerhard Herzberg gold medallist, Dr. Paul Corkum, at the Fairmont Chateau Laurier in Ottawa.

This prize is awarded by the Natural Sciences and Engineering Research Council of Canada to an individual who has demonstrated sustained excellence and influence for research done in Canada, leading to significant advances in the natural sciences or engineering. The winner also receives $1 million in research funding.

Prime Minister Stephen Harper presented the award to Dr. Corkum during a gala on March 16, 2009, at the Fairmont Chateau Laurier in Ottawa.

Dr. Corkum's selection as gold medalist stems from his innovative research in the cutting-edge field of attosecond science. The ultimate goal of his work is to control the movement of electrons as they speed along inside molecules. The potential applications range from quantum computing to diagnostic medicine. ■

Publications Mail Agreement No. 40062591
Return undeliverable Canadian addresses to:
National Research Council Canada
1200 Montreal Rd.,
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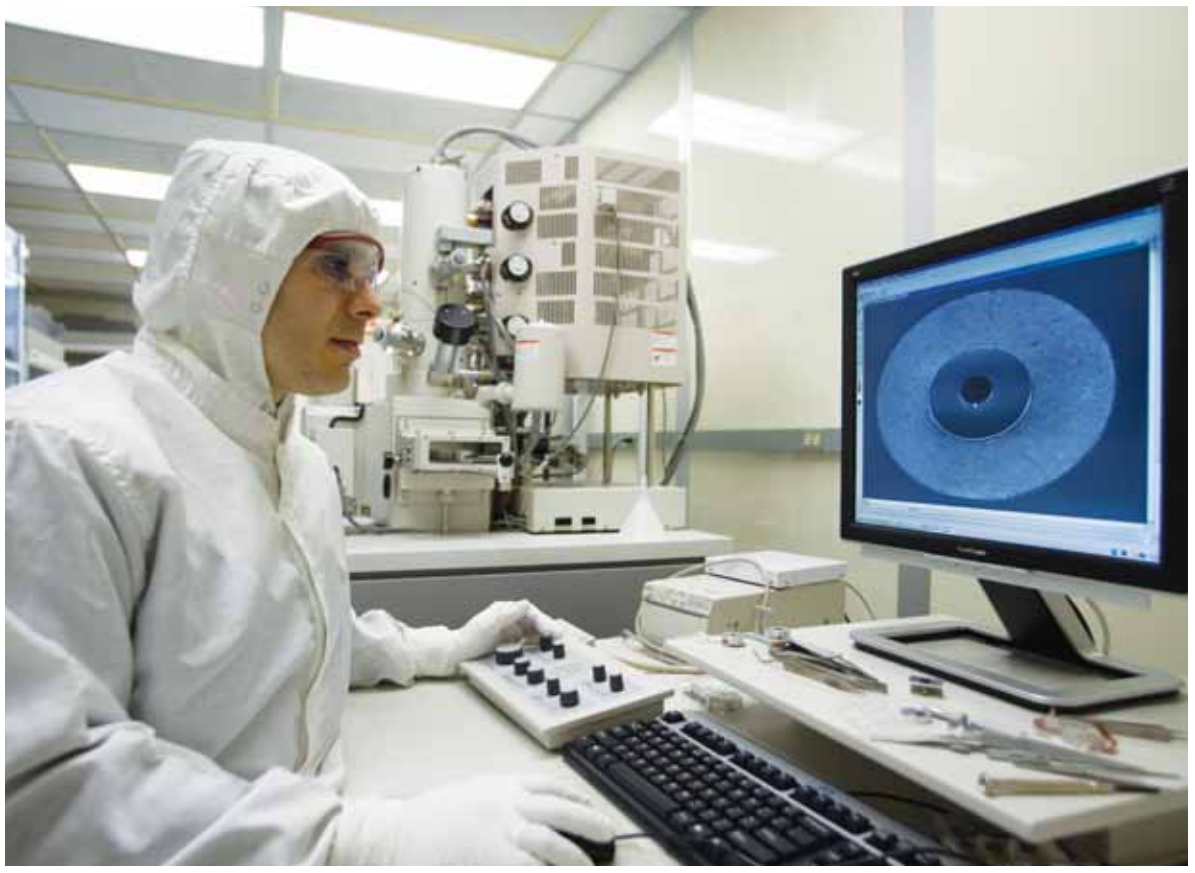
TECHNOLOGY CLUSTER INITIATIVES

Photonics illuminates new markets



"Photonics" was synonymous with telecommunications back in 2004 when the NRC Canadian Photonics Fabrication Centre (NRC-CPFC) began taking business. Today, five years later, NRC-CPFC experts are talking about the birth of remarkable new applications. While still driving growth in the information and communications sector, photonics is now enabling novel technologies in health care, manufacturing, security, energy and the environment.

"We're helping industry through the early stages of applications in dramatically different fields," says Dr. Sylvain Charbonneau, Director of NRC-CPFC. "For example, photonics could play a central role in molecular analysis, leading to better diagnostics. Work is progressing on photon-based sensors to make industrial processes safer for the environment. And photonics will soon play a much bigger role in the manufacture of highly specialized components."

Located on the NRC campus in Ottawa, NRC-CPFC is a $150 million technology commercialization facility built in partnership by NRC and the Province of Ontario. A cornerstone for NRC's photonics cluster strategy, this world-class facility offers services found nowhere else in Canada. NRC-CPFC customers take advantage of a 37000 square metre industrial grade semiconductor foundry and testing labs to bring new product ideas to life.

Group IV Semiconductor is one such customer. This Ottawa-based company is leading the way to affordable and energy efficient light bulbs that vastly outperform today's compact fluorescent bulbs. Group IV has been developing its materials and fabrication process with NRC-CPFC, using semiconductors instead of gases or filaments for its bulbs. To date, solid-state light bulbs have been too expensive to mass produce, but the company aims to dramatically reduce their cost — overcoming the critical price barrier and enabling widespread adoption.

Another customer is Cyrium Technologies, a Canadian company with a technology that could significantly improve the efficiency and cut the cost of solar power generation. Because NRC-CPFC is helping Cyrium fabricate its prototype solar cells, the young firm doesn't have to invest large amounts in its own labs and equipment while trying to break into the market. With generous venture capital, this company is on the path to commercial success.

Gain Microwave is another happy customer. This company supplies gallium nitride (GaN) technology solutions and provides components for broadband wireless applications, as well as aerospace and defence systems. "NRC-CPFC produces the GaN wafers for our firm," says Dr. Alan Harrison, General Manager of Gain Microwave. "It is the sole facility in Canada that can offer the commercial grade foundry service we need."

"NRC-CPFC produces the GaN wafers for our firm," says Dr. Alan Harrison, General Manager of Gain Microwave. "It is the sole facility in Canada that can offer the commercial grade foundry service we need."

With a view to supporting medical research, two NRC institutes are now working with NRC-CPFC to produce an integrated "patch-clamp array chip" to monitor the electrophysical activity of neurons. This chip could be used to study both the molecular-level cellular processes underlying neurodegenerative diseases and the action of medications. The Centre will play a crucial role in fabricating the first generation of chips on a silicon platform, for testing and further development.

NRC-CPFC is a valuable resource for the cluster of Canadian photonics companies that turn to it for the design, prototyping and manufacture of highly specialized components. The Centre has played a pivotal role in expanding Canada's optical technology base from telecommunications into promising new sectors. ■

Photonics is a $710 billion global industry that impacts every sector of the economy and the daily life of every Canadian. Yet, despite its pervasiveness, this "science of light" has a relatively low profile among our leaders and decision makers.

Illuminating a World of Opportunity
Canadian Photonics Consortium, January 2009

UPCOMING EVENTS

The Crossroad for BioTransfer 2009
May 5, 2009, Montréal, Quebec

The annual Crossroad of Biotechnology brings together Montréal's business and science sectors. Hosted by the NRC Biotechnology Research Institute, this year's event will feature an intensive one-day program focusing on technology licensing opportunities. Three major players in intellectual property creation will present their best life sciences technology licensing opportunities in the health sector: NRC, the Montreal Excellerator and Gestion Univalor. For details, visit: www.biotransfer.ca

2009 BIO International Convention
May 18–21, 2009, Atlanta, Georgia

The BIO International Convention is the largest global event for the biotechnology industry. It attracts the biggest names in biotech, offers key networking and partnering opportunities, and provides insights and inspiration on major trends affecting the industry. This year's convention will cover all aspects of the biotechnology and life sciences industries including investments, policy, state initiatives and economic development, and the international marketplace. For details, visit: www.bio2009.org

Hydrogen + Fuel Cells 2009
May 31–June 3, 2009, Vancouver, British Columbia

The fourth edition of this biennial conference will feature keynote addresses from prominent industry and government figures, as well as plenary and parallel sessions focusing on key issues in the hydrogen and fuel cells sector. The exhibition and trade show will provide attendees with a place to network and partner with global leaders in the business, government and scientific community. For details, visit: www.hfc2009.com

International Council for Scientific and Technical Information (ICSTI) 2009 Public Conference and General Assembly
June 9–12, 2009, Ottawa, Ontario

The NRC Canada Institute for Scientific and Technical Information will host ICSTI's 2009 Summer Public Conference at Library and Archives Canada in Ottawa, Ontario from June 9–10. This year's theme will be "managing data for science," with a focus on recent developments in data management. The program will also address other relevant topics, ranging from integration in published outputs and re-purposing to hosting, archiving and preserving data. ICSTI's 2009 General Assembly will take place after the conference, on June 11 and 12. For details, visit: www.icsti.org

12th Federal Partners in Technology Transfer (FPTT) National Meeting
June 17–19, 2009, Ottawa, Ontario

This year's FPTT National Meeting will focus on "Marketing and mobilizing your technology." The meeting will provide an opportunity to discuss and learn how to use the latest technology transfer practices to turn research results into action. For details, visit: www.fptt-pftt.gc.ca

12th International Conference on Fracture
July 12–17, 2009, Ottawa, Ontario

The 12th International Conference on Fracture will focus on key issues in structural integrity, strength and fracture of materials and structures for the 21st century, including applications in geophysics, medicine, integrated modelling and engineering. For details, visit: **www.icf12.org**

MOCA-09
July 19–29, 2009, Montréal, Quebec

The Joint Meteorological, Oceanic and Cryospheric Assembly (MOCA) for 2009 will be hosted by the International Association of Meteorology and Atmospheric Sciences, the International Association for the Physical Sciences of the Oceans, and the International Association of Cryospheric Sciences. The conference theme is "Our warming planet." For details, visit: www.moca-09.org

LEADING-EDGE R&D

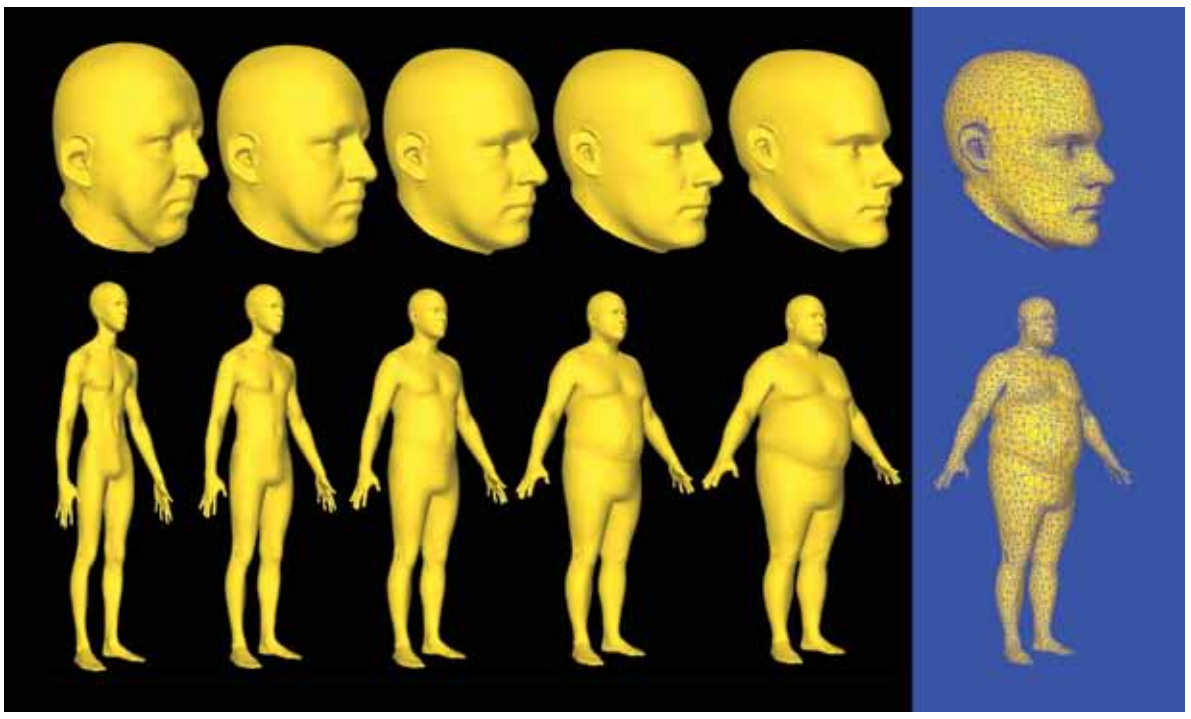
Shaping the next top model

A grey, three dimensional "virtual face" stares blankly out of a laptop screen. Sliding a series of software controls from side to side, Dr. Chang Shu makes the face morph into hundreds of different shapes, each one showing variations in key facial dimensions.

Welcome to the digital human modelling project, an NRC-led initiative that addresses the growing need for 3D information on the human body. The project partners the NRC Institute for Information Technology (NRC-IIT) in Ottawa with other government, university and industry organizations, including among others Defence Research and Development Canada (DRDC).

"Our aim is to develop new tools for rapidly imaging and modelling human body shapes and then apply the tools toward a wide range of applications," says Dr. Shu of NRC-IIT. For example, he and his colleagues have developed digital modelling software to help DRDC design new helmets for Canadian soldiers serving in Afghanistan.

"DRDC wants to develop helmets that protect both the head and neck, which is vulnerable to shrapnel from an improvised explosive device on the ground," he explains. "Until now, helmet designs were based on anthropometric measurements, which involve the use of simple tools such as calipers and tape measures to measure linear distances. But if you want to design the best helmet possible, you need 3D shape information."



Under the digital human modelling project, NRC is developing new software tools to rapidly image and model human body shapes.

To collect this data, DRDC scanned the heads of some 400 Canadian soldiers. "Our software then analyzed the 3D-scan data and characterized the soldiers' head shapes," says Dr. Shu. "By doing so, we computed an optimal set of shapes, which are being used to design specific helmet sizes that best fit the soldier population."

"This is a new way of using surface 3D anthropometry data for industrial product design."
Dr. Chang Shu, NRC

"This is a new way of using surface 3D anthropometry data for industrial product design," he adds. Besides helmets, digital human modelling could facilitate clothing manufacturing, transportation, aerospace and furniture design. The technology could also be used for medical, security, forensic and entertainment applications.

In the medical field, for example, advance visualization tools are now being applied to the human brain, as part of an NRC project to create virtual surgery techniques to plan surgery and train medical students, says François Blais, leader of NRC-IIT's visual information technology group.

The roots of the human digital modelling project date back to 2000 with the launch of the Civilian American and European Surface Anthropometry Resource (CAESAR) project — an international consortium, involving public and private sector organizations, that acquired 5,000 different human body scans from North America and Europe. "This was the world's first large 3D anthropometric survey," says Dr. Shu, "and NRC was the first organization to publish results of statistical shape analysis on CAESAR data."

Unique in the world, the NRC-IIT team boasts expertise in everything from 3D data acquisitions to image processing and visualization. "Many groups can do 3D scans, but to make full use of 3D data you need advanced statistical shape analysis," says Dr. Shu. "Our technology is available now so a lot of people want to collaborate with us." ■

Up to Code?

For two decades, NRC has helped the Canadian construction industry gain a head start in bringing innovative construction products to the marketplace.

Established in 1988, the NRC Canadian Construction Materials Centre (NRC-CCMC) is a voluntary national evaluation service for innovative building materials, products, systems and services. The Centre provides opinions on whether these comply with the minimum performance established by the National Building Code of Canada, which is used by the provinces and territories to establish building regulations in their own jurisdictions.

"We play a key role both for the industry and for provincial and territorial regulators," says Denis Bergeron, Director of Codes and Evaluation at the NRC Institute for Research in Construction in Ottawa. "We give the construction industry and regulatory authorities a level of comfort and confidence regarding new products before they get standardized and referenced in building codes. We also provide third party verification on whether construction products meet a standard if there is no certification program available."

"We play a key role both for the industry and for provincial and territorial regulators.We give industry and regulatory authorities a level of comfort and confidence regarding new products."
Denis Bergeron, NRC

Products assessed by the Centre are used in commercial and residential buildings. "We evaluate a wide range of construction products from the foundation to the roof," says Dr. John Flack, Manager of NRC-CCMC. Since 1988, NRC-CCMC officers have looked at air barrier systems, insulation materials, windows, sheathing membranes, claddings, foundation drainage, steel framing, insulating concrete forms, exterior insulation and finish systems, polyurethane spray foam insulation, joist hangers, PVC railing systems and other innovative products.

"When a company invents something and wants to bring it to market, at some point it will need to demonstrate that its product meets the building code or the intent of the code," Bergeron explains. "On a fee-for-service basis, we analyze any comparable products or systems that are actually specified in the code (i.e. code-acceptable solutions) to determine the performance expected by the code, and then assess whether the new product meets this performance, based on independent testing arranged by the client."

"Our stakeholders include building officials, provincial and territorial building regulatory authorities, trade and industry associations, construction product manufacturers and distributors, laboratories and testing organizations, research groups/universities, builders, architects, engineers, certification agencies, standards developers, and other government departments," he adds.

The NRC-CCMC service is recognized by provincial and territorial building regulatory bodies across Canada. "This does not mean that they're bound by anything that we publish. Provinces and territories have jurisdiction over building construction and because of other considerations — such as municipal bylaws, other regulations or official directions — they may or may not use our opinion, or they may qualify it," says Bergeron.

NRC-CCMC has developed a solid reputation in Canada and abroad for the quality of its evaluations and its assistance to the construction industry. This reputation is also put at work in support of trade initiatives with other countries to increase confidence abroad in Canadian products and technologies. ■

More information on NRC-CCMC's evaluation services can be found at:
irc.nrc-cnrc.gc.ca/ccmc

What's this?

This is a plastic test part fabricated on a micro-injection moulding machine at the NRC Industrial Materials Institute. It is used to demonstrate the micro-moulding of plastic with very fine details and to validate simulation software created to accurately model micro-injection moulding.

To view more science photos, visit NRC Picture Perfect Science at: **www.nrc-cnrc.gc.ca/multimedia/picture/index_e.html**

WORKING WITH INDUSTRY

Green cars get amber light

The NRC report offered some 30 recommendations touching on equipment safety, licence requirements, education, restrictions on use in mixed traffic, and changes in traffic signal phasing.

To help pave the way for environmentally friendly cars, Ontario's Ministry of Transportation (MTO) is considering recommendations from NRC on the introduction of low-speed vehicles (LSVs) into mainstream traffic. LSVs run on electricity, so they produce no direct emissions — good news for those concerned about greenhouse gases and air quality.

These battery fueled cars reach a maximum of 32 to 40 kilometres per hour and are recommended for use only in controlled environments where they have minimal interaction with other vehicles. LSVs are now being pilot tested in British Columbia, Alberta, Ontario and Quebec.

MTO commissioned the NRC Centre for Surface Transportation Technology (NRC-CSTT) to study the risks associated with introducing low-speed vehicles in mixed traffic on Ontario's public roads. The study noted that the low speed of these vehicles could impede traffic and put their drivers at risk. It warned of a substantially higher risk of driver injury and fatality due to the relatively low mass of LSVs compared to other vehicles on public roads. It also analyzed risks related to human factors, road conditions and the equipment in LSVs, such as the adequacy of their braking systems, lights and seat belt assemblies. The NRC report offered some 30 recommendations touching on equipment safety standards, licence requirements, education about the performance and safety limitations of LSVs, restrictions for their use in mixed traffic, changes in traffic signal phasing to accommodate slower vehicles, and more. NRC-CSTT recommends the use of LSVs as passenger vehicles in mixed traffic only when they meet certain safety requirements.

Located in Ottawa, NRC-CSTT provides research, development, evaluation and testing services for the rail and road transport industries, the military, and vehicle and equipment manufacturers. Its mission is to improve and protect human life through mobility, with a focus on vehicle safety.

The NRC report, *Safe Integration of Electric Low-Speed Vehicles on Ontario's Roads in Mixed Traffic*, is available on the MTO website. ■

Bombardier's new robotics system is used to position aircraft fuselage panels on a riveting machine.

Automating aerospace assembly

In collaboration with NRC, Montréal-based Bombardier Aerospace has introduced its first robotics system for the assembly of aircraft components.

Designed to improve productivity in a broad sense, the system also reduces tendonitis and related health problems in workers by improving their working conditions, says Claude Perron, group leader of automation and robotics at the NRC Institute for Aerospace Research in Montréal. Currently, the robots are working three shifts.

"Since 2004, we have been helping a couple of aerospace companies develop robotics to help replace human processes," adds Perron. "The industry wants to improve quality and repeatability, and replace processes that cause tendonitis and other musculoskeletal illnesses, thereby improving working conditions for employees." With help from NRC, Bombardier has implemented an automated positioning system, whereby robots replace a human operator, who would previously position a fuselage panel on a riveting machine. "Now, instead of handling the fuselage panel, workers sit in front of a computer screen and monitor the positioning operations done by the robots," says Perron.

According to Perron, the robotics system was a collaborative creation: Bombardier developed the human-machine interface and fixtures, while NRC researchers led by Bruno Monsarrat developed technologies for calibrating and controlling collaborative robot work-cells, as well as new off-line programming methods.

> *"Now, instead of handling the fuselage panel, workers sit in front of a computer screen and monitor the positioning operations done by the robots."*
>
> Claude Perron, NRC

"There are several steps in the assembly process where robots could be or are starting to be used in the aerospace industry," notes Perron. "Every time a worker has to apply a tool to a part there can be health issues." And due to potential labour shortages in the aerospace industry, the pressure to automate will intensify. ■

Fuelling buildings of tomorrow

Often touted as a universal energy solution, fuel cell and hydrogen technologies have the potential to do far more than just power the vehicles of tomorrow. Now they are being examined as a clean and economical way to supply electricity and heat for homes, offices and commercial buildings. But how well will they actually perform in buildings? How will we connect fuel cells to existing heating and ventilation systems? Will buildings need to be reinforced or redesigned to accommodate this technology?

These were some of the questions raised at an NRC workshop on integrating fuel cells and hydrogen technologies in buildings. Held in December at the NRC Institute for Fuel Cell Innovation (NRC-IFCI) in Vancouver, the workshop was attended by some 50 people from government, academia and industry, including fuel cell researchers, regulators, building inspectors, designers, consultants, builders and technology developers.

"NRC is exploring ways to support the development of building applications for fuel cell technologies," explains Denis Bergeron, co-organizer of the workshop, and Director of Codes and Evaluation at the NRC Institute for Research in Construction (NRC-IRC) in Ottawa. "The workshop's goal was to identify real and perceived barriers or knowledge gaps to the application of these technologies in buildings, as well as opportunities for NRC and other actors to help the fuel cell industry."

One of the workshop's conclusions was that the fuel cell industry needs a strong business case with a clear value proposition. "It needs to show that fuel cell technology contributes to larger goals such as greenhouse emission reductions or energy targets, and compares favourably to other technologies in terms of safety, efficiency and affordability," says David Semczyszyn, Director of Operatons and Technology Demonstration at NRC-IFCI and co-organizer of the workshop.

"The workshop also identified that before the industry asks government decision makers, homeowners and builders to promote or use fuel cell products, more research needs to be done on the integration of the technologies in buildings," adds Bergeron. "This is where NRC and other federal agencies can play a role. We might be able to help the industry develop the case for building applications, by investigating the most efficient way to integrate fuel cells into buildings." ■

For a copy of the forum report, contact **Denis Bergeron:** denis.bergeron@nrc-cnrc.gc.ca or **David Semczyszyn:** david.semczyszyn@nrc-cnrc.gc.ca

PARTNERSHIPS AND COLLABORATIONS

Manufacturing a competitive edge

The urgent need to increase revenues and productivity in Canada's manufacturing industries has sharpened the attention of politicians and economists on measures to give Canadian manufacturers a competitive edge. Significant technology development is required to help this sector remain sustainable and globally competitive.

Responding to this need, NRC has launched an R&D strategy and mobilized a team of experts to boost innovation in the manufacturing and materials engineering sector.

"NRC has exceptional expertise to offer in the development of advanced materials, innovative processes and decision-aid systems," says NRC President, Dr. Pierre Coulombe. NRC has already begun selecting projects and partners.

Researchers across several NRC institutes will work together to develop lighter, safer, more affordable and environmentally friendly materials — including polymer blends, foams, composites and films, nanomaterials and particulate materials (metals and ceramics), as well as specialty metals.

To reduce production costs and impacts on the environment, NRC researchers will work toward enhancing processing technologies — machining, robotics and automation, joining and surface technologies, moulding and forming, and nanoscale manufacturing of polymers and metals. These improved processes will help minimize energy consumption, waste and greenhouse gas emissions.

Finally, NRC will develop decision-aid systems to improve the quality, efficiency and environmental safety of manufacturing processes. NRC researchers will apply advanced computational and sensing technologies that make use of modelling, simulation and interaction hardware.

"NRC aims to strengthen the global competitiveness of Canada across the whole supply chain from SMEs to OEMs."
Blaise Labrecque, NRC

"The segments that will benefit from this R&D are primary materials producers, engineering firms, machinery manufacturers and thousands of components producers — mostly Canadian small and medium sized enterprises (SMEs)," says Dr. Coulombe. One of NRC's objectives is to help Canadian SMEs link to international original equipment manufacturers (OEMs) and help them integrate global supply chains. (An OEM is typically a company that uses a component made by a second company in its own product, or sells the product of the second company under its own brand.)

As one plank of its R&D strategy for manufacturing, NRC has launched the Advanced Materials Initiative (AMI), undertaking projects with industry partners in the aerospace, automotive, construction and manufacturing sectors.

"The goal of AMI is to help Canadian manufacturers develop and implement technologies based on two main thrusts: new high-performance composite materials and surface coatings," explains Blaise Labrecque, coordinator of the initiative. "NRC aims to strengthen the global competitiveness of Canada across the whole supply chain from SMEs to OEMs." NRC will invest more than $6 million in this initiative from 2009 to 2012 ■

Standardizing the feed

Continued from page 1

batches and standardize effective doses to meet Canadian Food Inspection Agency (CFIA) standards.

STI-NA Vice-President of Technical Services, Shane Patelakis, says the product boosts animal immune systems, rather like low-dose antibiotics that farmers use to reduce herd diseases. But beta glucan can be certified organic, leaves no antibiotic residues, and costs about the same.

The problem: several North American companies make beta glucans of many qualities, but few market it for animals. Stirling Products had to prove it met CFIA standards for purity and quality. But Patelakis found no industry-standard test, and existing tests met neither CFIA's nor STI-NA's needs.

Accurate, consistent quality control was crucial for Stirling Products, says Patelakis. Batch purity varied naturally and the company needed to sell standard doses for different types of animals — ranging from 40 grams per metric tonne of feed for poultry to 200 grams for cattle.

Patelakis' background as a food scientist had exposed him to the NRC Institute for Nutrisciences and Health (NRC-INH) in Charlottetown, and so he turned there for help.

"We wanted to differentiate our company, and we needed the credibility of an independent national organization to back that up," says Patelakis. "We went directly to NRC. It helped us better understand our process and our product."

Through Dr. Bob Chapman, the group leader at NRC-INH, and his colleague, Dr. Jim Johnson, Stirling Products gained access to research and expertise that helped it identify a test that should measure up to CFIA standards.

"We needed the credibility of an independent national organization . . . we went directly to NRC . . . they understand the business side."
Shane Patelakis, VP, Technical Services, Stirling Products North America Inc.

The team combed the science literature and found an enzyme-based test. Unfortunately, it was complex, tedious and overly challenging for technicians, who had to handle numerous steps over many hours — and the accuracy of the final measurement involved luck as well as skill. "That presented a problem for us," says Dr. Chapman. "We started thinking: 'there must be a better way'."

He found the answer more or less down the hall. NRC-INH is part of a unique partnership in which researchers from NRC, Agriculture and Agri-Food Canada, the University of Prince Edward Island, and industry share space, information and equipment in their building on the university's campus. That equipment includes a nuclear magnetic resonance (NMR) instrument.

Working with Dr. Chris Kirby, the machine's resident expert, the team found a way to use NMR to accurately test the particular sugars they wanted. With the wrinkles ironed out, the new test takes only a quarter of the time of the original test and satisfied Stirling Products' needs. They are now working with CFIA to ensure it meets their needs as well.

As a bonus, it could be widened to test for other yeast-based sugars. "That will open up the value chain for other uses," Dr. Chapman notes, adding that breweries could be interested in adapting the test to aid making better beer.

It's a leap forward that the NRC-INH team is now writing about in a scientific paper. This is one of many instances, says Dr. Chapman, in which NRC-INH has developed new techniques for testing Canadian bioscience products.

"Instead of working technicians, the test works the technology," he says. "There's only one real technician step, and it's easy to teach."

Patelakis says Stirling Product's experience with NRC-INH may be unique to Canada. "It's nice that we have the opportunity for partnership," he says. "This institute is hands-on. They really want to work with industry, they understand the business side, and they operate at the same pace as business people." ■

Hydrogen lifts the load

Continued from page 1

Adrian Corless, now Plug Power Canada's Chief Technology Officer, began developing the fuel cell packs with Cellex in 1999. At the time, the infant fuel cell industry was targeting obvious "megamarkets" — automotive and home power — but Cellex CEO (now Plug Power Canada President) Chris Reid knew these markets needed massive, unbuilt hydrogen infrastructure to work. He also knew warehouse complexes concentrated enough forklifts to simplify hydrogen delivery and make forklift fuel cells quickly practical and profitable. Powering forklifts is a niche market, but its potential worldwide value is $6-8 billion dollars a year.

When Reid heard that NRC was establishing its fuel cell institute, Cellex became the first tenant of NRC-IFCI in November 1999. There, it gained access to high grade offices, machine shops, Vancouver's first publicly available hydrogen-safe labs for testing its prototypes, as well as gas procurement, information technology and administrative support. Cellex also gained crucial networking opportunities and the credibility to attract investors.

Its initial product development went so well that Cellex raised enough investment capital to lease its own building the next summer. The former two-person concern graduated from the incubator with 330 square metres of offices and labs. Over the next six years, it prepared its product for market, as customers began to notice the obvious cost advantages. By 2006, clients like Wal-Mart had tried Cellex fuel cells and wanted more.

"Having those customers validate our technology and start to purchase it in a commercial form led Plug Power to make the move to purchase Cellex," says Corless. "NRC was very helpful to us. Because of the infrastructure and support it provided, we were able to demonstrate our first prototypes seven months later. Without NRC — the investment they were willing to make on infrastructure, and their willingness to incubate new companies — it would have been difficult for us to get off to such a quick start and attract customers as quickly as we did."

NRC-IFCI has since grown into a regional networking and innovation hub. The institute is currently incubating 14 hydrogen fuel cell companies, and houses the Canadian Hydrogen and Fuel Cell Association (CHFCA) as well as NRC-IRAP (Industrial Research Assistance Program) and NRC-CISTI (Canada Institute for Scientific and Technical Information) offices. It continues to be a catalyst, attracting new foreign investment, start-ups and spin-offs to grow Vancouver's fuel cell technology cluster. "NRC-IFCI is a facility that any one company by itself would be unable to build, but that many companies have a need for," says John Tak, President and CEO of CHFCA. ■

SCIENCE OUTREACH

Engineering eggscellence

Students from Osgoode Public School look on as NRC employee, Tim Glassford, measures their egg-drop prototype.

Imagine you work for a disaster relief organization. A hurricane has devastated a coastal city, leaving thousands of people homeless. Relief supplies need to be air-dropped to the residents immediately, as all roads to the area are blocked. How do you ensure the supplies arrive undamaged and land as close as possible to the disaster site?

This was the authentic scenario posed to 72 elementary school classes in Ottawa and surrounding communities this winter, launching the 2009 NRC Engineering Challenge — an annual event to celebrate National Engineering Month. To simulate the disaster relief, some 2000 grade 5 to 7 students, working in small teams, were asked to design and construct an engineering prototype — a compact, but hardy "egg drop device" using an approved list of recycled materials. The device would have to carry its cargo (a raw egg) along a ramp, drop 1.75 metres onto the floor and then roll another 1.75 metres to a target — all without damaging the egg.

In this year's Challenge, which culminated in a final competition on February 27, each team was judged on the creativity and innovation shown in its prototype, the volume of the prototype (which could not exceed 20 cm in any dimension), and the precision of the drop. "But keeping the egg intact was the main goal for each team," says Stephan D'Aoust of the NRC Centre for Surface Transportation Technology in Ottawa.

One of 38 volunteer engineers from NRC and other organizations, D'Aoust regularly plays a key role in the success of this annual event, which provides teachers with an engaging way to introduce scientific concepts to young students. He and other volunteers mentor up to four classrooms throughout the four-week Engineering Challenge.

"We present the project and give an introduction to engineering," says D'Aoust. "We then visit our school for a few hours each week until the end of February, when a school-level competition is run to select one or two teams to participate in the final. The competitive process gives students a glimpse of how products evolve. One of the best parts of being a volunteer," he adds, "is when students come up with innovative and ingenious ideas that you haven't thought of yourself."

"One of the best parts of being a volunteer is when students come up with innovative and ingenious ideas that you haven't thought of yourself."
Stephan D'Aoust, NRC

"Our role is to guide children through the process of designing, building and testing a prototype," notes Hélène Roche of the NRC Institute for Research in Construction. "We try to teach them how engineering works in the real world. Many students want to start building a device before they've sketched any designs. Once they have a clear picture about what they want to do, we 'approve' their drawing so the building can begin."

In previous years, Engineering Challenge participants have simulated other real-life problems by constructing a vehicle to carry fragile cargo in the Arctic, a catapult to propel samples from Mars to Earth, and a car powered by a rubber band. ■

Seaplane floats tested

NRC researchers recently evaluated the performance of two prototype seaplane floats designed by Seaflight Industries of Vernon, B.C. Intended for use on small aircraft, such as the de Havilland Beaver, the new floats explore the potential of various design modifications to reduce take-off distances and improve a seaplane's stability in rough water. The new floats also incorporate composite materials.

"Seaflight wanted us to find out whether their new designs reduce drag, which should shorten the required take-off run."
Rob Pallard, NRC

Seaflight Industries, which specializes in maintenance work on seaplanes, was introduced to the NRC Institute for Ocean Technology (NRC-IOT) in St. John's, Newfoundland, through the NRC Industrial Research Assistance Program. "Seaflight wanted us to find out whether their new designs reduce drag, which should shorten the required take-off run," says Rob Pallard, a vessel performance analyst at NRC-IOT. The company also hoped that its new designs would make seaplane floats less susceptible to "porpoising" — an undulating fore-and-aft motion that can occur when a seaplane taxis.

A model seaplane float is tested at the NRC Institute for Ocean Technology's towing tank facility in St. John's.

Led by Pallard, an NRC team tested four model floats: the original de Havilland Beaver design, a modified de Havilland float, and the two Seaflight prototypes. The tests were conducted in NRC-IOT's 200-metre towing tank, which features a wavemaker and is used for resistance, propulsion, wake survey, flow visualization and other studies. ■

Membrane magic

Continued from page 1

For Vaperma, Dr. Guiver is developing a novel class of highly selective and permeable polymers that can efficiently separate gaseous compounds. These newly developed materials perform radically better than most currently available membrane polymers, allowing unusually large amounts of gas to flow through. They're also selective enough to allow a desirable gas to cross while barring unwanted ones.

"This is an extraordinary class of materials," he says. "Our goal has been to improve the way membrane materials are made, to ensure consistency and quality. We've also introduced completely new materials, enabling us to tune their selectivity to different gases to get better separation capability."

NRC-ICPET is also helping Vaperma scale up the manufacture of these novel polymers from lab-size to industrial-size batches. So far, Dr. Guiver's group has managed to reduce the time needed to synthesize Vaperma's test polymers from days to just one or two hours.

"Speaking generally, gas permeable polymers have many applications," says Dr. Guiver. These include making enriched oxygen or pure nitrogen from air; capturing carbon dioxide from smokestack gases to clean the environment; and removing carbon dioxide from natural gas so it can be pumped through pipelines without corroding them.

Besides refining ethanol, Vaperma foresees its products being used as a relatively reliable and cost-effective way to separate water from organic compounds such as acids, esters and the like. They could also be used to recover methane from crude natural gas, and to purify manufactured biogases.

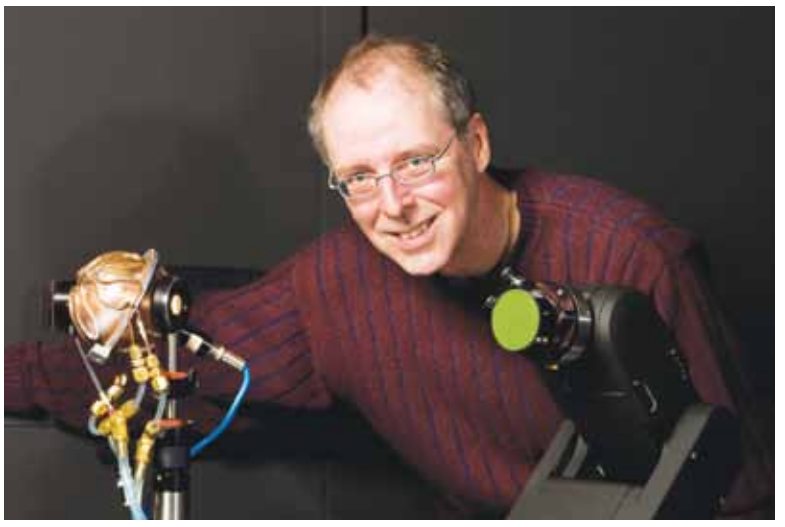
"There are huge potential energy savings from using membranes rather than traditional energy-intensive separation technologies."
Dr. Michael Guiver, NRC

"Apart from natural gas processing, there are also great opportunities in the petrochemical industry," notes Dr. Guiver. "There are huge potential energy savings from using membranes rather than traditional energy-intensive separation technologies in a wide spectrum of applications."

Thanks to NRC's help, Vaperma is well on its way of realizing its goal to become a global leader in the manufacture and supply of advanced gas separation solutions for clean energy and industrial uses. ■

LEADING-EDGE R&D

Reflecting on colour



Dr. Réjean Baribeau and the gonioreflectometer he developed at NRC

There's more to colour than meets the eye, according to NRC specialists who have taken the science of measuring colour and appearance to new levels of precision.

The NRC Institute for National Measurement Standards (NRC-INMS) has developed a leading-edge "gonioreflectometer"— a highly sensitive instrument that can rapidly measure, in three dimensions, the reflectance properties of materials with a variety of colour attributes and surface properties. That's good news for manufacturers of new iridescent paints that reflect a range of hues and exhibit different surface texture or other spatial effects, when light hits them from different angles.

Cosmetics, cars, appliances, clothing and high-end packaging are some of the products for which the proper management of colour and appearance are critical for commercial success. NRC's capacity to accurately measure 3D reflectance will also serve other interests, such as anti-counterfeiting, remote sensing, cultural heritage and medical imaging applications, or the production of new geometry-sensitive materials, such as special effect pigments.

Dr. Réjean Baribeau, a researcher at NRC-INMS, is the mind behind the enhanced gonioreflectometer. "With integrated robotics to move the target material around, our design allows us to measure bidirectional reflectance at higher speed and less cost than other existing similar instruments," he explains. "Our gonioreflectometer is also smaller and easier to use."

A gonioreflectometer consists of a light source illuminating the material to be measured and a sensor that captures the light reflected from that material as it rotates around a hemisphere. The rotation of the light source and the sensor around the target material is what allows for reflectance to be measured in 3D.

"It's extremely challenging to quantify absolutely the surface appearance of materials, or to predict the degree to which different materials will match," says Dr. Baribeau. "Measurements must take into account the interplay between visual perception, the angle and quality of lighting, as well as the optical properties and surface texture of a material." He demonstrates this by holding up a manufacturer's paint sample that reflects a dramatically different colour of varying intensity when held at different angles. Like a peacock's tail flashing in the sun, the colour of the paint chip changes from purple to teal blue, and then to green.

"Our instrument allows us to capture the full reflectance spectrum simultaneously instead of creating a multitude of separate measurements based on different wavelengths," says Dr. Baribeau. "We can characterize the 3D optical qualities of materials much faster."

NRC's objective is to open a new national measurement facility that will allow industry to measure materials with unusual optical qualities and calibrate their own 3D reflectance measurement instruments. The national metrology institutes of other nations will also benefit from NRC's enhancements. ■

NRC NEWSLINK

NRC NewsLink is published four times a year by the National Research Council of Canada. It informs readers about the many NRC research and innovation programs, services and initiatives that serve the needs of industry, the economy and all Canadians.

Publisher:
NRC Communications
and Corporate Relations

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ISSN 1913-1607

Flying safely longer

How long can an F-18 fighter jet wing be cycled non-stop, up-and-down, before it finally falls apart? How much vibration can a helicopter fuselage absorb before it forms cracks? How does the structural damage caused by an aircraft explosion compare to wear and tear?

These are the questions routinely tackled by NRC's Structures and Materials Performance Laboratory (SMPL). The Ottawa facility — an 85-person wing of the Institute for Aerospace Research (NRC-IAR) — conducts research on issues affecting the design, strength, durability, structural integrity and performance of aircraft components. It also develops new design, analysis and manufacturing technologies for structures and materials, as well as for noise and vibration control.

"We look at the actual materials used to manufacture the airframe, including the fuselage and wings, as well as the materials used in gas turbine engines," says Nick Bellinger, who leads the SMPL's aerospace structures group. "We try to understand how those materials react to their environment. Our goal is to predict what will happen to aircraft materials as they age, determine how to extend their life, and anticipate when they will need to be repaired or replaced."

"One of our biggest clients is the Department of National Defence," he adds. "We help them keep their aircraft flying safely for longer periods. We also do work for Pratt & Whitney Canada, Rolls Royce, Bombardier, Bell Helicopter Canada, and small and medium-sized enterprises.

The NRC lab tests everything from small samples of aluminium, titanium, metallic superalloys, stainless steel or composite materials to larger components and full-scale aircraft. "We use the latest in non-destructive evaluation methods to monitor our test specimens," says Bellinger. "Our equipment includes hydraulic load frames with a fluctuating piston to introduce loads into specimens. We have a shaker table, which simulates the vibration that aircraft experience when flying. And we have a reverberation chamber, which lets us test the effects of sound on a component."

Among its roles, the reverberation chamber is used for full-scale satellite testing. "When a satellite is launched, it has to withstand a huge amount of noise during lift off," explains Bellinger. "Our reverberation chamber can simulate the lift-off noise and thereby certify that a satellite will survive the launch."

> *"Our goal is to predict what will happen to aircraft materials as they age, determine how to extend their life, and anticipate when they will need to be repaired or replaced."*
> Nick Bellinger, NRC

Besides its analytical and testing services, the NRC facility conducts research to extend the lifespan of aircraft materials and components. "Our lab has developed a novel erosion-resistant coating for aircraft engine components, which was recently licensed to Innovative Materials Technologies of Gatineau, Quebec," notes Bellinger. "We have also developed a heat treatment process that makes some aluminium materials less susceptible to stress corrosion cracking — the process is currently being certified by the Australian military. And we are now looking at technologies for repairing the metal skins on aircraft."

As part of NRC-IAR, SMPL is helping the industry extend the life of aircraft fuselages and engines, generating considerable savings for aircraft operators. ■