University - Industry Synergy

1999

Synergy Awards for R&D Partnerships

The Conference Board of Canada

NSERC CRSNG

Canada

1999 Award Winners

Category A-1 Small- and medium-sized companies

Alberta-Pacific Forest Industries Inc.
University of Alberta

Universal Dynamics
University of British Columbia

Category A-2 Large companies

Falconbridge Ltd.
University of Waterloo

Syncrude Canada Ltd.
University of Alberta

Category B Ventures involving several industry partners

CREWES Project
(consortium of 28 companies
and the University of Calgary)

Category C Leo Derikx Award

Canadian Microelectronics Corporation
(consisting of more than 60 companies
and academic research institutions)

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The Synergy Awards – defining successful university-industry partnerships for R&D

Synergy (sin' er jee) n., pl. ***-ies***. the combined or co-operative action of two or more agents, groups or parts etc. that together increase each other's effectiveness.

Now entering their fifth year, the Synergy Awards were launched by NSERC (the Natural Sciences and Engineering Research Council) and The Conference Board of Canada to foster increased university-industry collaboration in R&D, and to showcase the benefits of pooling resources and making the most of Canada's technological know-how.

The criteria against which the winners were judged included: the effective use of university and industry human and technical resources, including evidence of high-quality research, superior management skills, effective training of graduate students, and innovation, creativity and entrepreneurship. The winners also demonstrated a lasting relationship between partners — one that had tangible commercial and/or knowledge-based benefits to both partners.

NSERC and The Conference Board of Canada want to ensure that effective partnerships like these continue to flourish. This year's winners define what successful university-industry synergies are all about — leveraging the R&D capabilities of each partner to provide economic benefits to Canadian communities and to enrich academic and research programs within Canadian universities.

The Leo Derikx Award: A tribute to excellence in more ways than one

The measure of a man is the esteem of his peers. This idea has always been an underlying principle of the Synergy Awards, and now it's represented in the naming of one Synergy Award in particular.

In 1999, the award for innovative models of long-standing interaction in the precompetitive stage of R&D, previously called Category C, was renamed in honour of Leo Derikx, recently retired NSERC Director General of Research Partnerships.

Derikx, for two decades, was the driving force for building and developing university-industry partnerships in Canada. The Synergy Awards are one of the fruits of his innovative labours.

For Derikx, science-based innovation has always represented the pinnacle of true research achievement. Now his peers would be the first to agree that this achievement was Derikx's as well.

"My greatest satisfaction was being able to give a helping hand to some of Canada's top researchers when they needed it most," says Derikx. With the Leo Derikx Award, he can continue to give this much-needed and much-appreciated boost for many years to come.

The power and the potential of university-industry partnerships

The path to success in the new millennium is paved with innovative ideas. As world economies become more open, gaining a competitive advantage is increasingly a product of our ability to develop, adopt and exploit technology. For Canada to compete in the new global marketplace, we must all work together in the innovation process.

University-industry partnerships are one of the best incubators for this process, and thankfully, they're becoming the rule rather than the exception. It's a strategy that capitalizes on the strengths and resources of each partner. Canada's universities supply a steady stream of innovative ideas, while industries specialize in exploiting that expertise to create exciting new commercial opportunities.

Canada has been so successful in this new approach that the impacts of these partnerships can now be felt all through the economy. These partnerships have led to productivity improvements and have created a pool of cutting-edge researchers. They have also created knowledge-based industries and jobs that ensure future scientists and engineers will find career opportunities in Canada.

The award winners described on the following pages demonstrate what a shared vision and purpose can accomplish for the social and economic well-being of Canada.

From sustainable forest management to advanced microelectronics research, they show the power and the potential of university-industry synergy — and the path to the future.

We salute their efforts and celebrate their success. Congratulations!

James R. Nininger
President and Chief Executive Officer
The Conference Board of Canada

Thomas A. Brzustowski
President
NSERC

Promoting best practices in university-industry R&D partnerships: the original partners

The Conference Board of Canada

The Conference Board of Canada's mission is to help members anticipate and respond to the increasingly changing global economy. As Canada's leading not-for-profit, independent applied research organization, the Conference Board serves more than 500 member companies from business, government and the public sector by providing objective information and analysis on economic, management and public policy issues. Since 1954, the Conference Board has been committed to the development and exchange of knowledge about organizational strategies and practices, emerging economic and social trends and key public policy issues. Thirty-five chief executives from major organizations across the country make up the Board of Directors. Annually, the Conference Board organizes and hosts over 200 meetings, produces 125 publications, answers over 4,000 information requests and holds over 90 leadership programs.

NSERC (the Natural Sciences and Engineering Research Council)

NSERC is the national organization for making strategic investments in Canada's capability in science and technology. NSERC supports both basic university research through grants, and project research through partnerships between universities and industry. In this way, NSERC contributes to the advanced training of highly qualified people in both areas to help build a strong national economy and improve the quality of life of all Canadians.

In 1999–2000, NSERC will invest more than $540 million in university-based research and training in the natural sciences and engineering. In 1998–99, NSERC supported nearly 9,000 Canadian researchers and over 12,000 university students and postdoctoral fellows. In addition, NSERC programs provided employment to about 15,000 Canadians, of whom 80 per cent were students and postdoctoral fellows. The remainder were skilled technicians and research professionals.

Partnering for progress

The Synergy Awards program is just one of many ways NSERC encourages and promotes partnerships between universities and industry. In fact, NSERC sponsors 10 other programs that foster collaboration.

- **Industrial Research Fellowships** allow companies to hire a highly qualified researcher for up to two years to advance R&D in an area of strategic importance. While adding to their own research qualifications, the Fellows also help the company enhance its R&D capabilities.
- **Industrial Postgraduate Scholarships** offer a cost-effective way to enhance a company's research capabilities. These scholarships allow students to complete their graduate studies while working on a research project of interest to them, their academic supervisor and their industry sponsor.
- **Undergraduate Student Research Awards in Industry** allow a company to develop a working relationship with a university's most promising young researchers — before they graduate. The cost-shared awards cover summer employment or a co-op work term on an industrial R&D project relevant to a student's program of study.
- **Collaborative Research and Development Grants** expand research capacity by giving companies access to the state-of-the-art knowledge and experience found in Canadian university research labs. Projects are carried out jointly with one or more industrial partners, and participating companies exploit the research results.

- **Technology Partnership Program Grants** support very applied research at the commercialization end of the R&D spectrum, with extensive industry collaboration.
- **Research Partnership Agreements** offer the advantage of three-way cost sharing to capitalize on the complementary R&D capacity of industry, government and university research labs. These agreements support a range of research in selected areas, from basic to pre-commercial.
- **Research Networks** advance a company's or university's research agenda by bringing together a diverse group of researchers to collaborate on a common theme.
- **Strategic Projects** help make the costs of high-quality, pre-competitive research more manageable by supporting university research in partnership with industry. These projects produce economic, social, industrial and environmental benefits for Canadians.
- **Industrial Research Chairs** allow a company to work with a distinguished researcher and research team on a major research initiative in an area important to the company. The industrial partner shares the costs with NSERC.
- **The New Faculty Support Program** allows companies to share the cost of setting up a promising researcher in a university faculty position that's relevant to their business. NSERC and the sponsoring company contribute equal amounts toward the researcher's salary.

Linking researchers across the country

One of NSERC's most unique vehicles for promoting partnerships among industry, universities and government is the Networks of Centres of Excellence (NCE) program. Designed to develop Canada's economy and improve our quality of life, these nation-wide networks combine excellent research with industrial know-how and practical investment.

There are currently 15 NCEs working in many diverse areas, including: arthritis; bacterial and genetic diseases; computer-aided learning; forestry and environment; geomatics; health information; structural innovations in civil engineering; mathematics; mechanical wood-pulps; microelectronic devices; photonics; protein engineering; robotics; and telecommunications.

In these areas, almost 900 researchers work on projects involving 45 universities, 350 companies, 100 federal and provincial agencies and almost 200 other organizations throughout the country.

The NCE program is administered by NSERC, the Medical Research Council, the Social Sciences and Humanities Research Council, and Industry Canada.

1999 Selection Committee

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Al-Pac and the University of Alberta see the forest *and* the trees

There's an old saying that some people can't see the forest for the trees, meaning they can't see the "big" picture because they get lost in the details. But now, thanks to a pioneering partnership between the University of Alberta's Department of Biological Sciences and Alberta-Pacific Forest Industries Inc. (Al-Pac), that cliché may not hold true — at least for the forest industry. Their research findings and new practices are revolutionizing how the Canadian forest industry operates.

A fundamental rethinking

For many years, the forest industry has used a set formula to harvest and replace trees in Canada: clear-cutting, followed by replanting of fast-growing species. These aggressive practices were based on an agricultural model that concentrated on a sustained yield of high-demand timber.

The founders of Al-Pac, however, had a dream to revolutionize the way forestry was practised. Then-Director of Environmental Resources, Dr. Daryll Hebert issued a challenge to researchers at the University of Alberta: "You can either criticize Al-Pac from the sidelines or partner with us to provide the science to engineer a paradigm shift in the way forestry is done." Since then, some 33 professors from 8 universities have taken the challenge.

The result of this unique partnership is a more natural model of forestry that maintains biodiversity and promotes a wide array of plant, animal and insect species.

"Disturbances are common in boreal forest systems," says Dr. Stan Boutin, professor of biological sciences at the University of Alberta. "Forests go through natural cycles of growth and devastation from phenomena such as forest fires, but they grow back. And it's the way they do that's important."

Sustainable forest management has been a real cultural shift within Alberta-Pacific Forest Industries. They've learned a new way of thinking based on nature – and that it's possible to apply science in the bush.

Mimicking natural regrowth patterns

In a forest of aspen and white spruce, for example, if an area is levelled by fire or harvesting, the aspen will naturally return first, and the spruce will come in under the protective canopy of the aspen.

In the old model, companies would have replanted the area with spruce, using aggressive techniques like herbicides and thinning to keep out the aspen. But now, Al-Pac takes an approach that mimics the natural regrowth patterns: harvest the aspen first and return for the spruce.

"This kind of sustainable forest management has been a real cultural shift, both within Al-Pac and within the industry," says Kirk Andries, Director of Corporate Services with Al-Pac. "We've learned a new way of thinking based on nature — and we've learned that it is possible to apply science in the bush."

Spreading the word

And the researchers have been equally pleased. Not only have their major forest fragmentation and lake corridor studies garnered international scientific recognition, their results have already had a significant influence on buffer width design. Their findings will form the basis for major revisions to the rules by which forest companies harvest around lakes and streams.

By 1994, the partnership had been so successful that the partners believed there was an opportunity to take their ideas to a new level. Working together, Al-Pac and the University of Alberta researchers helped to develop a proposal for a sustainable forest management network that would spread the concepts fostered in Alberta across Canada.

Their proposal was accepted by the federal Networks of Centres of Excellence program, and the Sustainable Forest Management Network, headquartered at the University of Alberta, was born. To date, more than 100 researchers from 24 universities have joined, and the network receives funding from 11 forest companies, as well as the federal, Alberta and Quebec governments.

The next challenge

The main focus now for the University of Alberta and Al-Pac is on integrating forestry activities with the activities of Alberta's oil and gas industry. Called integrated resource management, this approach is intended to plan industrial activities with the environment in mind.

For many years, the forest industry has used a set formula to harvest and replace trees in Canada: clear-cutting, followed by replanting of fast-growing species. The unique partnership between Alberta-Pacific Forest Industries and the University of Alberta, however, promotes a more natural model that maintains biodiversity and promotes a wide array of plant, animal and insect species.

Dr. Stan Boutin
Professor of Biological Sciences
University of Alberta

University-industry collaboration builds a sustaining partnership

Working together on the sustainable forest management project has definitely resulted in a beneficial partnership between the University of Alberta's Department of Biological Sciences and Alberta-Pacific Forest Industries Inc. (Al-Pac). But more than that, it has also increased the effectiveness of efforts to integrate environmental thinking into the forest industry as a whole.

Sustainable development has been defined as development that meets the needs of the present generation without jeopardizing the needs of future generations. With their efforts to preserve biodiversity and follow nature's example in forestry, Al-Pac and the University of Alberta are doing just that.

"There's nothing proprietary about our research. We're pushing the envelope in the industry by introducing forestry management practices that can be used right across the country," says Kirk Andries of Al-Pac. "The forest industry traditionally moves slowly and cautiously, but many of the big companies are taking notice and responding. In fact, they're starting to push us."

Equally important, the partnership is training a whole generation of biologists interested in forestry to solve real-world problems in realistic ways.

"With this project, academic involvement in forestry has moved from impact assessment to problem solving," says Stan Boutin of the University of Alberta. "We're coming at things from a completely different perspective and working with people from many disciplines to put new practices in place."

"Alberta's forests sit on the richest reserves of oil and gas in the world, so this is an exciting challenge for sustainable forest — and sustainable resource — management," says Boutin. "It will take some time to implement, but it must be the way of the future."

"This project is in the formative stages now, and it will be a challenge because the oil and gas industry works within an entirely different regulatory regime and planning process," says Andries. "But already we're working with Gulf and talking to Syncrude and Suncor — the big players in the industry. We're hoping to build from there."

Equally important as changing forestry practices, the Al-Pac–U of A partnership is training a whole generation of biologists interested in forestry to solve real-world problems in realistic ways.

Kirk Andries
Director of Corporate Services
Alberta-Pacific Forest Industries Inc.

Universal Dynamics and the University of British Columbia make waves with "BrainWave™"

In process industries such as pulp and paper, food processing and glass making, being "in control" has nothing to do with a power trip. It means making things run as smoothly and efficiently as possible.

Thanks to BrainWave™, an innovative, model-based adaptive controller developed by Universal Dynamics and the University of British Columbia's Department of Electrical and Computer Engineering, many companies are reaping the benefits of being firmly in control of their processes.

BrainWave™ is computer software that maintains each stage of a process at peak performance targets, thus improving product quality, increasing plant production and lowering operating costs.

From theory...

In 1988, UBC's Dr. Guy Dumont, Senior Paprican/NSERC Industrial Research Chair in Process Control, and head of the UBC Pulp and Paper Centre's Process Control Group, was looking at the problem of adaptive control in the process industries. Traditional adaptive controllers based on transfer functions were too complex and unreliable, and plants often shut them down in favour of manual control.

"We wondered if there was another way to look at plant dynamics that would require less prior knowledge, that would accurately describe varying time delays and that would be robust enough to handle unmodelled dynamics," says Dumont.

Dumont and Christos Zervos, one of his students completing his PhD thesis, decided to use a network of Laguerre functions as a radically new representation of process dynamics (see sidebar). Dumont, Zervos and Dr. P.R. Bélanger of McGill University had first used Laguerre functions in the early 1980s while Zervos was working toward his master's degree at McGill. "Once we made the decision to use the Laguerre functions," says Dumont, "90 per cent of the problem was solved."

After completing the theoretical development of the algorithms, the researchers began proving their scheme in an industrial setting. They designed a straightforward predictive controller, called the Laguerre Unstructured Self-Tuner (LUST).

Next came trials on the control of pH in the bleach extraction stage at a pulp and paper plant. LUST dramatically reduced the pH variability, which was reported in a Pulp and Paper Canada press release. That caught the eye of Steve Hagemoen, President of Universal Dynamics.

BrainWave™ is a "smart cruise control" for industry – computer software that helps industrial processes run as smoothly and efficiently as possible. Here, Bill Gough, Product Manager at Universal Dynamics, shows off BrainWave™ doing its thing.

Steve Hagemoen
President
Universal Dynamics

Success a function of vision

Laguerre functions are a set of basis functions — the best-known basis functions are sine and cosine used in Fourier series. They were developed in the 19th century to solve differential equations, and were used 70 years ago to describe transient behaviour in electrical circuits. But they weren't used much after that until recently.

Structurally very simple and very good at describing time delays, Laguerre functions offer big advantages over the transfer functions traditionally used in process controllers.

By building a Laguerre-based adaptive control, UBC's Dr. Guy Dumont made several advances:

- *parameter estimates are unaffected by correlated disturbance;*
- *the nominal model is unaffected by unmodelled dynamics;*
- *the estimated model is always robustly stable;*
- *the amount of prior information required is minimized; and*
- *more complex processes can be handled simply by adding more Laguerre "filters."*

... to practice

Hagemoen sent two young engineers to meet Dumont and read Zervos's thesis. Universal Dynamics then applied its engineering experience to the math to build a stand-alone controller for a kiln automation system for the lime industry. In the following years, they continued working with Dumont to create a PC-based version of the controller, now called BrainWave™.

"What we've done is to develop a 'smart cruise control' for industry," says Hagemoen. "It learns the characteristics of the road and adjusts the throttle to maintain speed, whether going uphill or downhill. It automatically responds to changes, minimizing any variation in the speed."

With minimal prior information, BrainWave™ builds its own comprehensive model of industrial processes by observing the operation of the process. It then uses these models to make accurate forecasts of process response. By comparing the actual process to the predicted response, BrainWave™ determines the necessary control action to bring the process to the optimal setting as quickly as possible.

Universal Dynamics is now a recognized leader in process-control engineering and control product development. BrainWave™ is used around the world in many processes such as drying, frying, evaporating, distilling, digesting, cooking, and extruding. Currently, Universal Dynamics is modifying BrainWave™ for the marine and biomedical fields as well as other industrial applications. They've also developed anode monitoring systems for electrochemical plants, including chlorine manufacturing and aluminum smelting.

"I tell our customers we're in the productivity-improvement business," says Hagemoen. "We started with the adaptive controller, but now we offer packages that incorporate BrainWave™, engineering and hardware that provide customers with a complete solution. Working with UBC and Guy Dumont was the best thing we ever did!"

Dr. Guy Dumont
Senior Paprican/*NSERC*
Industrial Research Chair in Process Control
and
Head of the UBC Pulp and Paper Centre's Process Control Group
University of British Columbia

Falconbridge – University of Waterloo partnership hits pay dirt

Finding a long-term, self-sustaining solution to acid mine drainage (AMD) is one of the greatest challenges facing environmental managers in the mining industry. Fortunately, a 10-year partnership between the University of Waterloo's Department of Earth Sciences and international mining giant Falconbridge Limited is now shedding new light on the problem.

The mining and milling of sulphidic ore deposits generates large quantities of sulphide-bearing waste rock and finely crushed mill tailings. When exposed to oxygen and water, these by-products generate acidic effluents, which can leach heavy metals and contaminate the soil and water supplies.

The Canadian mining industry spends approximately $100 million annually to control AMD. These costs cover a wide range of activities: the collection and treatment of acid drainage; the construction of engineered structures to contain mining by-products; the relocation of mining by-products to contaminant areas; and the rehabilitation of mine, mill and containment areas after operations have ceased.

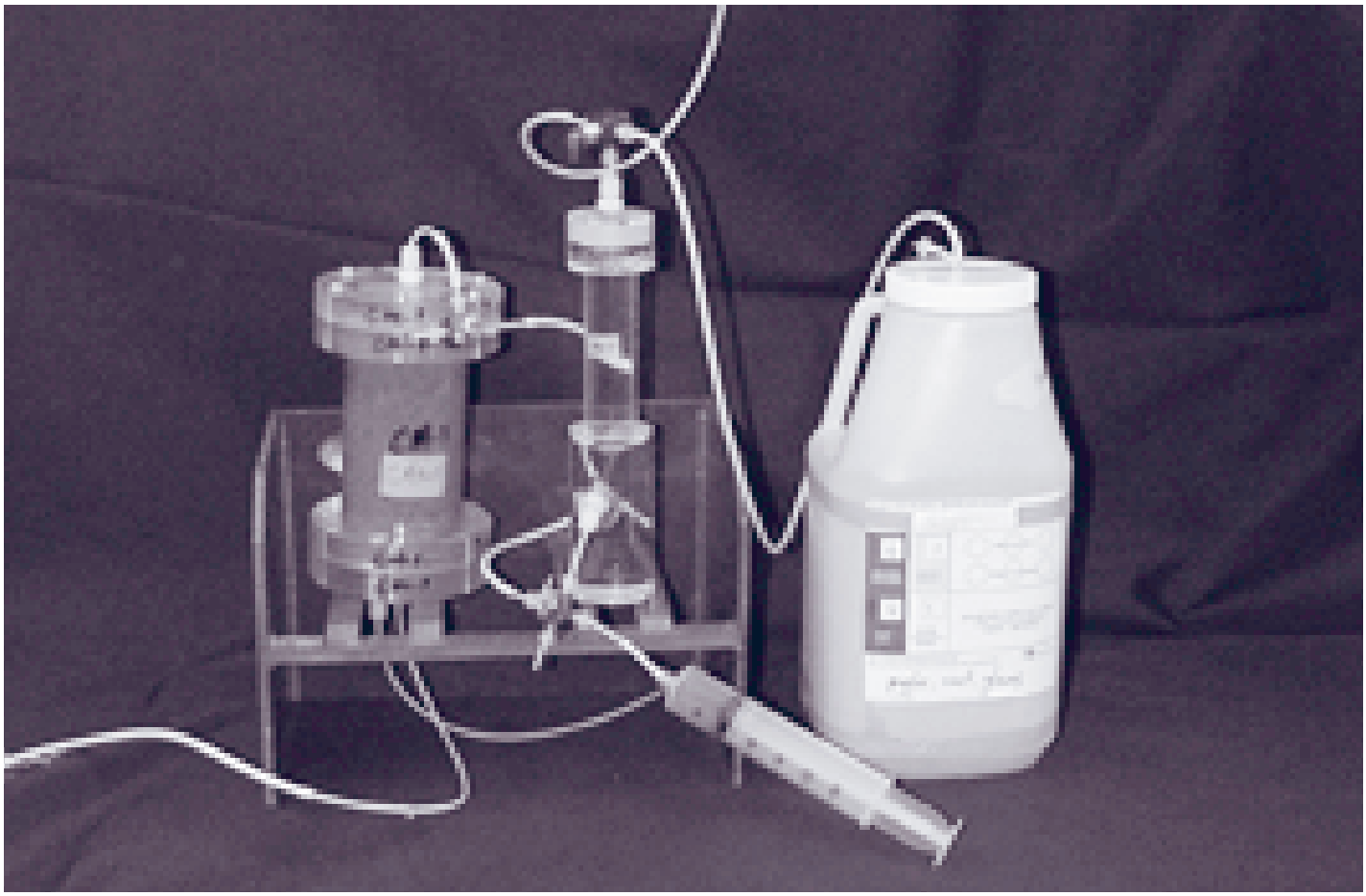
A more natural approach

Unfortunately, these conventional approaches are expensive to operate and maintain, and require a long-term, intensive commitment. Dr. David Blowes of the University of Waterloo's Department of Earth Sciences is looking at a more natural approach — a biological process that once put in place will continue to operate on its own.

"Maintaining a water collection and treatment system into perpetuity is hugely expensive," says Blowes. "The systems we're designing will stand alone for long periods of time. They'll probably need replacement occasionally, but they won't need the day-to-day management required in the past."

Under the direction of Blowes and colleagues Drs. Emil Frind and Carol Ptacek, the University has also developed mathematical models to help mining companies quantify the potential risks associated with mining by-product facilities. "Our initial work to understand the problem and look at the effects of AMD has given Falconbridge a much better understanding of what the long-term implications are for AMD," says Blowes. "And that plays directly into how they design their closure plans and how they make their commitments for the future."

Installation of a permeable reactive barrier for the treatment of acid mine drainage, near Sudbury, Ontario.



Initial work to understand acid mine drainage (AMD) and its effects has given Falconbridge a better understanding of what the long-term implications are for AMD. This column experiment is used to treat groundwater that contains mine by-products commonly released from tailings.

Denis Kemp
Director of Environmental Development
Falconbridge Ltd.

Adding some finesse

The absence of long-term operation and maintenance costs could mean significant savings for mining companies. "Through this work, our environmental liability has been significantly reduced," says Denis Kemp, Director of Environmental Development at Falconbridge. "I think as we continue with this research, the cost of mine closures will probably be reduced from original estimates by approximately 70 to 80 per cent. That's a huge reduction in costs and a great leap in progress."

The benefits of the partnership haven't been for Falconbridge only. The collaboration has garnered international recognition for the University of Waterloo and led to research partnerships with other universities and corporations. In addition, the University has been awarded patents for two of its remedial technologies.

The results of this decade-long collaboration have brought environmental managers a long way toward their goal. "Technologically, we've made great progress in our thinking over the past 10 years," says Kemp. "At the beginning of this program we were taking a more brute-force approach. We figured if you smother the tailings with enough material then you're going to solve the problem. Now, because of the knowledge we have gained through Dr. Blowes' research, we are using much more finesse — an approach based on science."

"The systems we're designing will stand alone for long periods of time. They'll probably need replacement occasionally, but they won't need the day-to-day management required in the past."

Dr. David Blowes,
Department of Earth Sciences,
University of Waterloo

Researchers are looking at more natural approaches to dealing with acid mine drainage. Here they take samples of groundwater below a mine tailings dam near Sudbury, Ontario.

Dr. David Blowes
Department of Earth Sciences
University of Waterloo

Waste not, want not

"One person's waste can be another person's treasure," says Denis Kemp, Director of Environmental Development at Falconbridge Limited. "And in our case there is some potential for this to hold true."

With support from Falconbridge, Dr. David Blowes of the University of Waterloo's Department of Earth Sciences is looking into the possibility of using waste materials from other industries, such as the pulp and paper or lumber industries, to create a chemically reactive, moisture-retaining cover for mine tailings. This cover would consume oxygen and stabilize dissolved metals within the tailings impoundment.

"Essentially, layers of this organic waste would be put on top of the tailings, and because it's so fibrous it retains water that, in turn, starves the site of oxygen," explains Kemp. In addition, the organic nature of the cover encourages vegetation, which naturally goes through a life cycle creating more fresh organic material as it dies.

"The beauty of this system is that nature would eventually take over the process, making it self-sustaining over the long term," says Kemp. And that's good news for mining companies and the environment.

Syncrude Canada Ltd.

University of Alberta

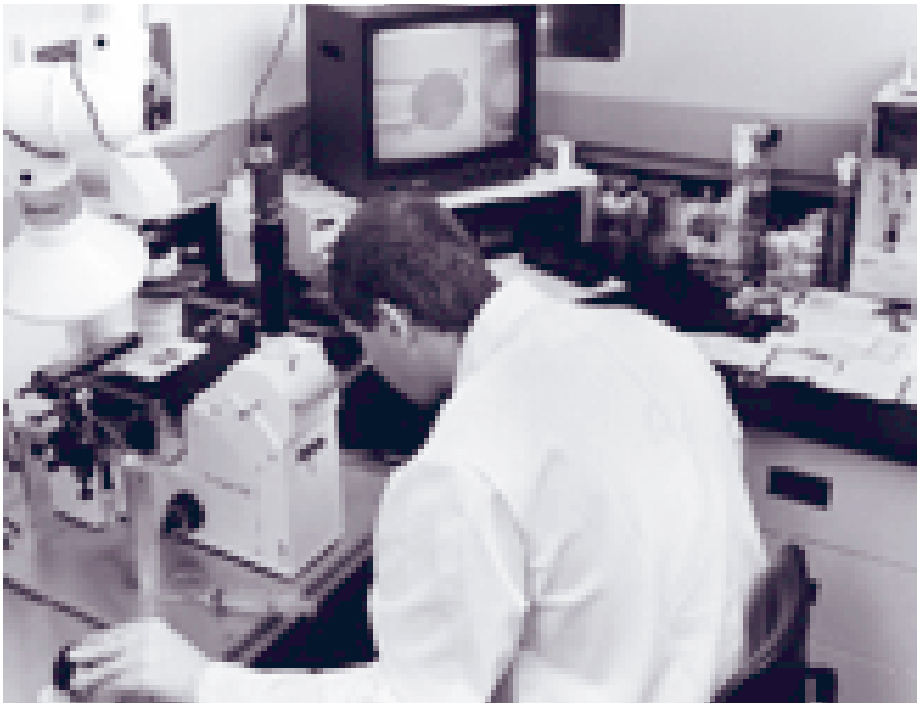
For Syncrude and the University of Alberta, where science leads, technology follows

It's a challenge, but it's a nice one to have. Canada's richest known oil reserves lie in northern Alberta's oil sands. They're estimated to hold about 1.7 trillion barrels of oil, which is substantially more than the total oil reserves of all OPEC countries combined. Unfortunately, the oil in the oil sands is difficult to extract.

Canadian researchers, governments and industry have been working for years to unlock the tremendous wealth of this resource, and they're making headway. And a partnership that was formalized in 1996 between Syncrude Canada Ltd., the University of Alberta's (U of A) Department of Chemical and Materials Engineering, and NSERC, through the NSERC Industrial Research Chair in Oil Sands, is picking up the pace significantly.

Mining for oil

To mine the oil sands, Syncrude takes apple-sized oil-sand lumps from the ground, puts them in a pipeline, adds hot water and air to begin the 'digestion,' and transports the mixture to a processing plant a few kilometres away. En route, the oil sand and water mix, and the oil begins to separate. The oily froth that results is skimmed off at the processing plant and cleaned before being upgraded to a high quality, light sweet crude oil.



In this lab at Syncrude, as in many others, researchers from the company and the University of Alberta are working to advance scientific knowledge and engineering expertise for the oil sands in three crucial areas: improving and expanding hydrotransport; finding better ways to separate bitumen; and building on past progress in oil sand transportation.

"Pipeline transportation is an improvement that's been introduced over the last few years. We used to transport the oil sand to big tumblers on conveyor belts, with thousands of moving parts and enormous potential for breakdowns. The pipeline gives us more control over the process and eliminates the tumblers entirely," says Dr. Jacob Masliyah, professor of chemical engineering and NSERC Industrial Research Chair Holder at the University of Alberta. Masliyah and Dr. Zhenghe Xu, another professor at the U of A, spend a fair bit of their time at the Syncrude Research Centre.

Pipeline transportation — also called hydrotransport — is one of the priority areas in which Syncrude and the U of A are conducting basic research on the oil sands and the problems of extracting the oil. Other priorities include looking at better ways to separate and transport bitumen (see sidebar).

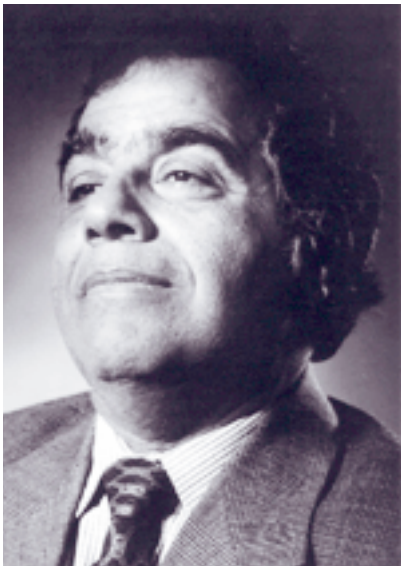
Open lines of communication

Perhaps outside the norm of other research partnerships, open communication and true collaboration are also a priority for Syncrude and the U of A. Often, organizations play their research cards close to their chest, but these partners realized early on the benefits of going further in sharing information and giving access to facilities, thanks to the blueprint of collaboration established by Dr. John Clark, manager of Syncrude Research.

"The University of Alberta researchers have the same access to Syncrude research facilities and privileges that our employees have," says Dr. Jan Czarnecki, Team Leader, Technical Research Services, at Syncrude. "They attend seminars, share office space and chat with each other in the halls and over coffee. The transfer of knowledge is not an issue."

This interaction speeds up the collaboration process, but it also holds enormous benefits for the students involved. They gain industry experience by working in an industrial research centre on problems that stem from real needs. Even better, they see that people need their results and that their work serves a very real purpose.

Dr. Jan Czarnecki
Team Leader, Technical Research Services
Syncrude Canada Ltd.



Dr. Jacob Masliyah
NSERC Industrial Research Chair Holder
and
Professor of Chemical Engineering
University of Alberta

Partnership focuses on three research priorities

Using a pipeline to transport mined oil sand mixed with water was a tremendous breakthrough in oil sand transportation, but Syncrude and the University of Alberta (U of A) aren't content to stop there. They're working to advance scientific knowledge and engineering expertise for the oil sands in three particularly challenging research areas: improving and expanding hydrotransport; finding better ways to separate bitumen; and building on past progress in oil sand transportation.

- *Improving and expanding hydrotransport*

Just because something works well doesn't mean it can't work better. That's why the U of A's Dr. Jacob Masliyah broke the pipeline process down into its essential physics, then recreated it in a mathematical model. With this tool, Syncrude and others in the oil sands industry can test new pipeline design parameters, such as temperature, length and velocity, quickly and efficiently. It's resulting in continuous improvement and cost savings in the oil sands industry.

- *Finding better ways to separate bitumen*

Bitumen separation should be a simple process: oil should float on water, sand and clay should settle, and air bubbles should just help bitumen on its way out of the mixture. Unfortunately, it doesn't work that way. Tiny water droplets get trapped in the oil, and they're difficult to remove.

Masliyah and his team of researchers with their industrial colleagues are looking at the reasons why the tiny water droplets are so stable and do not coalesce. "We don't understand it all yet," he says, "but the research is getting there." When it does, the findings will have an enormous impact on not only the oil sands industry but on the conventional oil industry's — and other industries' — production processes.

- *Building on past progress in oil sand transportation*

Syncrude originally built its processing plant close to its oil sands mining location. Eventually, however, the company exhausted the bitumen resources close to the plant and moved the mine to a new location. But then there was a problem: how to transport the oil sand to the processing plant. Hydrotransport has provided one solution, but Syncrude is still looking for others.

"With our Aurora mine, we are building a new extraction plant nearby," says Syncrude's Dr. Jan Czarnecki. "We will be doing the initial processing there, then pipelining the raw recovered bitumen mixture to the base plant. We're still learning about the system, and we're making progress.

University of Calgary – CREWES partnership produces groundbreaking results

Finding out what lies below the Earth's surface is crucial to all kinds of organizations, from oil and gas companies to environmental and geotechnical groups. For 10 years, the Consortium for Research in Elastic Wave Exploration Seismology (CREWES) has been conducting groundbreaking research — in more ways than one — to find new methods of making seismic images of the Earth's subsurface.

The project has led to major advances in the use of three-component (3C) recordings of three-dimensional (3D) wave responses. The technology records two main types of seismic waves — compressional and shear — using one vertical and two horizontal sensors (see sidebar). This 3C-3D image gives a much more informative picture of the subsurface than previous methods. It can, for example, tell geologists not just what geological structures are below the surface, but what types of rocks and fluids make up those structures.

International consortium

CREWES is a research partnership between the University of Calgary and 28 industry sponsors in seven countries, including Canada. The consortium is run by seven faculty members within the University's Department of Geology and Geophysics. Supported by an administrative and technical staff of 10, the faculty members work directly on the project, conduct research and supervise about 20 graduate students.

Dr. Robert Stewart, a professor of geophysics at the University of Calgary, and colleagues Drs. Jim Brown and Don Lawton founded CREWES in 1989. Stewart has served as its director ever since. "Before we founded CREWES, the relationship between university geosciences and the local hydrocarbon industry was largely undeveloped," says Stewart. "We started CREWES to help rectify that situation and to enhance the geophysical research that was taking place at the University."

Pooled resources

CREWES sponsors provide the project with funds, guidance, field data and work placements for the University's students. CREWES funding enables graduate students and research associates to conduct research in areas that are important to the companies. In return, the university shares its research results with the sponsors. During the last four years alone, more than 50 software packages have been distributed to CREWES sponsors by university researchers. Sponsors have donated commercially acquired field data and software valued at more than $10 million.

One of CREWES' founding objectives is to educate students — a goal it has met with success. Industry support and summer internships have allowed the students to gain experience in and knowledge of industry challenges and practices. To date, CREWES has seen 32 MSc and 8 PhD students graduate (all of whom are professionally employed). In addition, three former students have started their own companies. For its part, the University has been able to attract high-calibre students because of the industry's involvement.

Dr. Robert Stewart
Project Director
CREWES,
Member of the Board and Seismology Advisor
PanCanadian Petroleum Ltd.
and
Professor of Geophysics
University of Calgary

Close ties

A CREWES Industrial Advisory Board, which includes five representatives from sponsor companies, meets twice a year. Bill Goodway is a member of the Board and a seismology advisor with PanCanadian Petroleum Ltd. "We look at the direction of the research and provide strategic and technical guidance to the project," says Goodway. "Although we meet formally only twice a year, there's also a lot of informal interaction between the Board and the project. In addition, the rest of the sponsors are encouraged to participate and provide feedback through questionnaires and discussions at the annual meeting."

The relationship is also strengthened through numerous joint projects involving field work, student and staff research, summer internships for students, and a monthly CREWES newsletter. CREWES researchers also conduct courses for its sponsors and train company employees in the latest technologies in seismic imaging.

Stewart credits this close interaction between university and industry partners as part of the reason for the success of the collaboration. "We've earned an international reputation as a leader in advanced seismic exploration techniques and that's been great for everyone involved — the University, students, faculty, and the industry partners," he says.

Industry support and summer internships have allowed students to gain experience in and knowledge of industry challenges and practices. Here CREWES staff and students gather for a group photo.

Close interaction between university and industry partners is one of the reasons the University of Calgary–CREWES collaboration has been so successful. CREWES sponsors and staff members view posters at the CREWES annual sponsors' meeting.

Like a Slinky™

"In simple terms, what we've done is take a somewhat stark image, sort of like a black and white picture, and added colour to it by using a different kind of wave," says Dr. Robert Stewart, project director and professor of geophysics at the University of Calgary.

Stewart says the waves are like the motion you get from a Slinky™ toy when you hit it. "If you stretch out a Slinky™ between your hands and whack it on one end, there's a vibration that goes down the length of the Slinky™ and reflects back — that's like a compression wave. Traditionally, that's how subsurface images have been made," he explains. "However, if you wave the Slinky™ back and forth with one hand, you can produce an "s"-shaped wave that snakes down and then bounces back from the other hand — and that's like a shear wave."

The "elastic" in elastic wave exploration refers to a combination of the shear and the compression wave. "Both waves provide us with information about the Earth," says Stewart. "When both waves move into the Earth and then echo back they can tell us what they've encountered along the way."

At the Canadian Microelectronics Corporation, smaller means bigger — and better

For the past couple of decades, very small electronic microchips — about the size of a dime — have been a very big part of our lives. Just how big, many of us may not realize.

"The average person interacts with a microchip about 300 times a day," says Dr. Tony Marsh, President of the Canadian Microelectronics Corporation (CMC). Microchips are now integral to everything from automobiles to telephones and remote controls for TVs and stereos.

The ubiquity of microelectronics means that excelling in this rapidly changing technology is essential to Canada's economic success. But keeping pace depends on ensuring the supply of equipment and expertise.

That's why in 1984 universities, industry and government established the CMC, an ongoing partnership that for 15 years has creatively and efficiently used NSERC funding and industry contributions to provide universities with a world-class infrastructure for international competitive research.

From across Canada, approximately 400 academic faculty and 900 students fabricate more than 400 microelectronic designs each year.

The results? Universities get access to costly research tools and support; Canadian companies get access to world-class research in different areas of microelectronics and a supply of highly skilled people; and Canadians benefit from a stronger economy and a higher standard of living.

Partnership a practical necessity

"The complexity and cost of designing and manufacturing a microchip can be very intimidating, and beyond the resources of many individual Canadian universities," says Marsh. The tools are expensive to acquire and demanding to use, and the skills and knowledge take time and resources to develop and maintain.

This makes partnership a practical necessity. Through CMC's National Design Network, universities have access to design tools and methodologies, on-line training and engineering support, computer workstations, prototype chip fabrication, and test equipment.

Three "easy" steps to making a microchip

Making a microchip is no easy task. Fifteen years ago, microchips had maybe 50,000 transistors; today, many have well over a million, and some have up to 10 million. The process of designing, manufacturing and testing a microchip can be time-consuming, costly and very complex.

That's where CMC comes in.

As part of course work or research, students and researchers from across Canada will design microchips on computers using the design models and tools supplied by CMC.

Every few weeks, CMC accepts these designs, merges them into a "multi-project wafer" and coordinates the manufacturing. The wafer is the fundamental manufacturing unit in microelectronics. It is a very thin slice of highly pure silicon, to which layers of different materials are added to make transistors and the interconnections between them. When the multi-project wafer is ready, CMC "slices it up" and sends the individual chips back to the universities.

Students and researchers then test out their prototype chips to make sure they actually work, and use them for further study, to build complete systems in the lab, or to take the results right through to commercialization.

"People learn a lot more by doing things," says Dr. Ian McWalter, Chairman of the Board of CMC and Executive Vice-President and COO of Gennum Corporation, an industry member of CMC. "What CMC enables microelectronic researchers to do is to reduce their ideas to chips and test them in the lab, which is a great advantage. It creates a discipline in the research that is hard to achieve solely through simulations or computer models."

Dr. Anthony Marsh
President
Canadian Microelectronics Corporation

Dr. Ian L. McWalter
Chairman of the Board
Canadian Microelectronics Corporation
and
Executive Vice-President and COO
Gennum Corporation

By pulling together these individual components once and delivering them to multiple university sites, CMC reduces costs and duplication of efforts and increases the productive time available to researchers. And by connecting universities with Canadian companies and with each other, CMC can take the experience gained by one researcher and multiply the benefit of the lessons learned for researchers and microelectronic manufacturers across Canada.

Tested and true

The success and durability of the CMC partnership is founded on the participation and commitment of its members — 37 university research institutions, 23 industry partners and 6 individual partners. Industry involvement helps create technology opportunities and determine research directions, and university involvement makes sure that CMC stays in touch with the needs of researchers.

"We really do believe we've got a good model here that perhaps other industries could follow," says Dr. Ian McWalter, Chairman of the Board of CMC and Executive Vice-President and COO of Gennum Corporation, an industry member of CMC.

Dr. Bill Miller
Vice-Chairman of the Board
Canadian Microelectronics Corporation
and
Professor of Electrical and Computer Engineering
University of Windsor

The shape — and size — of things to come

CMC university-industry collaborations will continue to push the frontiers of physics and design complexity, and advance the power of telecommunications and computing. They are also combining electrical, mechanical, optical and chemical technologies to open up exciting new areas. For example:

- *Researchers at McGill University are attaching optical devices to microchips to move data inside computing or telecommunications systems thousands of times faster than systems based purely on electricity. This innovative lightwave technology will revolutionize short-distance interconnections just as optical fibers revolutionized long-distance communications.*
- *Researchers at the University of Toronto are working on a faster, more cost-efficient way to move data around the Internet by using a sophisticated new chip — with more than one million transistors — to build a new type of network switch.*
- *Researchers at École Polytechnique de Montréal are using biomedical chips to create systems that may one day restore some hand movement to people with paralysis and partial sight to those with vision problems.*