

# IEEE

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# Canadian Review

*La revue canadienne de l'IEEE*

 Pinawa Station  
1908

 First Distance  
Speech  
1876

 Alouette - ISIS  
1962 - 1993



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The *IEEE Canadian Review* is published 3 times/year as follows: Spring (to appear in April-May), Summer (to appear in August-September), and Fall (to appear in December). Its principal objective is to project an image of the Canadian electrical, electronics, communications and computer engineering professions and their associated academic and business communities to:

- (i) Canadian members of IEEE;
- (ii) Canadian members of the profession and community who are non-members of IEEE;
- (iii) The associated Canadian academic (i.e. universities, colleges, secondary schools), government and business communities.

To ensure that the *IEEE Canadian Review* has the desired breadth and depth, editors are responsible for screening articles submitted according to the following general themes:

- |                          |                   |                |
|--------------------------|-------------------|----------------|
| 1- National Affairs      | 4- Education      | 7- Computers   |
| 2- International Affairs | 5- Power          | 8- Electronics |
| 3- Industry              | 6- Communications |                |

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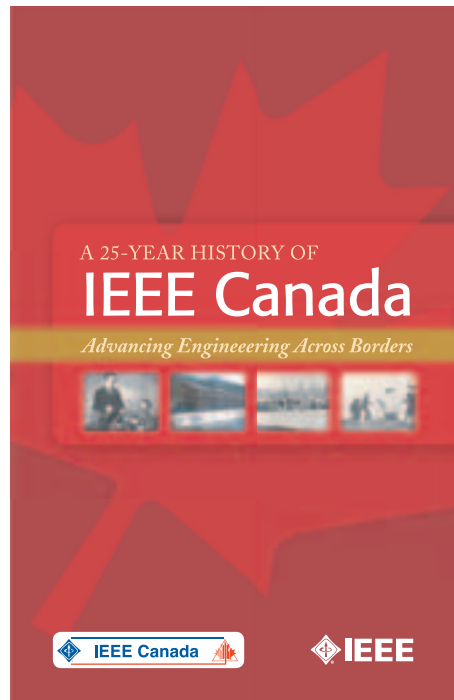
**IEEE** Les Jalons du IEEE en génie électrique et informatique (IEEE Milestones) sont des désignations prestigieuses pour des réalisations historiques majeures dans nos domaines d'activité. La Région 7 de l'IEEE, alias IEEE Canada (la seule une-région-un-pays de notre Institut), a eu le privilège d'accueillir nombre de cérémonies de Jalons, incluant deux cette année.

Le 4 mai 2008 une plaque commémorative a été dévoilée à Paris (Ontario) pour la « Première transmission vocale à distance » : L'expérience pionnière d'Alexander Graham Bell le 10 août 1876 démontrant que la téléphonie pouvait aller plus loin que la pièce d'à côté.

Début juillet un Jalon IEEE a été inauguré près de Winnipeg (Manitoba) pour la Centrale hydroélectrique Pinawa – une réalisation innovante du génie électrique en climat froid complétée en 1908, et le sujet d'un article de fonds dans ce numéro de la Revue.

Nous reconnaissons et célébrons aussi dans ce numéro une réalisation canadienne plus récente en aérospatiale et génie électronique, qui est aussi un Jalon IEEE: le programme de satellites Alouette-ISIS. Colin Franklin, SMIEEE, Ingénieur électrique en chef pour Alouette 1 et Ingénieur en chef pour le programme de satellites ISIS subséquent, est l'auteur d'un article qui fournit un témoignage de première main sur ce projet extraordinaire.

Pour compléter l'image *a mari usque ad mare*, vous pouvez maintenant lire une brochure sur votre IEEE Canada, les réalisations des derniers 25 ans. Vous pouvez la parcourir en format électronique à <http://www.ieee.ca/history/>. Des exemplaires imprimés seront offerts au Congrès des sections IEEE à Québec, et autres événements à venir. Elle est très bien faite; je vous encourage à vous en procurer des exemplaires lorsque vous tomberez dessus, et à les donner à vos collègues et autres ingénieurs. C'est une question de fierté pour ce que nos prédécesseurs ont réalisé, et une promesse pour ce que nous pouvons apporter en tant que professionnels engagés.



*This well written and informative brochure details the many achievements of both individuals and sections from the last 25 years. Developed for distribution at the Sections Congress, it is also available on-line.*

**IEEE** Milestones in Electrical and Computer Engineering are prestigious designations of major historical achievements in our fields of practice. IEEE Region 7, a.k.a. IEEE Canada (the only one-country-one-region of our Institute) has been privileged to host a number of Milestone ceremonies, including two this year.



May 4, 2008 saw the dedication of a commemorative plaque in Paris, Ontario for the First Distant

Speech Transmission: Alexander Graham Bell's pioneering experiment on August 10, 1876 demonstrating that telephony could go further than the next room.

Early July saw the dedication near Winnipeg, Manitoba of an IEEE Milestone for the Pinawa Hydroelectric Station – a groundbreaking achievement in cold climate power engineering completed in 1908, and the subject of a feature article in this issue of the Review.

We also acknowledge and celebrate in this issue a more recent Canadian accomplishment in aerospace and electronics engineering that is an IEEE Milestone: The Alouette-ISIS Satellite Program. Colin Franklin, SMIEEE, Chief Electrical Engineer for Alouette 1 and Chief Engineer for the follow-on ISIS satellite program, is the author of an article that provides an inside view of this extraordinary project.

To complete the *a mari usque ad mare* picture, you can now read a brochure about your Canadian IEEE and achievements from the last 25 years. You can peruse it in electronic format at <http://www.ieee.ca/history/>. Printed copies will be offered at IEEE Sections Congress 2008 in Quebec City, and other upcoming events. It is really well done; I encourage you to pick up copies whenever you happen upon them, and give them to fellow engineers and colleagues. It is about pride for what our predecessors have done, and a promise for what we can deliver by being involved professionals.

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# 2008 Electrical Power & Energy Conference

## Energy Innovation

October 6 - 7, 2008

Vancouver, BC



### Conference Notification — EPEC 2008

*A forum for industry experts, business communities and academia to exchange ideas and current information related to energy systems.*

#### Keynote Speakers

**Michael Howard**, *Senior Vice President R&D*  
Electric Power Research Institute (EPRI)

**Bob Reid**, *Chairman, Board of Directors*  
British Columbia Transmission Corporation (BCTC)

#### Conference Topics

##### Extending the Limits of Transmission and Distribution

- Physical asset condition monitoring
- Real-time operational limits
- Power flow control
- Impact of supply continuity

##### Generation and Alternative Energy Expansion

- Large generation expansion & its environmental impact
- Small Distributed Generation
- Energy storage
- Impact of Distributed Generation

##### Intelligent Grid Technologies

- Data gathering and information flow
- Wide area operation, control, & protection
- Cyber security in the automated grid
- Self-healing networks, islanding, load shedding
- Microgrids operation

##### Conservation and Energy Efficient Technologies

- Shaping consumer habits & Smart Billing
- Power Factor correction
- Power Quality
- Energy efficient loads

*More than 150 abstracts already accepted!*

#### Energy Policy and Innovation

The topics at this conference will reflect innovations in the social and economic aspects of electric energy policy and initiatives, as well as traditional papers addressing technical issues.



*Vancouver's Stanley Park offers a quiet place to relax with a great view of the city's skyline.*

IEEE Canada is proud to present the 8<sup>th</sup> Annual Electrical Power and Energy Conference (EPEC). Attracting a worldwide audience of energy professionals, our theme for 2008 is **Energy Innovation**.

The 2008 EPEC will take place in the beautiful city of Vancouver, on the Canadian West Coast in the province of British Columbia. Registration available on-line (see conference URL below).

EPEC 2008 is jointly sponsored by:



BC Hydro PowerSmart, BC Transmission Corporation,  
IEEE Canada & PES (technical co-sponsor).



**Conference occurs October 6-7<sup>th</sup>**

For details and registration, please visit the conference website: <http://www.ieee.ca/epec08>

# An Innovative Transmission Future



BC Transmission Corporation is committed to ensuring BC's electricity grid supports the province's growing economy. BCTC's culture of innovation, our commitment to advancing technologies, and our leadership in industry initiatives ensure that we are at the forefront of innovation now and in the future – to the benefit of all British Columbians.

**BCTC is pleased to sponsor the 2008 IEEE Electrical Power Conference in Vancouver, British Columbia.**



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*BC Transmission Corporation is the Crown corporation that plans, operates and maintains the province's publicly-owned electrical transmission system.*

Ferial El-Hawary, FIEEE, FEIC, FMTS, President of IEEE Canada: 2008-2009 / Présidente de l'IEEE Canada: 2008-2009

**I**t is a pleasure to report on the outcome of our Spring'08 Regional Board Meeting which was held May 3rd and 4th in Niagara Falls. The meeting was followed by a very successful, well attended CCECE'08 - the highlight being the celebrations at the Awards Banquet. Preceding the Regional Board meeting, a one-day Training Session for Section Chairs was held Friday May 2nd. This session was also well attended; the topics and the speakers focused on the new Member Geographical Activities (MGA) Model. I would like to thank all the invited speakers for their efforts and for attending our meetings. Also, I wish to thank the team of organizers for their fine volunteer work that ensured success to these events.



With the impending arrival of the IEEE 125th Anniversary Celebrations, there was an urgent need to establish a task force on the History of IEEE Canada. The Board has approved the establishment of an Ad hoc Committee on the History of IEEE Canada. Its purpose is to focus on the History of IEEE Canada since its origins, to collect and document the history of the Region with a view to publishing a "History of IEEE Canada" in hardcopy and electronic formats. It will advise on costs and explore means of funding for reporting to the IEEE Canada Board in the Fall Meeting. This project should be completed by the beginning of 2009, in time for the 125th Anniversary of IEEE.

President-elect Om Malik has agreed to be the Coordinator of this Committee on the Executive Committee and the Board of IEEE Canada. Directors Emeriti Wally Read and Ray Findlay are Co-Chairs. Members are Past Presidents of IEEE Canada as follows: Wally Read, Ray Findlay, Bob Alden, Linda Weaver, Vijay Bhargava, Tony Eastham, Celia Desmond, Dave Kemp, Mo El-Hawary, Bill Kennedy, Bob Hanna. The committee has the discretion to include additional members on an as needed basis, and some volunteers have already manifested themselves. ■

**C**'est avec plaisir que nous rapportons les résultats de notre Réunion de printemps 2008 du conseil régional, qui s'est tenue les 3 et 4 mai à Niagara Falls. Ensuite nous avons assisté à un CCECE'08 très réussi dont la pièce de résistance était le Banquet des prix et récompenses. Avant la réunion régionale, une session de formation d'un jour pour les présidents de section s'est tenue le vendredi 2 mai. Cette session a aussi eu une bonne participation; les sujets et conférenciers se sont penchés sur le nouveau modèle d'activités géographiques pour les membres (MGA) du IEEE. Je désire remercier tous les conférenciers invités pour leur efforts et pour avoir participé à nos rencontres. Aussi, permettez-moi de remercier les organisateurs pour leur excellent travail bénévole qui a assuré le succès de ces événements.

Avec l'arrivée imminente des célébrations du 125e anniversaire de l'IEEE, il y avait un urgent besoin d'établir un groupe de travail sur l'Histoire de l'IEEE Canada. Le Conseil a approuvé l'établissement d'un comité ad hoc sur ce sujet. Son but est de se pencher sur l'histoire de l'IEEE Canada depuis ses origines, rassembler et documenter l'histoire de la Région en vue de publier une « Histoire de l'IEEE Canada » sur papier et en format électronique. Il nous informera sur les coûts et explorera les alternatives de financement, et fera rapport à la réunion d'automne de l'IEEE Canada. Ce projet devrait être complété d'ici le début 2009, à temps pour le 125e anniversaire de l'IEEE.

Dr. Om Malik, notre président-élu, a accepté d'être le coordinateur de ce comité au sein du comité exécutif et du conseil d'administration du IEEE Canada. Les directeurs emeriti Wally Read et Ray Findlay en sont coprésidents, et les membres sont d'anciens présidents du IEEE Canada : Wally Read, Ray Findlay, Bob Alden, Linda Weaver, Vijay Bhargava, Tony Eastham, Celia Desmond, Dave Kemp, Mo El-Hawary, Bill Kennedy, et Bob Hanna. Le comité peut ajouter des membres à sa discrétion selon les besoins, et des volontaires se sont déjà manifestés. ■

## IEEE SECTIONS CONGRESS 2008

*Celebrating Volunteer Achievements Worldwide*

September 19-22, Québec, (QC)



**I**note with pride that IEEE Canada (IEEE Region 7) hosted the memorable Section Congress 1990 in Toronto. In 2008, we are very happy once again to host Section Congress and the prestigious IEEE Honor Awards Ceremony – both events to be held in October 2008 in Quebec City. Let us share the celebration and congratulate all the awards winners for their achievements.

The theme of Section Congress 2008 (SC08) is "Celebrating Volunteer Achievements Worldwide". The program has been developed over the last three years based on responses from the 2005 Sections Congress and a survey of Section Chairs conducted in 2006. The results were reviewed by the Program Committee which identified 35 topics to be included in 74 breakout sessions. Highly ranked sessions are repeated to allow participants to attend as many relevant sessions as possible.

The highlight and most important activity at Sections Congress is when the delegates develop and vote on recommendations that the IEEE will address in order to best serve the needs of its members for the next few years. The Program Committee has modified the recommendation process to address past concerns. All Region Committees have been asked to develop their recommendations prior to the official start of SC08. This pre-Congress activity aims to have broad-based discussions of IEEE issues, filter out those where the needed actions are not of a global nature, educate the primary delegates on the issues and understand the priorities within the regions for these various issues.

SC08 will start with Regional Caucuses, which will result in four issues/recommendations from each Region being forwarded to the Congress participants for consideration. All recommendations will be reported to the Congress and grouped into Issue Caucuses. These will take place on Sunday afternoon, but there will be a computer-based forum on each of the established caucuses. IEEE volunteers and staff, as well as all delegates, may participate in the forums to provide information about "prior art" related to the issue as well as activities underway.

Participants will attend an Issue Caucus of their choice and participate in turning the issues into well-formed recommendations for consideration by the Congress. There will potentially be 20 recommendations for the Congress to consider and be prioritized by vote on Monday. The Congress will then report the top ten recommendations in priority order and report the other recommendations as a pool.

I wish to thank the Sections Congress 2008 Organizing Committee Members for their excellent work that will make this Congress a showcase for all. We hope that participants will enjoy the program and have a memorable experience of Sections Congress 2008 as a whole, specially of our beautiful Quebec City celebrating its 400th years Anniversary in 2008.

**Bienvenue au Congrès des sections de l'IEEE 2008!**

**Bienvenue à Québec!**

**Bienvenue au IEEE Canada (IEEE Région 7)!**

Ferial El-Hawary, P.Eng., FIEEE, FEIC, FMTS



## OBIEC Standards Approved by CSA: An Alternative to the Canadian Electrical Code

The OBIEC Stakeholder Advisory Committee (<http://www.obiec.org/>) announced July 15, 2008 that the Canadian Standards Association (CSA)-OBIEC Technical Committee has approved two standards: C22.4 No. 1 Objective based industrial electrical code and C22.4 No. 2 OBIEC Safety management system-Requirements. They are intended for use by authorized industrial users as an alternative to the Canadian Electrical Code (CEC).

The OBIEC and its companion Safety Management System (SMS) Requirements standard are developed under the CSA consensus process involving a cross-section of stakeholders from across the country. Provincial and municipal regulators have also been significant contributors to the process.

Benefits for industry are expected to be significant, including enhanced safety performance and design flexibility with a strong emphasis on

superior engineering. The OBIEC has an element of continual improvement that includes operations and maintenance requirements to provide for a more complete cradle-to-grave life cycle for industrial electrical installations.

The OBIEC will encourage global best practices, products and technologies and will serve to lay a foundation for harmonization of an industrial user's Canadian and global operations. The CEC, NEC, IEC, IEEE and other industry-recognized standards are referenced, with the CEC serving as the benchmark for measuring safety performance.

Based on early pilot projects, industry can realize 10% to 15%—and maybe greater—cost savings in overall electrical installation while maintaining or even improving safety performance. On large projects this is significant.

Installation contractors will have a better road map from which to work from. Under an

OBIEC safety system, engineering designs will better reflect electrical installation specifications derived from the safety objectives of the OBIEC rather than under the current safety system where there is a tendency to pass on design responsibility to installers, relying on their knowledge of prescriptive requirements to compensate for gaps in design.

More than 75 companies and professional associations have partnered in various ways from seconding personnel, to providing seed funding and/or support in principle. As well, CSA and IEEE have signed an agreement to work jointly on linking this standard with the IEEE standards.

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## Celebrating 10 years of growth and achievements at Concordia University

by: Amir G. Aghdam, Professor, Concordia University and IEEE Eastern Canada Area Chair

A mini-conference was held May 29, 2008 to celebrate 10 years of great achievements at the Faculty of Engineering and Computer Science of Concordia University (Montreal, Quebec).

The event was sponsored by the IEEE Control Systems, Systems Man and Cybernetics, and Computational Intelligence Societies (through their Distinguished Lecturers Programs), the IEEE Montreal Section, and the Faculty of Engineering and Computer Science, Concordia University. It began with opening remarks by the author of these lines, then Dr. Nabil Esmail, Outgoing Dean of the Faculty, Dr. Rama Bhat, Interim Dean, and Dr. Anader Benyamin-Seeyar, Chair, IEEE Montreal Section. Many thanks to the speakers, as well as the organizers of the program: Anader Benyamin-Seeyar, Rama Bhat, Ahmadreza Momeni, Kaveh Moezzi Madani, Somayeh Sojoudi, Kian Jalaleddini, Éric Germain, Mohamed Cheriet, Manijeh Khataie and Lawrence Chen.

The event featured five invited technical presentations:

- Fundamental Limitations in the Dynamics of Vehicular Formations: Local versus Global Feedback, Dr. Bassam Bamieh – IEEE Distinguished Lecturer and Professor, University of California, Santa Barbara.
- Trade versus the Environment: Strategic Settlement from a Systems Engineering Perspective, Dr. Keith Hipel – Distinguished Lecturer of the IEEE and Professor, University of Waterloo.
- Feature Extraction in Computational Intelligence, Dr. Evangelia Micheli-Tzanakou – IEEE Distinguished Lecturer and Professor, Rutgers University.
- Cable: from CATV to DOCSIS 3.0, Mr. Gérard Terreault – Retired VP of Technology, Avantron Technologies.
- High-Speed Data Transmission over

Multimode Fiber, Dr. Scott Yam – Assistant Professor, Queen's University.

The Faculty of Engineering and Computer Science at Concordia University has come a long way from its modest beginnings since the university was formed in 1974 by the merger of Sir George Williams University and Loyola College. The growth in the past 10 years has been especially phenomenal. To a large extent this is the result of the vision, energy and leadership of Dr. Nabil Esmail, Dean of the Faculty from 1997 to 2008.

The Faculty has done exceedingly well in graduate education. The new Engineering and Visual Arts Building housing all the faculty members, graduate students and the research laboratories, is one of its kind. The number of Ph.D. graduates alone has reached a rate of 70 per year starting from a trickle of one or two graduates in the early 1970s. These graduates hold high positions in Canadian industry or have established themselves in universities across the world, and this is a matter of pride for the Faculty. It has started new undergraduate programs in Software Engineering and new graduate programs in Software Engineering, Industrial Engineering, Network Security, and Quality Systems in Engineering.

More than 50% of the 160-plus faculty complement have been hired in the past 10 years. This team is young and dynamic, and the research areas span the contemporary cutting edge research domain. The Faculty has close collaboration with the local industries, particularly in aerospace where Montreal is a world-level center. The Concordia Institute for Aerospace Design Innovation (CIADI) has more than 100 students working on paid projects from this sector. The Faculty has more than 20 Research Chairs, including the Canada Research Chairs, Concordia University Research Chairs and the Industrial Research Chairs.



Nabil Esmail, Dean of the Faculty of Engineering and Computer Science of Concordia University from 1997 to 2008



Presenter Scott Yam (left) receives a certificate of appreciation from Dr. Lawrence Chen, co-organizer of the mini-conference



Speakers Basam Bamieh, Gérard Terreault, Keith Hipel and Evangelia Micheli-Tzanakou join organizer Amir Aghdam (right).



Alexandre Abecassis is a patent agent and Partner at Fasken Martineau DuMoulin LLP, Lawyers and Patent and Trade-mark Agents.

*Alexandre Abecassis est agent de brevets associé chez Fasken Martineau DuMoulin S.E.N.C.R.L., s.r.l., Avocats et agent de brevets et de marques de commerce.*

Send any news clippings you would like to contribute via e-mail to [alexandre.abecassis@ieee.org](mailto:alexandre.abecassis@ieee.org)

*Veillez faire parvenir les coupures de presse proposées par e-mail à [alexandre.abecassis@ieee.org](mailto:alexandre.abecassis@ieee.org)*

MONTREAL, QC, 6 août 2008. Mechtronix Systems et la Ville d'Edmonton annoncent un partenariat pour déployer une technologie de séchage de biosolides à la station de traitement des eaux usées Gold Bar d'Edmonton. Le projet vise à démontrer l'efficacité énergétique et les qualités écologiques de cette technologie appliquée au traitement d'eaux usées municipales.

LONGUEUIL, QC, Jul. 24, 2008. Clemex Technologies announced that it has delivered five automated image analysis systems to three universities for a total amount of over 250k\$. The systems were delivered respectively to Brockhouse Institute for Materials Research of McMaster

University, Southwest University in San Antonio, Texas and the University of Toronto, Materials Engineering department.

ESPOO (Finland) and DENVER, CO, Jul. 23, 2008. Nokia and Qualcomm announced that they have entered into an agreement covering various telecommunication standards including GSM, EDGE, CDMA, WCDMA, HSDPA, OFDM, WiMAX, LTE and other technologies. The agreement will result in the settlement of all litigation between the companies. Under the terms of the new 15-year agreement, Nokia has been granted a license under all Qualcomm's patents for use in Nokia mobile devices and Nokia Siemens Networks infrastructure equipment. Nokia has agreed not to use any of its patents directly against Qualcomm, enabling Qualcomm to integrate Nokia's technology into Qualcomm's chipsets. The financial structure of the settlement includes an up-front payment and on-going royalties payable to Qualcomm. Nokia has agreed to assign ownership of a number of patents to Qualcomm.

TORONTO, ON, Jul. 23, 2008. The University of Ontario Institute of Technology and IBM announced a research project to help doctors detect subtle changes in the condition of critically ill premature babies. The software used in the project will receive biomedical data, such as heart rate and respiration, along with environmental data gathered from sensors and more traditional monitoring equipment on and around the babies. Physicians in the neonatal intensive care units at Toronto's Hospital for Sick Children and two other interna-

tional hospitals are participating in the study.

CALGARY, AB, Jul. 21, 2008. Hemisphere GPS announced the release of a new product for the aerial applications market which will improve the efficiency of applications and the productivity of pilots. More specifically, the new product will be used in a broad range of applications such as crop spraying, pest control, forestry, and fire management.

VANCOUVER, BC, Jul. 17, 2008. GPS Industries, a provider of WiFi-enabled golf management systems, announced that it has filed suit for patent infringement in the United States District Court for the Northern District of Illinois against ProLink Holdings, ProLink Solutions, ABC National Television Sales, and LinksCorp. The suit alleges infringement of U.S. Patent No. 5,685,786, which relates to on-screen display of centrally transmitted advertising and tournament standings information. GPS Industries has also asserted U.S. Patent No. 5,438,518, which relates to the Company's position-based hole advance and screen scrolling technology.

LONGUEUIL, QC, Jul. 8, 2008. HumanWare announced that it will expand its low vision product line with four new video magnifiers. With these new products, HumanWare expects to better serve the needs of the growing number of people with low vision, i.e. those whose vision cannot be completely corrected. The announcement was made at Vision 2008, an international conference on low vision held in Montreal in July 2008.

MONTREAL, QC, Jun. 17, 2008. Talkdynamics Technologies, a provider of IP-based intercom and conferencing software solutions, announced that it has been awarded a contract from Systems Engineering Support Services GbR for its VoIP conferencing and intercom system. The goal is to support voice communications at the European Space Agency for the International Space Station Operations; the system will deliver secured and encrypted multi conference communication to remote users around the world via the Internet Protocol (IP) and integrate seamlessly with the existing mission conferencing system. The deployment consists of setting up a multi-channel and IP-based voice communication link over the Internet, between the Canadian Space Agency and the Columbus Control Centre located at the German Space Operations Center.

MONTREAL, QC, 16 avril 2008. Nstein Technologies, un leader en solutions de publication en ligne pour les journaux, les magazines et les fournisseurs de contenu numérique annonce que sa technologie et celle d'IXIASOFT ont été retenues par l'Assemblée nationale du Québec pour un important projet de gestion documentaire. Ce projet permettra à l'Assemblée Nationale de « déployer une nouvelle plateforme centralisant et facilitant la gestion de contenu multimédia et la mise en ligne d'outils et services interactifs, et d'offrir aux internautes des fonctionnalités de recherche performantes et un accès privilégié à des contenus historiques de grande valeur. »■



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## A View from the West

On: Canadian Mood and Innovation Capacity, (Alberta) Oils Sands, Saskatchewan, Manitoba, British Columbia, and the Need for Power

- ◆ *Canadian Business Online* published April 14 and 28 two articles from Joe Castaldo titled "Economic Outlook: The Mood of a Nation" ([www.canadianbusiness.com](http://www.canadianbusiness.com)). The stories from across Canada are not meant to be a definitive statement on the Canadian economy, but rather a snapshot of seven cities discussing the "challenges businesses are facing as recession looms". A short but interesting overview of Canadian innovative capacity is provided in "The Power of Innovation" by Andrew Wahl (*Canadian Business Online*, [www.canadian-business.com](http://www.canadian-business.com), March 17, 2008). The July/August issue of *The Globe and Mail's Report on Business* provides information on Canada's leading corporations. They are ranked by various categories including profit, fastest-growing, investment returns, industry, and technology. Banks and Oil companies dominate the profit ranking. In terms of the biggest technology companies, Bombardier, Nortel, Celestica, IBM, and Research in Motion lead the way. *Canadian Business* published on April 26 in an article by Andrew Wahl and overview of "Canada's Best Workplaces". Leading the ranking is Back in Motion Rehab of Surrey British Columbia followed by 1-800-Got-Junk? of Vancouver. Links are provided to the methodology, and profiles of the companies.

- ◆ Issues related to the Alberta Oil Sands have attracted considerable attention nationally and internationally. Oil and gas innovations launched in Alberta are changing the way the business is done ("The Productivity Edge". *Alberta Venture*. 12(4):91-97. April, 2008. [www.albertaventure.com](http://www.albertaventure.com) ) and small communities are being reshaped ("Upgraderville". *Alberta Venture*. 11(12): 116-122. December, 2007.)

This natural resource consists of large deposits of oil-rich bitumen covering about 140,000 km<sup>2</sup> of sparsely populated boreal forest and muskeg. There are 173 billion barrels of oil in those sands proven to be recoverable with today's technology, and an estimated total of 315 billion barrels of potentially recoverable oil. Of the 87 active oil sands projects in Alberta, three are mining projects and the remaining use in-situ recovery methods.

This resource is a contributor to the world oil supply and provides a stable energy source for domestic and international markets. In 2006, about 1.35 million barrels per day of crude oil were exported to the U.S., supplying 13 % of their crude oil import. The oil sands are a key driver of the economy in Alberta and important economically across Canada ([www.oilsands.alberta.ca/documents/Economic\\_impacts.pdf](http://www.oilsands.alberta.ca/documents/Economic_impacts.pdf)). Oil sands activities create jobs, generate revenue and attract investment. Every dollar invested in the oil sands creates about \$9 worth of economic activity globally and \$6 in direct and indirect activity locally. Royalties from the oil sands help fund many programs and services, including Alberta's infrastructure, health and education systems.

Critics contend that government and industry measures taken to minimize environmental and health risks posed by large-scale mining operations are inadequate, causing damage to the environment. Major concerns include: Open-pit mining of the Athabasca oils sands impacts the Boreal forest and muskeg; approved oil sands mining operations are diverting too much water from the Athabasca River; and the production process emits a large quantity of greenhouse gases. Proponents of this development point out that all stakeholders, including the companies themselves and the Alberta Government, are investing heavily to ensure that this important industry is environmentally responsible and accountable to future generations.

- ◆ November 7, 2007 the people of Saskatchewan elected a new government headed by Premier Brad Wall, a successful entrepreneur. In

By Terrance Malkinson

School of Health and Public Safety  
SAIT Polytechnic, Calgary, Alberta



an interview by Keith Moen published in Saskatchewan Business

Canadians are becoming increasingly aware of diet and nutrition. BioAccess was launched in 2006 at the University of Saskatchewan's Plant Biotechnology Institute through start-up funding provided by the National Research Center. The article "Solution: BioAccess" (*Saskatchewan Business Magazine*. 29(3): 16-20, April/May, 2008) profiles this success story.

- ◆ The Jan/Feb 2008 issue of *Manitoba Business Magazine* published its ranking of the "50 Fastest-Growing Companies." ([www.manitobabusinessmagazine.com/50FastList.pdf](http://www.manitobabusinessmagazine.com/50FastList.pdf)). Leading the ranking is Aviva Natural Health Solutions followed by K-Tec Earthmovers. Aviva provides consumer education and a professional selection of health and wellness products. The topic of Recycling Outdated Information Technology Equipment is discussed in "New Uses for Old Computers" (*Manitoba Business Magazine*. 30(3): 17-21. April, 2008.) Jan Wehner reveals the extent of the generated IT equipment waste and potential solutions. In the May Issue of the same magazine CALM Airlines which services northern Manitoba and the central Arctic is profiled (pp. 6-11). Gail Morgerg the companies chairman was chosen as Manitoba's Entrepreneur of the Year.
- ◆ Looking at British Columbia: "Back on Track" (*BC Business*. 36(6):79-85, June, 2008. [www.bcbusinessonline.ca](http://www.bcbusinessonline.ca)) discusses how the railroad industry is re-emerging to play a key role in the economy. The province is perfectly situated to capitalize on increasing Pacific trade opportunities. (As well, Alberta is also looking at municipal and provincial railway infrastructure to transport products and people; the Edmonton-Calgary corridor is a high priority). It's almost "back to the future" as railways historically were responsible for the early growth of Canada. An article by Lauren Kramer "The Orient Express" published July 1 describes some of these Pacific business opportunities as well as those emerging from the Beijing Olympics. Public-private partnerships (P3s) are increasingly used to bring some of the benefits of the private-sector delivery of public goods and services. Three experts, Tom Ross, Larry Blain, and Brock Johnston discuss their thoughts on this business model in the article "Round Table: All Together Now".
- ◆ As the economy expands Canada needs to produce more power and to upgrade and expand its distribution systems. Several articles in the July, 2008 issue of *Alberta Venture* ([www.albertaventure.com](http://www.albertaventure.com)) discuss this developing issue in Alberta. "Choked" by Anthony Davis describes electricity generation and transmission challenges. "Power Play" by Scott Valentine discusses the evolution of the retail electricity market after deregulation in 2000.

### About the Author

Terrance Malkinson is a communications specialist, business analyst and futurist. He was an elected Senator of the University of Calgary and a Governor of the IEEE Engineering Management Society. Currently he is Vice-Chair of the IEEE-USA Communications Committee, an international correspondent for IEEE-USA Today's Engineer Online, editor-in-chief of IEEE-USA Today's Engineer Digest, and associate editor for IEEE Canadian Review. He is the author of more than 330 publications and is also an accomplished triathlete. His career path includes medical research at the University of Calgary and North American business proposal management for the General Electric Company. Currently, he is with the School of Health and Public Safety/Applied Research and Innovation Services at SAIT Polytechnic. Opinions expressed are the author's. He can be reached at [malkinst@telus.net](mailto:malkinst@telus.net)







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# The Alouette Satellite Program

## An International Milestone in Canadian Science and Engineering

### 1.0 Introduction

The Defence Research Telecommunications Establishment (DRTE), Ottawa is where the Alouette program was conceived and where the first two satellites were largely designed and built. It was one of a number of establishments of the Defence Research Board (DRB) which reported to the Minister of Defence. DRTE had its origins in ionosphere sounding activities carried out by the Canadian Armed Forces and NRC during WW II. Before the satellite era, radio propagation via the ionosphere was the main method of long distance communications, other than via landlines and underwater cables. Subsequently DRTE became a leader in the field of ionosphere research and by the late 1950s had become one of the foremost research establishments on the continent, with Radio Physics, Communications, and Electronics laboratories that were on a par with any in the world. In 1969 DRTE was transferred to the newly created Department of Communications and renamed the Communications Research Centre (CRC). CRC is now an agency of Industry Canada and is the government of Canada's primary laboratory for R&D in advanced space and terrestrial communications.

With the launching of Sputnik in October 1957 it was realized at DRTE and elsewhere that a satellite-borne radar would provide a very powerful means of exploring the ionosphere from above (topside sounding), and that this could have important implications for long distance radio communications. The origin of the idea, is not clear but it was Dr. Eldon Warren who picked up the concept and put forward the daring proposal that DRTE should build a swept frequency topside sounder.

In July 1958, Lloyd Berkner, Chairman of the Space Science Board of the National Academy of Sciences of the United States announced that space and facilities in satellites would soon be available and called for suggestions for experiments on the upper atmosphere. This produced an immediate response from Peter Forsyth at the University of Saskatchewan for a rudimentary single frequency sounder - which was later expanded to four frequencies. At a meeting in October 1958, called by H.G. Booker of Cornell University to discuss ionosphere experiments in satellites, a number of groups in the USA and two from Canada - DRTE and the University of Saskatchewan - indicated their interest in topside sounding.



Eldon Warren



Jim Scott

This meeting resulted in Jim Scott, the Chief Superintendent of DRTE submitting a proposal to build a topside sounder satellite, firstly to ARPA at the Pentagon in Washington on 13 November 1958 and then to the newly created NASA on 31 December 1958. Not a simple sounder operating on a few frequencies, but a 0.5-12 MHz swept-frequency one that duplicated in a satellite the functions of ionosphere sounders then used from the ground (see Fig. 1). In the meantime, and on the assumption that the proposal would be accepted, work began on the satellite project at DRTE in January 1959. Sputnik and the cold war produced a sense of urgency.

NASA officials listened to the Canadian proposal with more than a little scepticism. They were convinced that the power and antenna problems involved, and the sheer technical complexity of installing the equivalent of a bottom side sounder in a satellite was far too difficult to do at that

By *Colin A. Franklin, SMIEEE*  
*Chief Electrical Engineer, Alouette I program*

### Abstract

With the launching of Canada's first satellite Alouette 1 from Vandenberg Air Force base, California on 29 September, 1962 Canada became the third nation in the world, after the Soviet Union and the United States, to design, build and control a satellite. The Topside Sounder Alouette 1 was an immense scientific and technological success. It was designated by the Centennial Engineering Board of Canada in 1987 as one of the ten most outstanding achievements in Canadian engineering in the past 100 years and in 2007 was designated an "event of national historic significance" by the government of Canada. It was also designated an IEEE Milestone in Electrical Engineering and Computing. This paper describes the little known origins of the program in the Department of National Defence, how the satellite was designed and its significance for the future of Canada in space. Rather than a detailed technical presentation it is more of a personal perspective from someone who was there from the beginning.

### Sommaire

Avec le lancement du premier satellite canadien Alouette 1 depuis la base aérienne de Vandenberg (Californie) le 29 Septembre 1962, le Canada devient la troisième nation au monde après l'Union Soviétique et les États-Unis à concevoir, construire et opérer un satellite. La sonde en contre-haut Alouette 1 a été un immense succès scientifique et technologique. Elle a été désignée par le Comité du centenaire du génie canadien en 1987 comme une des plus remarquables réalisations du génie canadien des derniers 100 ans, et en 2007 comme un « événement d'importance historique nationale » par le Gouvernement du Canada. Elle a aussi été reconnue comme un Jalon du IEEE en génie électrique et informatique. Cet article décrit les origines peu connues du programme au ministère de la défense nationale, comment le satellite a été conçu et son importance pour le futur du Canada dans l'espace. Plutôt qu'une présentation technique détaillée, il s'agit plutôt de la perspective personnelle de quelqu'un qui y était depuis le début.

time. International science was a definite plus for the fledgling NASA, however, so they agreed to invite DRTE to join their Topside Sounder Working Group, to launch the Canadian experiment. They sent the proposal along to the Central Radio Propagation Laboratory (CRPL) at Boulder, Colorado, to examine it for scientific merit and engineering feasibility. The CRPL agreed with the NASA view that the proposal was too ambitious, so their report recommended a fixed-frequency experiment as a first-generation Topside Sounder, and that DRTE "be encouraged to develop its swept-frequency system as a second-generation experiment."

A remarkable feature of the proposal was the absence of a serious feasibility study - apart from some basic calculations by Eldon Warren. For example no one knew how to design the sounder antennas or what the size, weight, and power consumption of the instrumentation might be.

There was no MOU and instead the agreement was formalized in an exchange of letters between the DRB Chairman (Zimmerman) and the Administrator of NASA in August 1959. It was to be a cooperative undertaking between Canada and the U.S. with each country paying its own costs in the project. The principal Canadian objectives of the program are listed at the top of the next page.

The Canadian contribution was to consist of the following: develop an ionospheric sounder for installation in a satellite to be provided by NASA; construct three models, one for installation in a satellite, one spare and one prototype; provide telemetry and recording equipment for at least one year at each of four stations, Resolute Bay, Churchill, Ottawa and St John's;

exchange copies of all ionograms with cooperating agencies. The United States agreed to provide the launch vehicle, launch facilities, and a worldwide network of ground stations. The U.K. joined the program later and provided four telemetry stations. As the project progressed three additional experiments were included - to measure cosmic noise, very low frequency (VLF) radio emissions and energetic charged particles. The last experiment was contributed by NRC.

By late 1959 however it became clear that the sounder system was too complex to be designed independently of the satellite. This meant that DRTE would now have to provide three satellites (two flight models and a prototype). This news was reportedly not well received at DRB HQ and ultimately led to a major diversion of finances and manpower from other programs in DRTE plus a subsidy from DRB itself.

The rest is history; the CRPL/NASA fixed frequency satellite (S-48) suffered delays, the Canadian satellite (S-27) kept more or less on schedule; S-48 suffered more delays; S-27 was launched on 29 September 1962, to become Alouette 1, the first satellite to be designed and built by a nation other than the United States or the Soviet Union. S-48 was eventually launched in August 1964. NASA later admitted publicly that they and CRPL were so convinced that S-27 could not possibly function for more than an hour or two, if at all, that they had made no plans to use data from it. In fact Alouette 1, constructed at a time when most satellites had a useful lifespan of a few months, continued to function and provided a wealth of data for ten years before it was turned off from the ground.

## 2.0 Design Challenges

Text books on space technology and the in-orbit radiation environment were non-existent and the open literature and internal NASA reports were sparse. The young Canadian engineering team had no prior experience in the design of space systems and hardware but was highly skilled in the emerging area of solid state electronics. It also had the great advantage of being in day-to-day contact with scientists in the Radio Physics and Communications Laboratories in DRTE. The decision by NASA to provide a relatively large launch vehicle, a Thor Agena-B, was a great help and eliminated weight as a serious constraint in the design of the satellite. Finally there was the excellent support received from the emerging Canadian space industry and the close working relationships and trust that developed with our NASA, CRPL and AIL (Airborne Instrument Laboratories) colleagues - AIL built the U.S. topside sounder. Indeed, once the technical work started we dealt with our US colleagues as if we were all part of one big family.

Little of the technology developed for ground-based sounders was directly applicable. Aside from the use of vacuum tube systems with their associated reliability problems and weight, size and power consumption, these sounders typically used large antennas and high power transmitters. Initially it was thought that these problems might best be solved using a swept-frequency CW radar instead of a more conventional pulse system, and a good deal of time was lost on this approach [1]. The develop-

ment of a vacuum tube transmitter was then undertaken - but abandoned when a parallel development showed the required performance could be obtained using transistors [2].

There were strenuous debates on the subject of transmitter power. Caution said to keep it low for reasons of cost, reliability and power consumption.

The bolder approach eventually prevailed and a transmitter power ten times greater than the calculated minimum needed was finally chosen. This was a milestone decision since it greatly eased the antenna design and the mass production of high quality ionograms.

There were more stormy debates, this time on cosmic noise. Two attempts were made to measure cosmic noise using Javelin rockets launched from Wallops Island in 1959. They failed. In 1960 a 3.8 MHz cosmic noise receiver was designed and flown on a

U.S. navy TRANSIT navigation satellite, providing the first measurements of cosmic noise to be made above the ionosphere [3].

### PRINCIPAL PROGRAM OBJECTIVES

- 1. Provide a basis for improvements in shortwave radio communications, particularly at higher latitudes, through a better understanding of the physics of the ionosphere
- 2. Acquire a better understanding of the properties of the ionosphere for the scattering and deflection of radar beams
- 3. Develop a Canadian capability in space technology

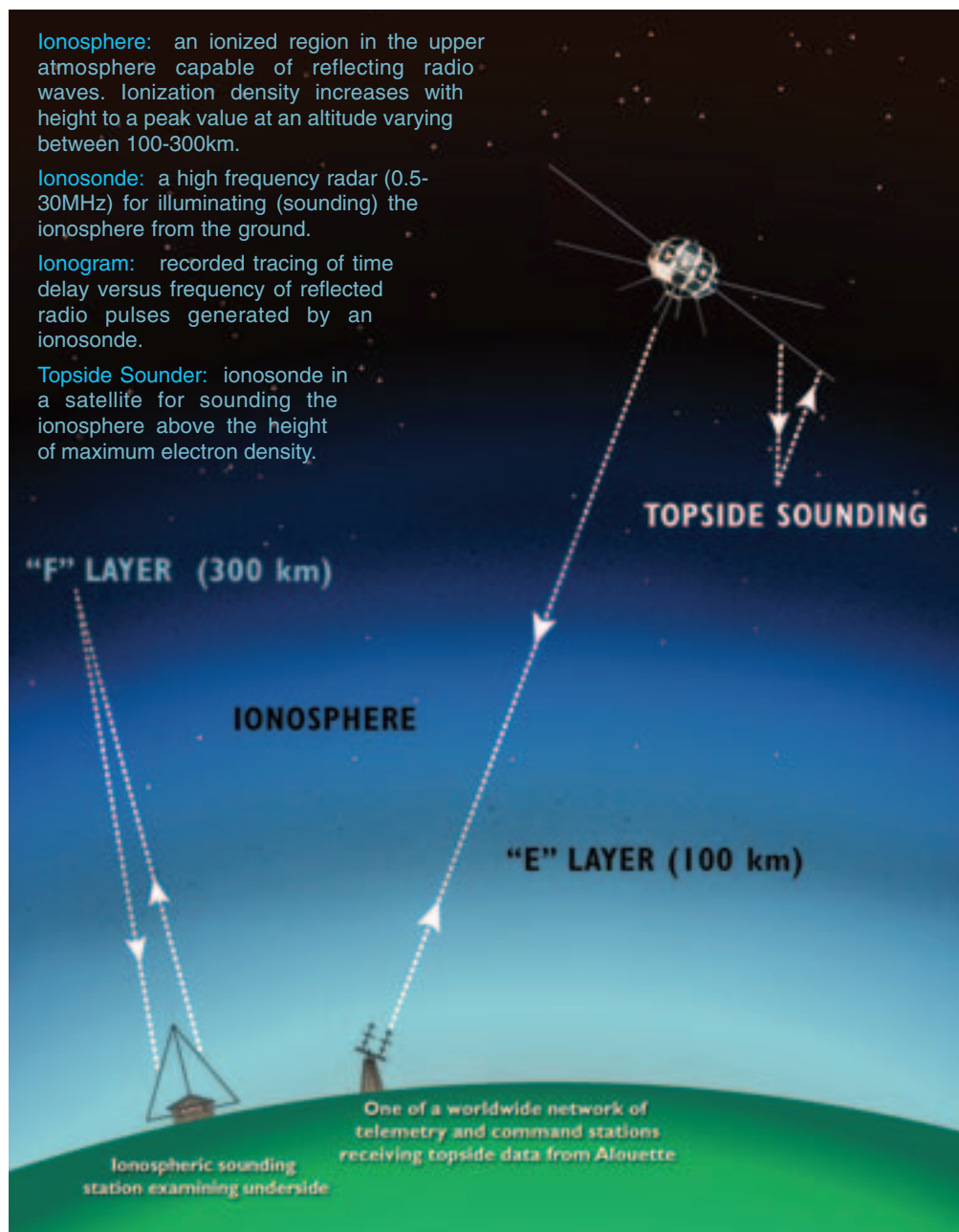


Figure 1: Bottom and Topside Sounding



One of the most difficult problems was the design of the sounder antenna system which had to cover a 0.5-12 MHz frequency range. This eventually consisted of two antennas in a crossed dipole configuration - 150ft tip-to-tip for the lower half of the frequency range and 75 ft tip-to-tip for the upper half of the frequency range [4]. Fig.2 shows the satellite with antennas extended during tests at de Havilland.

After examining a range of possibilities, all of which seemed impractical, a solution to the problem was found in a visit by DRTE engineers to NRC. A design by George Klein for an extendible antenna was suggested as a possible approach. A 20ft antenna had been designed and built by Klein at NRC in 1951, as a solution to a UK requirement for an antenna for a radio beacon to be dropped by military aircraft.

It looked promising and was forwarded to de Havilland (later Spar Aerospace) for evaluation and possible development. Klein's key idea was to preform a thin flat strip of spring steel into a cylindrical tube with an overlapping seam, and heat treat it. It is then stored in flat form on a spool. On extension the steel strip curls into its preformed shape to form a tube with considerable bending strength. A major development effort was required by de Havilland to convert the basic idea into an antenna for space use.

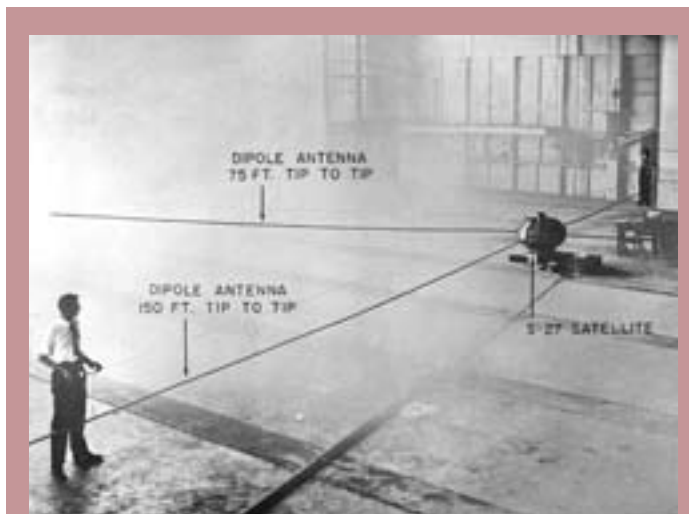


Figure 2: Satellite with Antennas Extended

aerospace company, finding the specifications too difficult to meet. When John Stewart at RCA Victor (in Montreal, now EMS Technologies) heard of our dilemma over breakfast at a Solid State Circuits conference in Philadelphia, he proposed that his team could do it. He was told to go ahead, forget about costs and contractual details, and get us an engineering model within two months. He succeeded, the subsequent flight models operated flawlessly, and the design became the standard for subsequent Canadian and U.S. ionosphere sounder satellites [6].

### 3.0 Design and Testing

The approach taken on reliability was novel and controversial. Little reliance was placed on statistical reliability calculations. Instead we insisted on a thorough understanding of semiconductor devices and circuit operation and worked closely with manufacturers to ensure that only semiconductors with

median parameter values were procured. Circuits capable of operating under much greater than expected temperature and power supply variations were developed to counter expected and unexpected modes of degradation and failure. The consequences of radiation damage to semiconductor components were minimized by designing for far larger variations in transistor parameters than was the accepted practice at the time. This was an early example of what is now known as Robust Design. At the time critics said we would end up damaging components and degrading reliability. Extreme temperature and voltage tests revealed time and again design weaknesses which were often easy to fix, and this was done even when the equipment had passed all its tests. To eliminate single point failures, there were spares for all transmitters and receivers and extensive redundancy in the power subsystem - including spare batteries. A great deal of effort was put into the design of the power subsystem including the design of dc-dc converters, suppression of transients and radio frequency interference, overload protection and dynamic load line analysis. To avoid seriously draining the batteries the satellite automatically switched off ten minutes after being turned on by a ground station. Finally we sent two flight spacecraft and two payload test teams to the launch site and ran a competition to decide which one to launch.

Similarly, on the mechanical side the structure and electronics units were designed for significantly higher than expected vibration levels. Also, deployable items were designed to be tested under 1g conditions on the ground, although critics claimed this was overdesign. Shortly before launch, to the alarm of the design team, the vibration levels previously specified by NASA for the launch vehicle were revised to much higher levels. New vibration tests on the spacecraft were required and were passed with no problems.

The power supply was designed for what appeared at the time to be a very pessimistic figure of 40% degradation for solar cell charging currents, after one year in orbit. This paid off as it allowed Alouette, unlike several U.S. satellites, to survive an unanticipated artificial radiation belt created in July 1962 by a hydrogen bomb test at high altitude over Johnston Atoll (South Pacific.)

With the assistance of the Defence Research Chemical Laboratories, Ottawa (now DRDC) a major effort was made to improve the reliability of commercially available Ni Cd batteries. This resulted in some important differences between the Alouette and ISIS batteries and those used in U.S. spacecraft. The resulting batteries functioned for ten years in Alouette 1 and 2 and twenty years in ISIS 1 and 2 and were superior to those used in any other space program of the period.

The electrical and mechanical design and most of the environmental testing was done in Canada. The Canadian Armament Research and



rocket from Wallops Island was carried out to test the extension of a pair of STEMs in space. It was a partial success; one STEM did not fully extend.

The VLF experiment was added almost too late in the program. The DRTE scientist responsible for its inclusion was Dr. Jack Belrose. It consisted of a 400 Hz - 10 kHz receiver connected to a sounder antenna - at a small risk to the main experiment. Designed and developed in six weeks, it was said to be the most cost effective experiment on the satellite and was a good example of how quickly decisions could be made and implemented on the program.

The design of the telemetry system was unexpectedly difficult. The sounder antennas generated multiple nulls in the radiation pattern of the telemetry antenna. Because the satellite was spinning, these nulls would have produced regular drop-outs in telemetry - which in turn would have hampered data analysis and severely reduced the value of the ionograms. The effect of the nulls was largely eliminated through a novel design of the telemetry and command antenna system in the satellite, and by diversity reception and combining on the ground [5].

Nine months before launch we had no telemetry transmitter to send the ionosphere data to the ground. This was due to the supplier, a major U.S.



Development Establishment, Valcartier provided the thermal-vacuum test facilities.

The De Havilland Special Products Division in Toronto, later to become Spar Aerospace Ltd, in addition to providing the STEM antennas, manufactured the satellite structure, and performed spin and centrifuge testing [7]. Sinclair Radio in Toronto designed the telemetry, command and beacon antenna subsystem in the spacecraft and were a major contributor in the design of the sounder antenna subsystem. Satellite vibration testing, dynamic balancing and solar simulation in vacuum was done at the NASA Goddard Space Flight Center. Detailed information on the design, construction and testing of Alouette 1 are given in [8]. Three views of the satellite are shown in Figs. 3, 4 and 5. John Chapman, Program Coordinator and Deputy Chief Superintendent of DRTE, is shown in Fig.3. Keith Brown, Satellite Section Head at DRTE and leader of the engineering team, is shown in Fig. 4.

#### 4.0 The Launch Campaign

The two flight spacecraft and their test teams, numbering about thirty engineers and technicians, were flown to Vandenberg Air Force Base

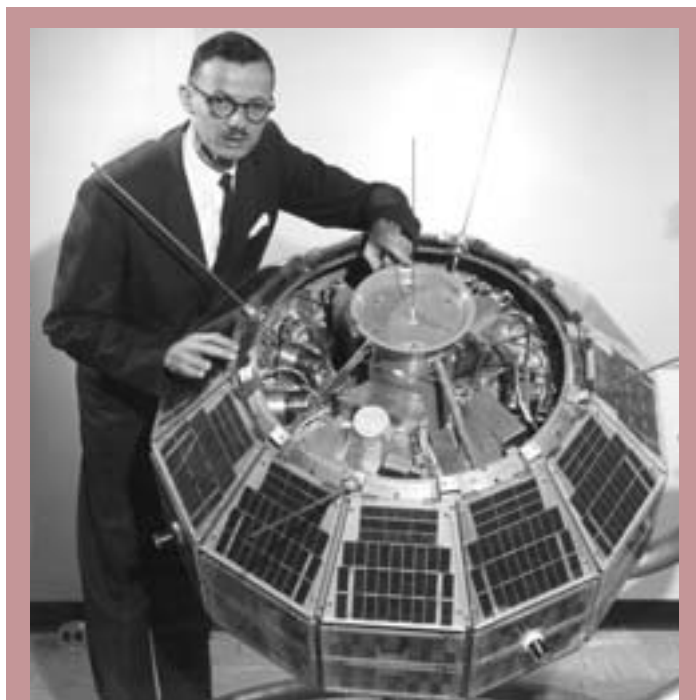


Figure 3: John Chapman with Backup Satellite – Oct. 1962



Figure 4: Alouette 1 and, from left to right, Colin Franklin, Keith Brown and John Barry



Figure 5: Alouette Vibration Testing, Goddard Space Flight Center

California by the RCAF in separate aircrafts. The prototype spacecraft was also brought along to verify any last minute changes on the flight spacecraft and rehearse mating with the launch vehicle. Pre-flight preparations took approximately six weeks. The Thor Agena-B was on a test flight. Alouette was underweight at 320 lbs and the vehicle had to be ballasted for launch.

There were a number of launch delays due to Southern Pacific Railroad fruit trains which had the right of way and always arrived without warning, passing within 75 m of the launch pad. Furthermore, every time a launch was scheduled the 43 inhabitants of the nearby village of Surf had to be evacuated.

At launch there were two DRTE engineers at the NASA Fairbanks, Alaska ground station to confirm antenna extension and overall status of the satellite. A NASA ground station in Johannesburg and a ship in the Indian Ocean were to receive vehicle and satellite telemetry. Satellite telemetry was turned on at launch and kept on until injection into a near perfect 1000 km circular orbit at an inclination of 80.5 degrees to the equator. Fairbanks confirmed antenna extension and normal operation of the satellite and this was soon followed amidst much jubilation by the reception of the first ionograms at DRTE in Ottawa.

#### 5.0 Program Achievements

Within a few weeks of the launch of Alouette 1, it was clear that the satellite would provide the comprehensive and detailed data on ionosphere structure that was its primary mission. Alouette 1 ionograms taken one day, six years and ten years after launch are shown in Figs. 6 and 7 on the following page.

This posed the question of whether there should be an ongoing satellite program and, if so, what form it should take. Most of the skills and expertise responsible for the success of the satellite were in a government establishment, and not in industry. If Canada was to reap the full benefits of space technology it needed a strong domestic space industry. John Chapman took the lead in negotiating with NASA a follow-up program of scientific satellites, and took action to ensure that an increasing proportion of the design and construction work would be carried out in Canadian industry. This led to the International Satellites for Ionosphere Studies (ISIS) programme in which Canada and the U.S. shared the major costs for the construction and launching of four more satellites; three Canadian and one U.S. The U.K. and seven other countries actively participated through the provision of telemetry facilities and scientific analysis effort. The three Canadian satellites were Alouette 2 - a refurbished Alouette 1 flight spare spacecraft launched in 1965 along with a U.S. probe satellite, and two observatory satellites ISIS 1 and 2 launched in 1969 and 1971 respectively. The two observatory satellites were heavier and more complex than the two Alouettes, and were prime contracted and built in Canadian industry. They carried tape recorders, probe and particle experiments from the U.S. and the U.K., and in the case of ISIS 2, two optical experiments. The principal experiment in each was still the ionosphere sounder which was essentially an upgraded version of the Alouette 1 system plus a fixed frequency sounder.

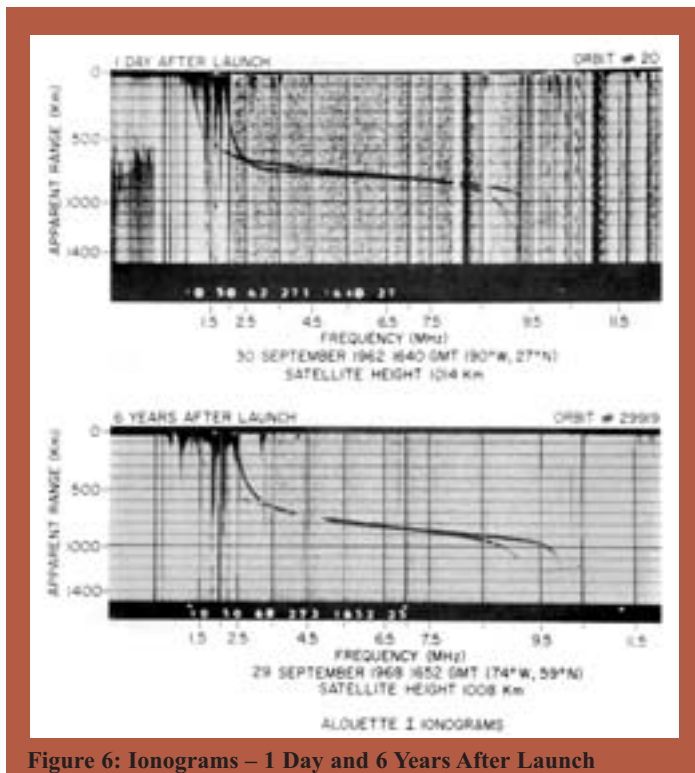


Figure 6: Ionograms – 1 Day and 6 Years After Launch

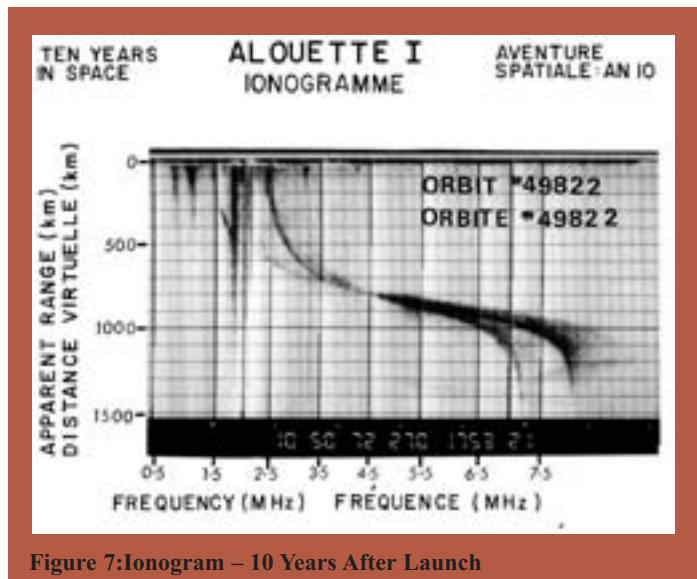


Figure 7: Ionogram – 10 Years After Launch

*N.Ed.:* This paper was also presented as the “McNaughton Lecture” on May 6, 2008, at the 21st Canadian Conference on Electrical and Computer Engineering. This followed the IEEE Canada Awards ceremony where the author received the IEEE Canada McNaughton Gold Medal in recognition of “outstanding contributions as a pioneer of the Canadian space program and a semiconductor circuit innovator”.

A further Canadian satellite in the series ISIS C was to study the higher regions of the ionosphere and magnetosphere out to 20 earth radii with 375 metre crossed dipoles. Planning was terminated on this satellite, to the great regret of the scientists and engineers involved, when the Canadian space program was redirected towards applications. It was necessary to wait 32 years for the next Canadian scientific satellite – the Canadian Space Agency (CSA) micro satellite MOST launched in 2003. This was followed also in 2003 with the much larger CSA ozone explorer SCISAT. Both satellites have been highly successful, are still fully operational, and are a further example of Canadian excellence in space science and engineering.

## 6. Conclusion

For ten years Alouette 1 provided scientific data that greatly extended our knowledge of the ionosphere and the earth’s upper atmosphere. The success of this project led to the creation of Telesat and the Canadian space industry and its expansion into Communications, Remote Sensing, Robotics for the NASA Shuttle and Space Station, and Satellite Aided Search and Rescue. The fact that Alouette 1 performed so well and beyond all expectations gave Canada an international reputation for excellence in satellite design and engineering.

## Acknowledgements

The author wishes to thank Louise Casavant and John Brebner of CRC for their assistance in preparing the figures and illustrations. Thanks are also due to Graham Booth and Friends of CRC for many background discussions on the Alouette 1 program and to Dr. LeRoy Nelms for his help on its early history. This paper is based on a presentation by the author at the IEEE International Milestone of Electrical Engineering Ceremony at CRC in 1993.

## Canadian Scientific Satellites

<p><b>Alouette 1</b> 1962 – 1972</p> <p><b>Alouette 2</b> 1965 – 1975</p> <p><b>ISIS 1</b> 1969 – 1990 loaned to Japan 1984-89</p> <p><b>ISIS 2</b> 1971 – 1990 loaned to Japan 1984-89</p>		<p><b>ISIS C</b> 1969 magnetosphere sounder (cancelled)</p> <p><b>MOST</b> 2003 micro satellite space telescope</p> <p><b>SCISAT</b> 2003 ozone layer explorer</p>
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### Satellite Performance: Alouette — ISIS Program

- Alouette-ISIS program was an immense scientific and technological success with more than 1200 papers and scientific reports published.
- Alouette 1 satellite designated by the Engineering Centennial Board of Canada in 1987 as one of the 10 most outstanding achievements in the history of Canadian engineering in the past 100 years.
- Alouette 1 satellite programme designated an “event of national historic significance” by the government of Canada in 2007.
- Alouette-ISIS program designated an IEEE International Milestone of Electrical Engineering, at a ceremony at CRC, Ottawa, May 1993.
- Proc. IEEE, *Topside Sounding & the Ionosphere* Special Issue, June 1969.
- Alouette 1 and 2 operated for 10 years before being turned off. The sounders and VLF receivers in ISIS 1 and ISIS 2 operated for 20 years. Gradual deterioration of batteries ended the operation of the satellites.

Background Photo: Launch of Alouette 1 on September 29, 1962 atop a Thor-Agena rocket



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## About the Author

**Colin A. Franklin** graduated M.Sc in Physics from Auckland University, New Zealand and Ph.D in Electrical Engineering from Imperial College, London. He was Chief Electrical Engineer for Canada's first satellite Alouette, Chief Engineer for the follow-on ISIS satellite program. He was subsequently Project Manager for the Department of Communications (DOC) Hermes Communications Technology Satellite, and Director General of Space Programs at DOC. He is a Member of the Order of Canada (CM), Fellow of the Royal Society of Canada, Fellow of the City and Guilds Institute of London and Senior member of the IEEE. His awards include the IEEE Canada McNaughton Gold Medal, the Julien C. Smith Medal from the Engineering Institute of Canada, the John H. Chapman Award of Excellence from the Canadian Space Agency, and the Alouette Medal from the Canadian Aeronautics and Space Institute.



## Book Review / Revue de livre

# Switch-Mode Power Supplies: SPICE Simulations and Practical Designs

*Author:* Christophe P. Basso

*Publisher:* McGraw-Hill Professional

*ISBN-10:* 0071508589

*ISBN-13:* 978-0071508582

*No. of pages:* 889

**T**his book covers the operation, analysis, computer simulation and practical design issues for commonly used switching power converters, for both non-isolated and isolated converter topologies.

The book is suitable for both entrance level and experienced power supply designers. It covers materials and knowledge from very basic operation to advanced design methodologies for switching power supplies. In the book, the simulation is used as a tool to analyze the steady state and dynamic performance of switching power converters.

The biggest advantage of the book is the practical design. The reader can learn all aspects of designing a switching mode power supply. The book discusses the steady state operation of power topologies and the voltage and current stresses, which is very important for selection of suitable power devices. More importantly, the book explores in very detail the small signal dynamic models of switching converters under commonly used control methods, such as voltage mode control, current mode control. In addition, the book provides several practical start-up circuits for switching power supplies under different operating conditions, which is often ignored by most books and designers. Similarly, the book provides several methods for over current protection.

*Review by Yan-Fei Liu, University of Ottawa*

Another advantage of the book is that it provides methodologies to design a compensation network in order to achieve a desired closed loop dynamic performance. These methods are step by step and practical. For example, the book provided a procedure to design the feedback compensation network based on several design methods, such as K factor method, Pole-Zero placement method.

In addition, the book spends quite some pages discussing the analysis and design of inductors and transformers, as well as the characteristics of capacitors used in switching power supplies, which are generally a weakness for a lot of power supply designers.

Besides the commonly used, general purpose Spice software, the book also introduces two other software packages, PSIM and SIMPLIS, which are specifically designed for simulation of switching power supplies.

The CD ROM coming with the book provides a lot of simulation examples and design files so that the reader can use the methods introduced in the book directly to significantly expedite his / her design.

In summary, the book is the most practical and useful book in switching power supply field I am aware of. It is a must-have for the vast majority of people who will analyze and design switching power supplies. The book is also a good reference for marketing and business development personnel to understand the high level technical challenges facing the power supply industry.





## Pinawa Hydroelectric Power Plant, IEEE's Latest Milestone

**T**he name Pinawa comes from the Cree Indian word for "Sheltered Waters". In 1906, the population of Winnipeg was close to 100,000 and expanding rapidly, and the Winnipeg Electric Railway Company had about 35 streetcars in operation along with some streetlights and a few domestic and business customers. Until then, costly electricity was being supplied by a coal burning steam plant located in Winnipeg. Because electric streetcar transportation was the major growing load, the company decided to meet this challenge with the supply of low cost hydroelectric power from the Winnipeg River some 65 miles to the northeast. The plant was located on a natural diversion channel of the Winnipeg River, away from the main stream.

When the decision was made to develop Pinawa, very little was known about construction in the northern wilderness – or the effects of frazil ice on the operation of a plant this size in winter temperatures that could drop to around minus 40 °C.

An examination of the engineering details of the project reveals how simple the installation really was. Most features were manually operated. This included equipment such as intake gates and valves as well as, of all things, the 25-ton powerhouse crane that was operated by hand-chains! Lighting was limited to one 100 watt incandescent bulb located beside each governor and illumination at a few other important locations. Emergency lighting consisted of kerosene lamps.

Construction of the plant was also very basic. With the exception of the steam-operated derricks, shovels, and drills, there were no other machines; just real horsepower and manpower. Rock drillers were paid 15 cents an hour. Approximately 75 teams of horses were on site, and that required handlers, blacksmiths, and a plentiful supply of fodder.

Because of rapid load growth in the 1920s, plans were made to accelerate for a 1931 in-service date the construction of the Seven Sisters

by *Lindsay Ingram and Manitoba Hydro Public Affairs*

### Abstract

The IEEE recognized in June 2008 the Pinawa Hydroelectric Power Project, located near Winnipeg (Manitoba), as a Milestone in Electrical Engineering and Computing. This 14 MW, 60 kV plant was a pioneer in cold climate power infrastructure building and operation. Canada has now eight IEEE Milestones, including two in Winnipeg Section for power installations - the other one being for the Nelson River HVDC Transmission System, 1972.

### Sommaire

Le IEEE a reconnu en juin 2008 la Centrale hydroélectrique Pinawa, située près de Winnipeg (Manitoba), en tant que Jalon du génie électrique et informatique. Cette installation de 14MW, 60kV a été pionnière dans la construction et l'opération d'infrastructure électrique en climat froid. Le Canada a maintenant huit jalons de l'IEEE dont deux dans la section de Winnipeg pour des installations électriques - l'autre étant pour le Réseau de transport d'électricité CCHT de la rivière Nelson, 1972.

hydroelectric plant on the main flow of the Winnipeg River. This comparatively gigantic station was rated at 165 MW. This would have meant the end of Pinawa since its diverted water flow would have been required for the more efficient Seven Sisters plant. But in 1931 it became evident that the Great Depression had gripped North America, and consequently work on the completion of the new plant was brought to a halt. Pinawa was then given a life extension and allowed to continue operation for another 20 years. Furthermore, its head was raised from 32 feet to 46 feet with modest changes, thereby increasing the output to 22 MW. Pinawa was retired in 1951 after a total life span of 45 years when Seven Sisters was finally completed.

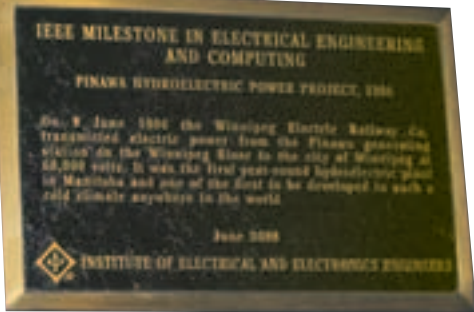
Looking every bit like a two thousand year-old Roman aqueduct, the concrete remains are on display to the public and are in the custody of the Manitoba Department of Culture, Heritage, and Tourism.

### About the Author

Lindsay Ingram is a retired Director of the System Planning Division with Manitoba Hydro where he spent 33 years. In retirement, he became Interim Director of the Manitoba HVDC Research Centre followed by consulting assignments. He is a Life Member of the IEEE, the Association of Professional Engineers and Geoscientists of the Province of Manitoba, and the Canadian Society for Senior Engineers (CSSE/EIC).



The Pinawa dam—some 65 miles to the northeast of Winnipeg—is located on a natural diversion channel of the Winnipeg River. With the onset of the Great Depression, planned expansion of the Seven Sisters hydroelectric plant was put on hold, giving Pinawa a life extension of 20 years. With modest changes its head was raised from 32 feet to 46 feet, thereby increasing the output from 14MW to 22 MW.



## *Pinawa IEEE Milestone Dedication Ceremony—June 6, 2008 Manitoba Electrical Museum, Winnipeg*

Following the IEEE Milestone dedication in 2005 for The Nelson River HVDC Transmission System, the first such landmark in Winnipeg Section, The Institute of Electrical and Electronic Engineers (IEEE) History Center recently recognized The Pinawa Hydroelectric Power Plant as a pioneering development. The Manitoba Electrical Museum located in Winnipeg was the site of the Milestone Dedication Ceremony on June 6th 2008. Members of the IEEE Winnipeg Section, Manitoba Hydro staff, consultants and historical groups, and representatives of other organizations were in attendance. Dr. Ferial El-Hawary,

President of IEEE Canada, Wanda Reder and Patrick Ryan, respectively President and Executive Director of the IEEE Power & Energy Society, unveiled a commemorative plaque, the main content of which reads:

### *IEEE MILESTONE IN ELECTRICAL ENGINEERING AND COMPUTING*

*On 9 June 1906 the Winnipeg Electric Railway Co. transmitted electric power from the Pinawa generating station on the Winnipeg River to the city of Winnipeg at 60,000 volts. It was the first year-round hydroelectric plant in Manitoba and one of the first to be developed in such a cold climate anywhere in the world. June 2008*



Ferial El-Hawary and Winnipeg-based IEEE Life Member Lindsay Ingram share a proud moment following the dedication of the Milestone Plaque. Winnipeg Section now hosts two Milestones - the other being for the Nelson River HVDC Transmission System, 1972.



Engineering details of the Pinawa powerhouse were frugally designed: A 25-ton crane was operated by hand-chains and lighting was limited to one 100-watt incandescent bulb located beside each governor and illumination at a few other important locations.



# Laboratoires-sur-puces

## Une nouvelle technologie de diagnostic cellulaire et moléculaire

### 1.0 Introduction

**L**a technologie de laboratoires-sur-puces (Laboratory-on-Chip – LoC) a un avenir prometteur parmi les microsystèmes dédiés à la détection, la mesure et l'analyse rapide et automatique d'une multitude d'applications biomédicales et environnementales. Une plateforme de LoC comprend généralement une partie microfluidique, des électrodes de détection et des interfaces microélectroniques. La figure 1 illustre une configuration de LoC où la section transversale d'un microcanal est située directement au-dessus d'une électrode de détection d'un circuit CMOS (complementary metal-oxide semiconductor). Des composants microfluidiques telles les microcanaux, microvalves et micropompes, dirigent et manipulent de petites quantités de fluides biologiques ou biochimiques. L'intégration des microsystèmes regroupant de structures microfluidiques et microélectroniques est un domaine en plein essor. Les travaux de pointe y portent sur la microfabrication de structures microfluidiques comme partie intégrante du procédé de fabrication microélectronique, plutôt qu'elles soient rajoutées aux puces a posteriori.

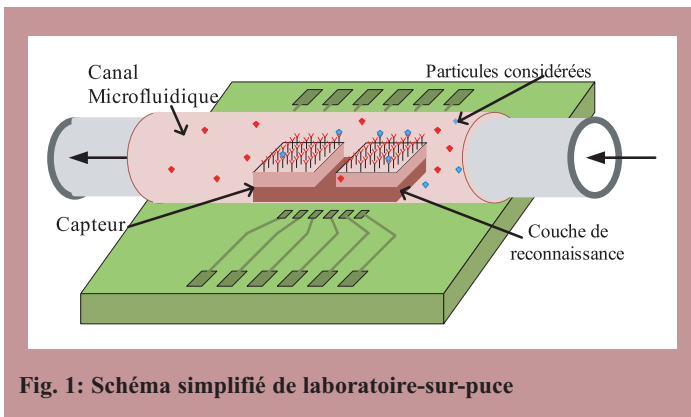


Fig. 1: Schéma simplifié de laboratoire-sur-puce

Parmi quelques exemples d'intégration hybride regroupant des composants microfluidiques et microélectronique, notons:

- Rasmussen et al: canaux microfluidiques sur une puce fabriquée avec des procédés conventionnels de micro-usinage de surfaces [1].
- Masteranglo et al: micro-usinage de surfaces polymères pour fabriquer les canaux microfluidiques sur la surface d'un circuit intégré CMOS [2].
- Chartier et al: méthode de fabrication d'une structure microfluidique intégrée sur une puce CMOS, basée sur les polymères et utilisant une technique de gaufrage à chaud [3].

La fabrication des composants microfluidiques requiert une attention particulière dans le cas des LoC utilisant la technologie CMOS afin de protéger le circuit électrique des produits biologiques et biochimiques. Idéalement, l'encapsulation microfluidique doit être le résultat d'un procédé à basse température avec des connections fluidiques fiables et hermétiques. La fuite des produits hors des composants microfluidiques risque d'augmenter les résistances et/ou les capacités parasites et modifiera par conséquent les caractéristiques du circuit. Aux références [4] et [5] nous proposons un procédé de fabrication microfluidique par écriture directe (PFED); ce procédé robotisé est utilisé pour fabriquer et intégrer les microcanaux sur la surface d'un circuit intégré CMOS contenant des capteurs capacitifs dédiés.

Les capteurs capacitifs CMOS ont récemment attiré l'attention des chercheurs qui utilisent des LoC pour des tests biochimiques, tel que la détection d'antigènes par liaison d'anticorps. Entre autres, la détection de virus [6], l'analyse cellulaire [7], la reconnaissance de l'ADN [8] et l'interception de la multiplication de cellules [9] ont été démontrés. La figure 2 représente schématiquement la configuration utilisée pour détecter de multiples cellules; elle regroupe des électrodes, un circuit d'interface et un ordinateur pour l'acquisition. Les applications de LoC complètement intégrées de la sorte exigent l'emploi d'un capteur capacitif hybride incluant un circuit d'interface et une électrode de détection

by Ebrahim Ghafar-Zadeh<sup>1</sup>, Mohamad Sawan<sup>1</sup>, Daniel Therriault<sup>2</sup>, Amine Miled<sup>1</sup>

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### Sommaire

Nous présentons dans cet article la conception, l'implémentation et la validation d'un microsystème de laboratoire-sur-puce utilisé pour la détection biologique. Ce microsystème est composé de capteurs capacitifs intégrés sur une puce microélectronique CMOS ainsi qu'une structure microfluidique fabriquée directement sur la surface de ces capteurs. Des résultats expérimentaux de détection sont rapportés pour valider la technique proposée.

### Abstract

In this paper, we present the design and implementation of a lab-on-chip system for biological detection purposes. This system consists of a microfluidic structure integrated atop of a capacitive sensor fabricated through standard CMOS technology. The experimental results are also demonstrated in order to show functionality of proposed system for Lab-on-chip applications.

fonctionnalisée. Pour cette fin, nous proposons dans cet article une matrice de capteurs capacitifs fabriquée par le procédé CMOS et intégrée à des canaux microfluidiques [10].

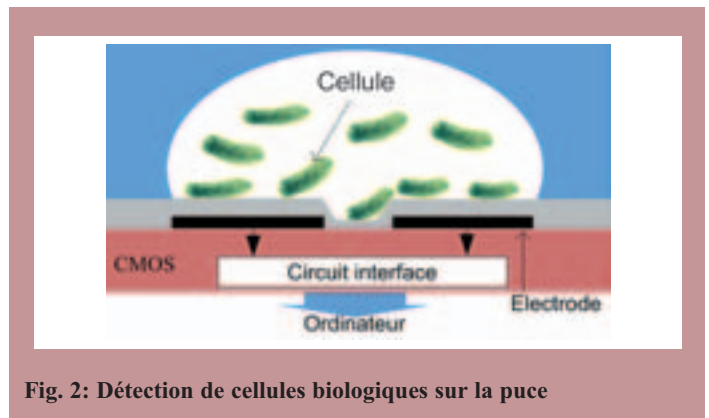


Fig. 2: Détection de cellules biologiques sur la puce

Différentes techniques de prélèvement de données ont été publiées pour des systèmes de capteurs capacitifs autonomes tels les accéléromètres basés sur des systèmes microélectromécaniques (MEMS). Les capteurs capacitifs utilisés dans les LoC n'exigent pas la détermination d'une seule valeur unique pour la capacité de détection, et il est primordial d'étudier le comportement du dispositif en présence de produit dans le microcanal. Dans la plupart des applications, les valeurs des capacités statiques avant et après l'injection du produit sont déterminées à partir des mesures dynamiques des capacités [11]; des techniques utilisant une valeur moyenne des capacités des sorties variant entre 1 fF et 1 pF sont souvent employées. Cette approche simple et efficace est un atout pour la conception et l'implémentation de grandes matrices de capteurs capacitifs [12]. En effet, l'implémentation d'une grande matrice de capteurs sur une seule puce nécessite la mise en œuvre d'un circuit compact et de faible complexité pour chaque capteur dans l'architecture matricielle, et cette contrainte nous empêche d'utiliser des amplificateurs opérationnels pour notre circuit étant donné la grande surface qu'ils occupent.

La mesure de la capacité basée sur la charge (MCBC) est une méthode simple proposée pour la première fois en 1996 pour les mesures de capacités d'interconnexions inférieures à un femto-Farad dans les puces

CMOS [13]. À cause de sa faible complexité, de sa haute précision et de la surface réduite utilisée, cette méthode de mesure statique s'est avérée être la meilleure alternative pour la conception de capteurs capacitifs de LoC. Parmi les rares travaux de MCBC pour les capteurs capacitifs, Guiducci et al ont réussi à détecter l'ADN par le biais de circuiterie externe à la puce et d'électrodes intégrées [14].

## 2.0. Circuit MCBC et interface

Plusieurs architectures dédiées aux capteurs capacitifs sont élaborées dans cette section. L'unité de base du circuit d'interface (UCI) proposé est illustrée à la Fig. 3. Dans ce circuit, un miroir de courant composé de transistors  $M_3$  et  $M_4$  est utilisé pour détecter et amplifier le courant de charge ( $I_S$ ), qui est converti en tension dans le condensateur d'intégration ( $C_{in}$ ) [11]. Lorsque le signal  $\phi 1$  est au niveau bas, la tension  $V_{out}$  commence à augmenter selon l'équation (1)

$$V_{out} = \frac{W_4/L_4}{W_3/L_3} \frac{\Delta C}{C_{in}} (V_{dd} - V_{TP}) + V_{off} \quad (1)$$

où  $W_3/L_3$ ,  $W_4/L_4$  et  $C_{in}$  sont respectivement les rapports largeur/longueur de  $M_3$ ,  $M_4$  et du condensateur d'intégration. Le décalage en tension ( $V_{off}$ ) est généralement causé par un défaut de symétrie dans les miroirs de courant et des circuits MCBC. Pour réduire l'effet de cette erreur, un miroir de courant ajustable est utilisé. Pour chaque entrée numérique D1-m, un courant ( $I_R$ ) est tiré des transistors  $M_{C1}$ - $M_{Cm}$ . Les rapports largeur/longueur de ces transistors sont déterminés par

$$\frac{W_{13}}{L_{13}} = 2 \cdot \frac{W_{C1}}{L_{C1}} = 2^2 \cdot \frac{W_{C2}}{L_{C2}} \dots = 2^m \cdot \frac{W_{Cm}}{L_{Cm}} \quad (2)$$

Tel qu'illustré à la Fig. 3, un miroir de courant à large excursion de tension ( $M_5$ - $M_{10}$ ) est utilisé pour améliorer l'excursion de la tension de la sortie  $V_{out}$  et pour réduire les imperfections de  $C_{in}$  – notamment pour les impulsions d'horloge à basse fréquence. Par ailleurs,  $M_{14}$  et  $M_{15}$  forment un amplificateur à source chargée qui isole le nœud d'intégration des capacités parasites des étages subséquents. Nous notons que la tension  $V_{off}$  est éliminée automatiquement par la soustraction de deux mesures consécutives précédant et suivant l'injection du produit. Donc, cette tension n'a aucun effet important sur la précision de la détection capacitive.

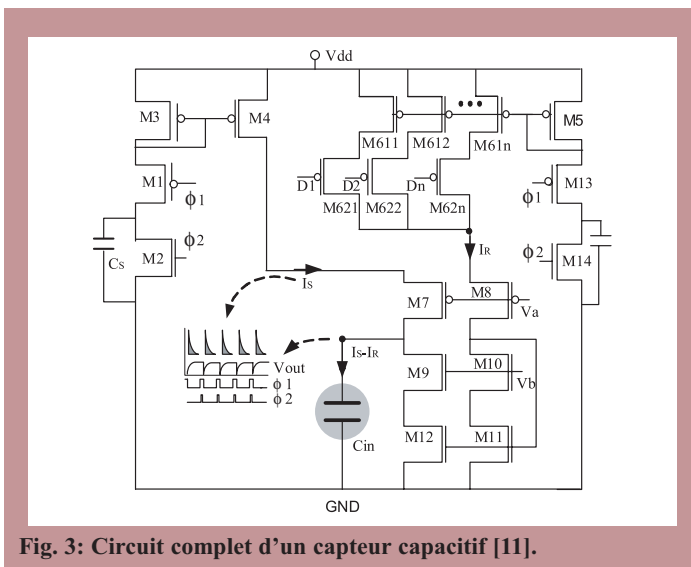


Fig. 3: Circuit complet d'un capteur capacitif [11].

## 3.0. Procédé de fabrication microfluidique

Le procédé de fabrication microfluidique par écriture directe (PFED) utilisé ici comporte trois étapes principales (Fig. 4). Initialement, les fils conducteurs de la puce doivent être recouverts pour éviter le contact direct avec les fluides dans les canaux (Fig. 4a); une résine d'époxy par-

tiellement polymérisée est versée sur la puce pour encapsuler les fils de connexion. Ensuite, l'encre organique ayant une consistance de pâte est extrudée à travers une micro-aiguille pour être ensuite déposée sur le substrat; nous avons utilisé une station Ultra 2400 de EFD Inc\*. Lors de l'extrusion, un robot de micro-positionnement I&J 2200 (de I&J FIS-NAR Inc.) déplace l'aiguille selon la trajectoire désirée. La figure 4b montre un simple filament d'encre déposé au-dessus d'une électrode de détection.

À la suite du procédé de déposition de l'encre, les tubes et autres connecteurs fluidiques sont placés et fixés aux endroits désirés sur la puce avec quelques gouttes de colle thermo fusible (Fig. 4b). Une déposition additionnelle d'encre des tubes est nécessaire pour remplir l'espace entre le filament d'encre et assurer la connexion fluidique. Un barrage d'encre est déposé afin de délimiter la zone d'encapsulation, et une résine d'époxy à faible viscosité est versée à l'intérieur de la zone d'encapsulation; sa polymérisation s'effectue à température ambiante pendant 24 heures (Fig. 4c). Ce procédé d'encapsulation d'époxy crée un lien rigide et hermétique sur la surface irrégulière de la puce sans boîtier. L'encre fugitive est fondue à  $\sim 75^\circ\text{C}$  et retirée sous une faible pression à vide ou sous une pression d'air. Finalement, de l'eau chaude est injectée dans le canal pour enlever les derniers résidus d'encre. Suite à cette étape, une solution peut être injectée directement dans le microcanal fabriqué sur la puce microélectronique pour des fins de détection. Fig. 4d montre le LoC fabriqué avec les connexions d'entrée et de sortie aux micro-tubes.

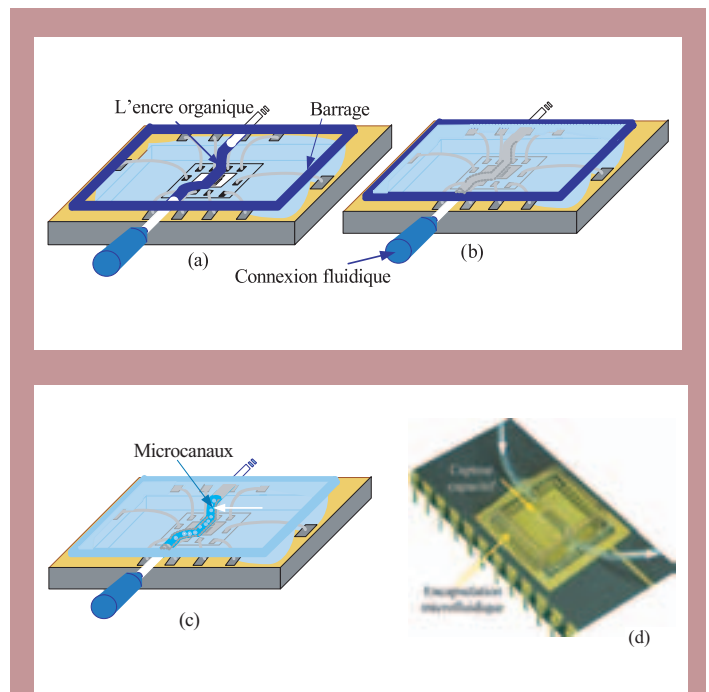


Fig. 4: Fabrication microfluidique par écriture directe: (a) encapsulation des fils conducteurs, déposition de l'encre organique et connexions avec les micro-tubes, (b) encapsulation de l'encre à l'intérieur de la zone délimitée, (c) l'encre fugitive est fondue et retirée, et (d) LoC fabriqué et connexions fluidiques.

## 4.0. Résultats Expérimentaux

Des puces microélectroniques intégrant des capteurs ont été fabriquées par la Taiwan Semiconductor Manufacturing Company (TSMC) avec le procédé CMOS 0,18 micron. En utilisant le procédé, les microcanaux fluidiques sont créés sur la surface des puces renfermant les capteurs. Un microscope stéréoscopique est utilisé pour observer la solution qui est injectée par une pompe seringue à l'entrée du canal microfluidique. L'oscilloscope (modèle TD57154 de Tektronix) nous permet de suivre l'évolution du  $V_{out}$  périodique (Fig. 5). Cette tension peut être utilisée à des fins de détection. La tension  $V_{out}$  générée lors de l'introduction des solvants organiques est tracée à la Fig.6; la variation de tension  $V_{out}$  est fonction des propriétés diélectriques. Le même système de capteur

\* Les noms d'appareils cités dans ce texte sont des marques déposées de leurs fabricants respectifs.



capacitif peut être utilisé pour détecter d'autres solutions particulières en appliquant une couche spécifique au capteur capacitif; cette partie du projet est en cours de développement.

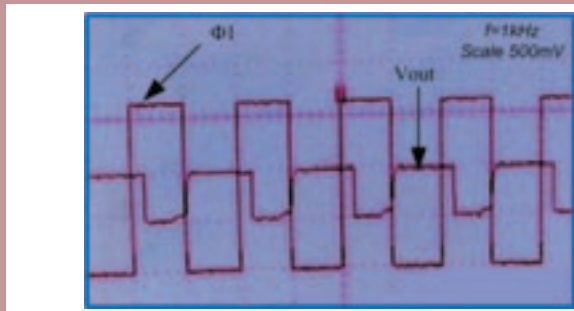


Fig. 5: La tension  $V_{out}$  mesurée à la sortie du capteur (voir Fig. 3).

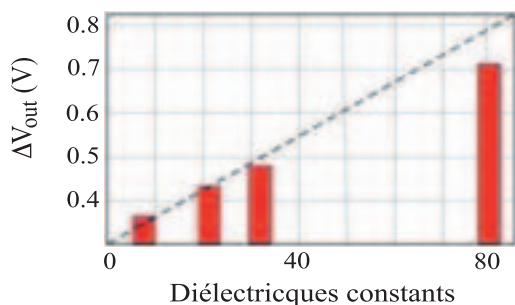


Fig. 6: Détection microfluidique sur puce.

## 5.0. Conclusion

Un circuit MCBC à complexité réduite et à haute précision a été utilisé pour un capteur capacitif CMOS intégré. Les capteurs capacitifs utilisés ont été implémentés en utilisant un procédé CMOS 0,18 micron pour la détection, et nous avons réalisé avec succès la détection microfluidique sur puce.

Le dispositif proposé pourrait être utilisé pour d'autres applications comme la surveillance de produit dans le canal, la microfluidique numérique, la détection cellulaire par analyses anticorps-antigènes, les micromatrices d'ADN complètement électroniques, ainsi que la détection de gaz chimique et de solvant organique pour la surveillance environnementale. Les circuits d'interface proposés offrent de bonnes alternatives aux matrices de capteurs capacitifs complètement intégrées qui sont indispensables pour les laboratoires-sur-puces. Nous travaillons actuellement à mettre en oeuvre autres circuits basés sur cette même méthode MCBC pour encapsuler le système capteur entier dans la même puce.

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# Intelligence Aloft

## Robust, Autonomous, Off-the-Shelf UAV Teaming

### 1.0 Introduction

owing to their distinct features and capabilities, unmanned vehicles are rapidly expanding into a wide variety of roles from Search and Rescue to resource surveys [1,2,3,4,5,6] to traffic monitoring [7] and combat systems [8,9] and other security applications [10,11,12]. As UAV systems continue to gain acceptance, demand grows for improved performance from the platforms. In particular, Unmanned Aerial Vehicle (UAV) platforms and systems are getting increasingly sophisticated and technically capable. However, in the vast majority of these devices, the computational resources are primarily located on the ground within the Ground Control Station (GCS) with little processing of sensor capabilities or true autonomy\* being found onboard the airframe itself. In order to truly avail users of such obviously capable systems, the computational resource focus should shift from the ground to the aircraft and the ability to operate autonomously in concert with other vehicles needs to be paramount.

The focus of the Quanser Cooperative Control Framework (QCCF) described in this paper is to provide a system whereby cooperative and multi-agent control schemes for UAVs can be rapidly generated, simulated, evaluated and executed on real hardware. The use of off-the-shelf hardware is also a key objective. The QCCF system is an extension of the development undertaken on other vehicle systems where the emphasis was on designing controllers without extensive avionics involvement [13,14]. Missions are programmed diagrammatically using Matlab Simulink with specific blocks designed by Quanser for vehicle operation, communications and cooperative tools. This is achieved while at the same time reducing the burden of vehicle and communications specific programming on the mission and control designer through a set of abstractions. Simulink control diagrams can then be executed and simulated using vehicle models integrated in the framework. Following successful simulation, the diagram can then be automatically converted to low-level executable code. The code is sent to the vehicle and the multi-agent mission is executed.

A variety of UAV simulators exists, each of which has particular suitability for given classes of problems [15,16,17]. However, these systems are often designed solely for synthetic environments and are thus difficult to apply to real vehicle systems

Other vehicle simulation packages such as the Aerospace [18] & Aerosim [19] blocksets provide the ability to graphically design controllers in Simulink but are primarily designed for simulating vehicle response and not multi-agent behavior. Multi-UAV packages exist such as that pro-

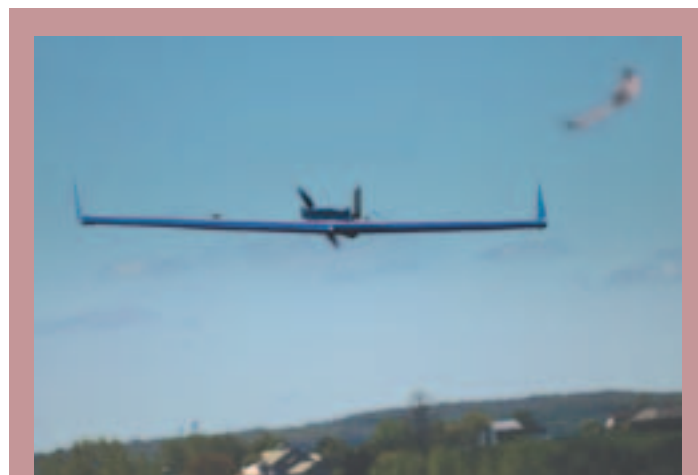


Figure 1: A pair of autonomous aircraft on landing approach following a cooperative mission.

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### Abstract

Unmanned Aerial Vehicles (UAVs) are gaining popularity across a broad spectrum of applications and fields. Two features with the potential to make very high-value contributions are autonomy and teaming. Current systems are usually operated individually and incorporate little or no autonomy in the flight control and even less in the mission level and communications components.

In order to address the lack of a scalable environment whereby teaming missions could be designed for multiple autonomous aircraft, the Quanser Cooperative Control Framework (QCCF) is being developed. The goal of this system is to develop a robust, portable, multi-agent cooperative control rapid prototyping environment for unmanned aircraft. This environment will enable high-level Decision Making and Control design for multi-vehicle control, high-fidelity simulation and seamless integration on any real Commercial Off-the-Shelf (COTS) UAV system. Real flight hardware has been included for evaluation of algorithms using the QCCF. This will allow the demonstration of effective multi-vehicle cooperative control operations from simulations to heterogeneous COTS UAV teaming. The framework is open with existing modules (such as vehicle models) available for use as templates for the addition of user-supplied components.

### Sommaire

Les drones ou avions sans pilotes (unmanned air vehicles - UAV) gagnent en popularité à travers un large spectre d'applications et de domaines. Deux caractéristiques ayant un potentiel de contribution scientifique très élevé sont l'autonomie et le travail coopératif. Les systèmes actuels sont généralement exploités individuellement et avec peu ou pas d'autonomie dans la gestion du vol et encore moins au niveau de la mission et des composants de communication.

Afin de remédier à l'absence d'un environnement évolutif par lequel des missions où de multiples drones autonomes coopérant ensembles pourraient être conçus, le cadre de travail en coopération de Quanser (QCCF) est en cours d'élaboration. L'objectif de ce système est de développer un environnement de prototypage rapide, solide, portable de multi-agents de contrôle de coopération pour les drones. Cet environnement permettra la prise de décision et le contrôle de haut niveau pour la conception multi-contrôle du véhicule, une simulation haute-fidélité et de l'intégration sans faille sur un véritable drone commercial prêt-à-utiliser (Commercial-Off-The-Shelf - COTS). Du véritable matériel de vol a été intégré pour l'évaluation d'algorithmes utilisant les QCCF. Cela permettra la démonstration de l'efficacité du contrôle des opérations de plusieurs drones en coopération à partir des simulations de travail coopératif de drones COTS hétérogènes. Le cadre de travail permet l'utilisation de modules existants (tels que les modèles de véhicules) disponibles pour utilisation comme modèles pour l'ajout de composants fournis par l'utilisateur.

duced by the US Air Force Research Laboratory or the UAV Engineering Simulator by OPAL-RT but again these are focused on simulations of vehicles and provide no interface to real hardware or vehicles.

\* In this case, autonomy refers to the ability to modify vehicle and flight behaviour in real-time based on locally (onboard) processed information rather than merely following a set of predetermined actions in the event of loss of ground-vehicle communications or similar behaviour.



## 2.0 The Quanser Cooperative Control Framework Concept

The QCCF is designed to readily facilitate the development of autonomous multi-agent UAV missions. As such, a number of the features of the system are primarily focused on ease of mission design and integration. This is based on a series of simple tool blocks that users can include in order to realise their own algorithms and mission scenarios. Conceptually, the system is designed such that the following steps are undertaken in order to design, simulate, launch and monitor a mission:

1. Open the mission design environment - for the QCCF, the current design environment is Matlab/Simulink
2. From the Quanser Toolboxes utilise base-level vehicle control using the QCCF Vehicle Abstraction Layer (VAL) blocks to enable fundamental vehicle behaviours (launch, fly-to-target, maintain designed flight track, land, etc.)
3. Add intervehicle communications using the QCCF toolbox
4. Add vehicle sensor blocks and mission data storage and data sharing
5. Design a multi-agent mission using these blocks and user generated algorithms, tools, diagrams etc.
6. Select the desired off-the-shelf UAV system of choice including flight stabilisation hardware (i.e., a UAV autopilot)
7. Repeat step 6 for each successive vehicle in the mission
8. Simulate the mission
9. Generate code for the selected hardware (which is then automatically downloaded to the vehicles)
10. Deploy the vehicles (i.e., press “Start” and monitor the mission progress).

## 3.0 Software Development and Simulation

The current software development, based on the Quanser real-time rapid prototyping environment, QuaRC, has focused on three key areas: the Vehicle Abstraction Layer (VAL) which allows a user to generate mission level commands to a vehicle (and simulate the vehicle) without needing extensive vehicle modeling, Vehicle Communications which will enable dynamic inter-vehicle communications, and Code Generation which then automatically generates suitable code for execution on the vehicle from the Simulink (or other) multi-agent control environment including the feature mentioned previously.

### 3.1. Vehicle Abstraction Layer (VAL)

To facilitate straightforward development of mission-level scenarios, the QCCF provides a Vehicle Abstraction Layer (VAL) comprised of vehicle control primitives (for example, loitering, events, flight-path following). The VAL primitives are designed such that the mission designer does not need aerodynamic modeling or avionics expertise. Instead, the high level commands are interpreted by the VAL and communicated to the vehicle autopilot(s). Similarly, during simulation, rather than generating code for execution on the vehicle, the high level commands interface with a mathematical model of the vehicle. From the designer's point of view, the same primitives are used for simulation and actual flight, making it easy to move from simulation to hardware flight tests and shortening the mission development cycle. The VAL framework also allows for simultaneous execution of real-vehicle flight and vehicle simulations (including simulations executing on the vehicles themselves during flight), which is useful for fault detection or predictive control algorithms.

From within Simulink, the VAL is comprised of tool blocks allowing direct porting of simulated algorithms to any supported vehicle/autopilot in a multi-threaded environment. The designer then works with these high-level mission command blocks only, precluding the necessity of low-level vehicle dynamics and stability control. The VAL's open framework allows the addition of new vehicle and autopilot drivers, which can then be used to simulate and fly missions using the VAL blockset.

### 3.2. Vehicle Network and Communications

Of crucial importance to any multi-agent scheme is the concept of inter-vehicle communications. In the case of a group of autonomous aircraft, special care must be taken to support the vehicles' ability to fly in and out of the communications network and still maintain the integrity of the

network amongst remaining vehicles. The QCCF allows for dynamic team composition and configuration with agents able to share sensor information, messages, and mission level task information.

Specific communications hardware selection is open to different devices. Currently, the QCCF supports on-board WiFi for inter-vehicle communications and long-range/low-bandwidth radio modems for status and ground monitoring. However, other devices are readily integrated with devices such as ZigBee or Bluetooth as well as more specific or proprietary communications readily supported.

### 3.3. Code Generation

The code generation functionality allows for all of the previous tools to be executed not just in simulation, but also on the vehicles themselves. This is achieved by automatically generating and compiling suitable code for execution on the vehicles. It should be noted that this process will still provide all of the functionality of the original Simulink diagram during mission execution with the ability to modify gains or view any signal in the original diagram within its own window.

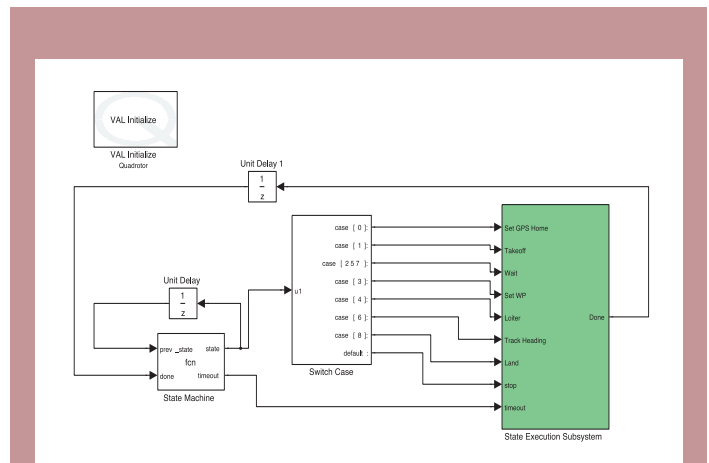


Figure 2: State machine diagram for flight simulation.

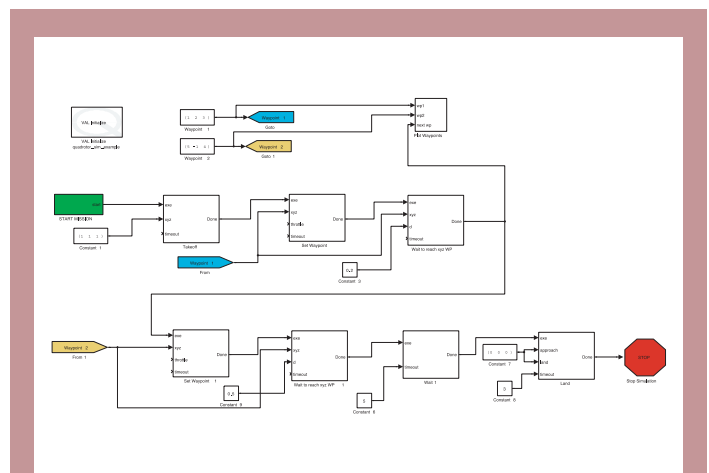


Figure 3: Sequential mission programming diagram used for flight simulation.

## 4.0 Simulation Results

Using the VAL blockset, missions can be quickly developed and simulated in Windows without the need of any additional vehicle hardware. In simulation, the VAL blocks automatically interface with a driver containing a mathematical model of the chosen vehicle rather than autopilot hardware, which also allows simulations to be run at a much higher sampling rate (e.g., 1kHz or more) than real-flight missions.

There are several techniques that can be used to develop mission scenarios within Simulink. One technique is to construct a finite state

machine that conditionally executes the various VAL primitives, and directly commands the corresponding autopilot/simulator actions. This technique has the drawback that it is cumbersome to add and remove mission states, and the user requires a more advanced knowledge of Simulink to program the mission. Figure 2 shows an example block diagram for such a state machine.

Another technique for developing missions is to use a set of VAL blocks that can be chained together in series, creating a sequence of mission steps. Figure 3 shows a block diagram using sequential mission blocks. This approach is more user friendly than the state machine design and is easily reconfigurable. Figure 4 shows the X, Y, and Z vehicle coordinates of a simulated vehicle flight using the sequential mission programming approach.

With the flexibility of the Simulink environment, there are virtually limitless ways to develop missions. The VAL greatly simplifies the task of communications with the vehicle autopilots and simulation models, allowing the mission designer to focus on high-level mission control.

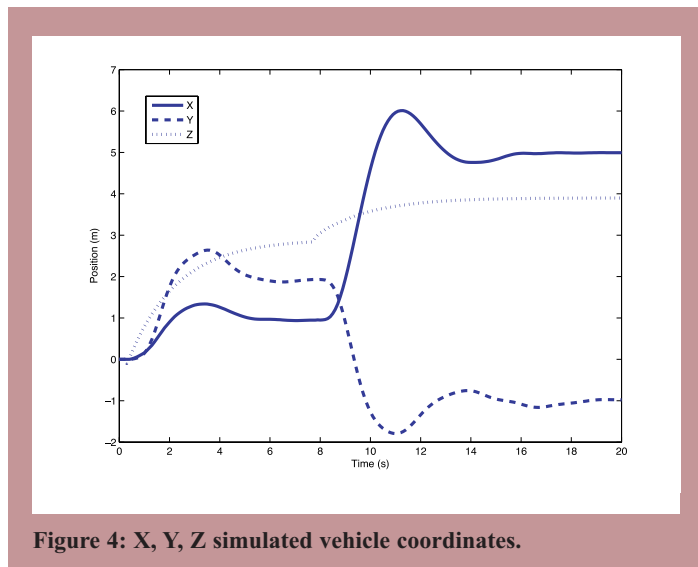


Figure 4: X, Y, Z simulated vehicle coordinates.

### 5.0 Hardware and Flight Results

Once a multi-agent mission controller has been designed, executable code is then automatically generated for transmission and execution on the vehicles themselves. In order to accomplish this, a high-level processor is integrated on the vehicle and communicates with the on-board autopilot. The control code is run on this high level processor which then converts specific mission and flight commands into protocols appropriate to the on-board autopilot. In this way, any supported autopilot (and, by extension, any vehicle supported by that autopilot) can be readily integrated into the multi-agent network.

Current vehicles that are supported by the QCCF (through the VAL) in both simulation and real hardware include fixed wing aircraft and autopilots from Procerus, rotary and fixed wing aircraft from Draganfly as well as vehicles designed in-house at Quanser such as the ALTAV (Almost-Lighter-than-Air-Vehicle) Mk II hybrid vehicle.

Flight experiments have taken place at the University of Toronto's Joker Hill Ecological Preserve and include cooperative communications through a flexible and dynamic network and coordinated flight with aircraft sharing error information to accurately match to a flight trajectory. In addition, on-board vision processing is used to identify and localize targets on the ground during flights and this information is used to develop flight path information for other vehicles including rotary wing VTOL aircraft and unmanned ground vehicles.

Using the same Simulink models developed for vehicle simulation, actual flight tests can be performed simply by turning off a "simulate" flag or a new mission can be designed using the VAL blockset. During flights, the QuaRC Console displays messages printed from QuaRC Print blocks running on the on-board vehicle processor, which can be used to communicate the current state of the mission and any other data pertinent to the operator. Various Simulink plotting tools allow the operator to view the position and orientation of the vehicle during flights as shown in Figure 5.

Data storage blocks can be connected to pertinent signals to save mission data (including vehicle state, waypoints, command executions, etc) to files on the target vehicle and/or the host computer. This is important for mission designers to keep records of flight tests. The data saved from flight tests can then be replayed in simulation, allowing the designer to analyze the mission performance and make alterations and improvements to the mission model.

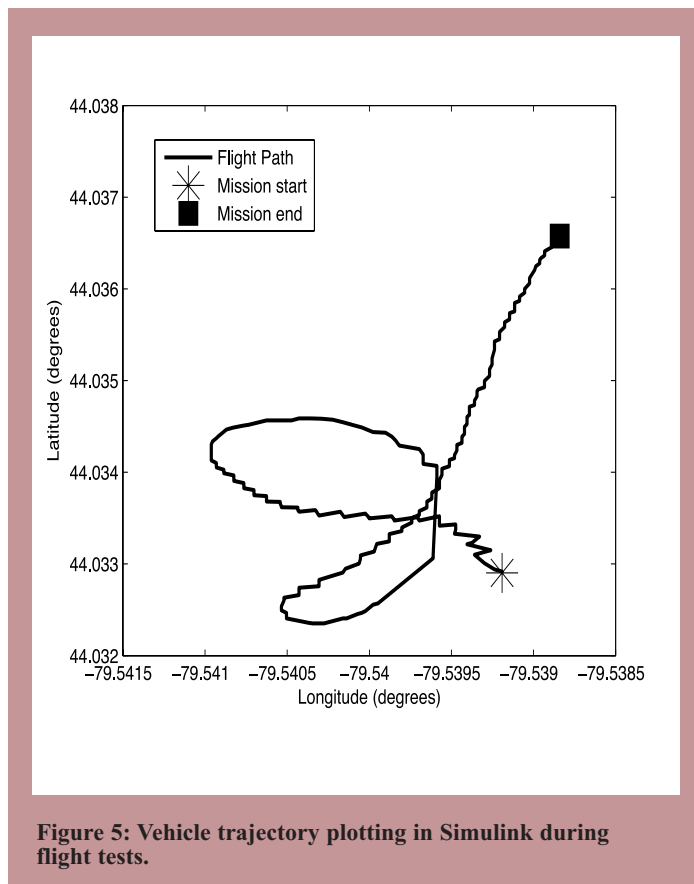


Figure 5: Vehicle trajectory plotting in Simulink during flight tests.

### 6.0 Conclusion

The QCCF is being developed to provide a multi-agent mission developer with the tools to readily and rapidly create, simulate and fly on real hardware a variety of mission scenarios. This is accomplished through the use of automatic code generation, as well as providing abstraction layers for communications, vehicle control and multi-agent tools.

The system is still undergoing extensive development but has been integrated on several vehicles in simulation and on flight-ready hardware (with real multi-vehicle cooperative missions flown). Further developments will include the use of different communications media for both vehicle-to-vehicle and vehicle-to-ground links (though the latter are primarily used for mission progress monitoring) as well as improved data and mission sensor information storage, retrieval, and sharing.

The same control and communications concepts, such as the QCCF VAL, can also be used on other vehicle system types. For example, Quanser is developing an Unmanned Ground Vehicle System in parallel with the QCCF which will be available for integration with multi-vehicle UAV missions as well.

At the current stage in the development, the QCCF has proven itself as a very valuable tool for rapidly and effectively conceiving, developing, and testing multi-agent UAV missions using off-the-shelf systems. The continued development is expected to enhance these capabilities and utilities even further.

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## About the Authors

**Ernest Earon** is currently Systems Manager at Quanser Consulting Inc. Dr. Earon received his PhD from the University of Toronto's Institute for Aerospace Studies in 2005 where his research focused on the adaptable, multiagent control of mobile robots for planetary exploration. Dr. Earon's current work is primarily in the field of unmanned aerial vehicles, specifically enabling autonomous and multiagent missions on these platforms.



**C. D. Fulford** received his Masters of Applied Science in Engineering from the Control Systems Group at the University of Toronto. His masters research dealt with non-linear control of high-precision magnetically-levitated positioning systems. He is now an R&D Engineer at Quanser Consulting Inc., and his current research interests include control of autonomous unmanned aerial vehicles.



**Norman H. M. Li** received the B.A.Sc. degree in computer engineering from University of Waterloo, Canada in 2004. He is currently working towards the M.A.Sc. degree in aerospace engineering at the Institute for Aerospace Studies, University of Toronto. His research interests include multi-agent and cooperative control of unmanned aerial vehicles.



**Rajibul Huq** received the B.Sc. degree from Bangladesh University of Engineering and Technology in 2002. He completed a Ph.D. in mobile robotics in 2006 at C-CORE, Memorial University of Newfoundland (MUN). Subsequently, he worked as a Post Doctoral researcher for the RAVEN (Remote Aerial Vehicles for Environmental Monitoring) project in the faculty of engineering at MUN. He received a NSERC Industrial Research & Development Fellowship in September 2007 and joined Quanser Inc. as a Post Doctoral fellow.



**C.A. Rabbath** is currently Defence Scientist at Defence Research and Development Canada - Valcartier. Dr. Rabbath received the PhD degree in 1999 from McGill University. He serves as Associate Editor for the journals IEEE Transactions on Control Systems Technology, Transactions of the Canadian Society for Mechanical Engineering, Control Engineering Practice, and the IEEE Canadian Review. He is active in the development of cooperative unmanned aerial systems with health monitoring and decision-making capabilities.



# 2<sup>nd</sup> CLIMATE CHANGE TECHNOLOGY CONFERENCE 2<sup>e</sup> Conférence sur les technologies du changement climatique

May 12-15 mai, 2009  
Hamilton, Ontario, Canada



## CALL FOR PAPERS

The 2<sup>nd</sup> Climate Change Technology Conference (CCTC2009) is a Canadian and international forum for engineers, scientists, policy advisors, industry and other stakeholders to share and exchange new information and ideas for dealing with climate change and global warming. It also provides an opportunity for participants to keep abreast of emerging techniques and technologies for the mitigation of, and adaptation to, the impacts of climate change. The CCTC2009 is organized by the Engineering Institute of Canada (EIC) and nine of its member societies.

The CCTC2009 will be held on the campus of McMaster University in Hamilton.

### *CLIMATE CHANGE ... DEAL WITH IT!*

The above theme reflects the need to prepare practical responses to climate change and global warming.

The proposed conference topic categories are:

- **Impacts:** Environmental and economic impacts; potential safety, health and security risks
- **Monitoring:** GHG tracking, emission measurement, engineering issues and indicators
- **Modeling:** Emissions/economic/climate, infrastructure design, energy systems and lifecycle
- **Mitigation:** GHG management, carbon free energy, carbon management and biofixation
- **Adaptation:** Engineering design, planning, processes, tools, risk management
- **Biorefining:** Products, biochemical and thermo-chemical technology
- **Education:** Strategies, paradigms and effect on the profession
- **Standards:** International standards initiatives, protocols, benefits of standards and other initiatives
- **Policy and Regulation:** Emission trading, environment, carbon sink and emission reduction incentives

Submissions relating to other relevant topics will also be considered.

**Interested authors/panelists** are invited to submit a proposal in English or French for a paper, poster paper or presentation. Paper manuscripts will be subject to peer review. Proposals should include: (a) The title and an abstract (< 400 words) providing a synopsis of the central theme; (b) The author's preferred topic category, see list above; (c) A list of full names, affiliations and contact information for the authors or panelists and (d) A designated primary contact with full contact information. Proposals should be submitted, by **September 15, 2008**, via the Conference website at [www.cctc2009.ca](http://www.cctc2009.ca) or sent by mail, Fax or e-mail to:

Mr. Eric Williams, Technical Subcommittee Chair, c/o Canoe-About Inc., 16 Brookview Crescent, RR#2Tiverton, Ontario, N0G 2T0, fax: 519-396-6926, e-mail: [info@canoe-about.ca](mailto:info@canoe-about.ca), phone: 519-396-8844.

### Dates to Remember:

Proposal submission	2008/09/15;	Notification of proposal acceptance	2008/10/30
Draft manuscript submission	2008/12/15;	Acceptance notification & reviewers' comments	2009/03/01
Final manuscript submission	2009/03/13. <sup>1</sup>	<b>Note 1. for inclusion in the conference DVD/CD proceedings.</b>	

For more information, visit [www.cctc2009.ca](http://www.cctc2009.ca).







## 2<sup>nd</sup> CLIMATE CHANGE TECHNOLOGY CONFERENCE 2<sup>e</sup> Conférence sur les technologies du changement climatique

May 12-15 mai, 2009  
Hamilton, Ontario, Canada

### DEMANDE DE COMMUNICATIONS

La 2<sup>e</sup> conférence sur les technologies du changement climatique (CTCC2009) est un forum international pour les ingénieurs, scientifiques, conseillers politique, industriels et autres intervenants intéressés à partager et échanger de nouvelles informations et idées afin de faire face au changement climatique et au réchauffement global. Elle offre aussi aux participants l'occasion de se tenir au courant des techniques et technologies émergentes en matière de réduction et d'adaptation aux impacts du changement climatique. La CTCC2009 est organisée par l'Institut canadien des ingénieurs (ICC) et neuf de ses sociétés membres.

La CTCC2009 se tiendra sur le campus l'Université McMaster à Hamilton.

### CHANGEMENT CLIMATIQUE ... AGISSEZ!

Ce thème reflète la nécessité de préparer des réponses pratiques aux conséquences du changement climatique et réchauffement global.

Les catégories de sujets proposées pour la conférence sont :

- **Impacts:** Impacts environnementaux et économiques; risques potentiels pour la sureté, santé et sécurité
- **Suivi:** pistage des GES, mesure des émissions, problème d'ingénierie et indicateurs
- **Modélisation:** Émissions/économie/climat, conception, systèmes énergétiques et cycle de vie
- **Réduction:** Gestion des GES, énergie zéro carbone, gestion du carbone et biofixation
- **Adaptation:** Planification et ingénierie pour l'adaptation, procédés, outils et gestion des risques
- **Biorafinage:** Produits, technologie biochimique et thermochimique
- **Éducation:** Stratégies, paradigme et effet sur la profession
- **Normes:** Développement (inter)national de normes, protocoles, bénéfiques des normes et autres initiatives
- **Politiques et réglementation:** Échange d'émission, environnement, puits de carbone et incitatifs de réduction d'émission

Les soumissions relatives à d'autres sujets pertinents seront aussi considérées.

**Les auteurs/ panelistes intéressés** sont invités à soumettre une proposition en anglais ou français pour un article, une affiche ou une présentation. Les articles manuscrits seront soumis à une révision par les pairs. Les propositions doivent inclure : (a) le titre et un résumé (< 400 mots) reflétant le thème principal; (b) la catégorie de sujet privilégié par l'auteur, voir la liste ci-dessus; (c) la liste des noms, affiliations et coordonnées des auteurs ou panélistes et (d) la désignation de la personne à contacter et ses coordonnées. Les propositions doivent être reçues d'ici le **15 septembre 2008** via le site Internet de la conférence [www.cctc2009.ca](http://www.cctc2009.ca), par la poste ou fax à:

M. Eric Williams, Président du sous-comité technique, c/o Canoe-About Inc., 16 Brookview Crescent, RR#2 Tiverton, Ontario, N0G 2T0, facsimilé : 519-396-6926, courriel : [info@canoe-about.ca](mailto:info@canoe-about.ca), tél : 519-396-8844.

### Dates importantes :

Envoi des propositions	2008/09/15	Avis d'acceptation des propositions	2008/10/30
Envoi des ébauches de manuscrit	2008/12/15	Avis d'acceptation et commentaires des réviseurs	2009/03/01
Envoi des manuscrits finaux	2009/03/13 <sup>1</sup>	<b>Note 1 : pour être inclus dans le DVD/CD des actes de la conférence.</b>	

Pour plus de renseignements, visitez [www.cctc2009.ca](http://www.cctc2009.ca)

# Engineering Management: What's New in the Literature?

On: Canadian Mood, Employee Engagement, Talent Search, Best Employers, Boomers Rentention, Employee Communications, Digital Libraries, Succession Planning, and Water Scarcity.

by Terrance Malkinson

School of Health and Public Safety  
SAIT Polytechnic, Calgary, Alberta

- ◆ The feelings of Canadians on the direction of their country is provided in "The Mood of Canada: A Country Moving in the Right Direction" (*Policy Options*, 29(1): 26-32, Dec07/Jan08, [www.irpp.org](http://www.irpp.org)). Nik Nanos found that two-thirds of Canadians from all regions and among all ages and both genders are optimistic about the future and believe that the country is moving in the right direction. They are confident about Canada's economic prospects and believe that our global reputation is improving. However, in a recent article in the March 31, 2008 *Canadian Business* ("Leadership: Guts Not Included". [www.canadianbusiness.com](http://www.canadianbusiness.com)) Andrew Wahl suggests that "in general, Canada seems behind the curve in terms of exhibiting the global leadership qualities that help businesses thrive."
- ◆ A series of articles in *Training and Development* (61(1), January 2008, [www.astd.org/TD](http://www.astd.org/TD)), discusses employee engagement. When employees are engaged they do not feel misused, over-used, under-used or abused. This translates into increased individual, group and organizational performance. The articles include: "What's the Big Deal about Employee Engagement" (pp. 44-49), by Paula Ketter; "10 Ms of Employee Engagement" (pp. 50-53), by Cris and Mel Wildermuth; and "Learning Influences Employee Engagement" (pp. 54-59), by Andrew Paradise. Strategies to build employee engagement are provided in "10 M's of Employee Engagement." Learning through challenging assignments and improving the frequency and breadth of learning opportunities are revealed as being highly rated factors in promoting employee engagement. Organizational cultures that value learning, career advancement, and employee engagement are important to both organizational success and employee performance.
- ◆ The search for talent in today's globalized workplace is international in scope. In "Managing the Global Workforce" (*BusinessWeek*, #4068, 28 January 2008, [www.businessweek.com](http://www.businessweek.com)), Jena McGregor and Steve Hamm provide a report written to coincide with the 2008 World Economic Forum in Davos, Switzerland. In an article titled "The Right Perks" McGregor provides insights into understanding how different cultures view salaries, taxes and benefits. In the article "It's about the face-to-face," McGregor and Hamm discuss how, despite new communication technologies, career success continues to be dependent upon face-to-face interaction.
- ◆ *FORTUNE's* annual ranking of the best companies to work for is provided in "The 100 Best Companies to Work for 2008" (*Fortune*, 157(2): 61-96, February 4, 2008, [www.fortune.com](http://www.fortune.com)). The employees themselves (over 100,000) were surveyed to create this ranking. Leaders included Google, Quicken Loans, Wegmans Food Markets, Edward Jones, Genetech and Cisco Systems. Information on the survey methodology and information on companies selected can be found at [www.fortune.com/bestcompanies](http://www.fortune.com/bestcompanies). An accompanying article by Anne Fisher (pg. 96), provides strategies on "How to get Hired by a 'Best' Company."
- ◆ The retirement of the baby-boomer generation is being felt in workplaces throughout Canada and worldwide. Baby boomers consist of the cohort group born between 1946 and 1964. In some cases organizations may be interested in retaining high performance employees beyond the normal retirement age. In "Flexible Phase Out" (*Training & Development*, 62(4), pp.34-37, April 2008, [www.astd.org](http://www.astd.org)), William Byham discusses the issue of retiring workers and provides organizational strategies for retaining talented individuals. In many cases retaining people, rather than rehiring them after their retirement, is the preferred course of action. In another article in the same issue "Safeguarding the Intellectual Capital of Baby Boomers" (pp. 30-33) by Beverly Kaye and Joyce Cohen discuss the value of investing time and effort in retaining the "baby-boomers".
- ◆ Providing communication in the most effective and appropriate way is necessary in today's diverse workplace. In: "Bringing Greater Diversity to Communications Methods" (*Strategic Communication Management*, 12(2):32-35, February/March 2008, [www.melcru.com](http://www.melcru.com)) Paul Roberts



will provide you with insights on the case for communication diversity and strategies for effective communication. Successful implementation will have a positive impact on employee engagement. A link is provided to a site for further information on the well adjusted organization.

- ◆ Libraries and other centers of information are transitioning to digital collections, which allows for more efficient utilization of the rapidly increasing store of information. In "Roles and Expectations for Digital Libraries" (*Educuse Review*, 43(2):31-38, March/April 2008, [www.educause.edu/er](http://www.educause.edu/er)), Peter Brantley discusses what digital libraries must do to meet new user expectations. The Taylor Family Digital Library ([www.tfdl.ucalgary.ca](http://www.tfdl.ucalgary.ca)) at the University of Calgary is one example of such a library that is being designed for the 21<sup>st</sup>-century information enthusiast. More than a building with books, it's a place to learn, to study, to talk, to work together, to research, and to get help with learning and research.
- ◆ As we journey through our careers, many of us are fortunate enough to have an individual who provides us with insights that help us achieve career success. These may be mentors, acquaintances, family members, a writer, or a host of other individuals. In "The Best Advice I Ever Got." (*Fortune*, 157(10):71-80, May 12, 2008, [www.fortune.com](http://www.fortune.com)), nineteen accomplished people share with you advice that they received that helped them achieve success and that you might apply to the management of your career.
- ◆ Organizations often are occupied with immediate business needs and do not plan for future leadership. In: "After You, Who?" (*CIO*, 21(15): 52-56, May, 2008, [www.cio.com](http://www.cio.com)) Diane Frank provides you with information on why organizations should have a succession plan. The author provides tips for putting a succession plan together, the principles of which apply to any business entity. Not only is succession planning important to the organization but it is also important to the employee in their career planning. On the same topic in "Implementing Your Succession" (*Training and Development*, 61(11):54-58, November, 2007, [www.astd.org/TD](http://www.astd.org/TD)), Christee Atwood discusses six key elements of a good succession plan and provides a list of 10 pitfalls to avoid. According to Atwood, a good succession plan assesses your company's leadership needs, determines key positions within your organization, and identifies core competencies needed for those positions. .
- ◆ Water is becoming an increasingly scarce resource. Global demand has tripled in the last 50 years and will only continue to grow. In: "Draining our Future: The Growing Shortage of Freshwater" (*The Futurist*, 42(3): 16-22, May-June, 2008, [www.wfs.org](http://www.wfs.org)) Lester Brown discusses how shrinking water supplies endangers the natural environment, food and energy supplies, and even statehood and international stability. In a related article ("There will be Water." *BusinessWeek*, #4089, 41-45, June 23, 2008 [www.businessweek.com](http://www.businessweek.com)) Susan Berfield discusses T. Boone Pickens belief that water will become an increasingly scarce resource and that it will be the "Oil" of the future. Boone Pickens is an American philanthropist and billionaire businessman. He recently officially opened the Boone Pickens Centre for Neurological Science and Advanced Technologies ([www.ucalgary.ca/news/june2008/pickenscentre](http://www.ucalgary.ca/news/june2008/pickenscentre)) at the University of Calgary..

## About the Author

Terrance Malkinson is a communications specialist, business analyst and futurist. He was an elected Senator of the University of Calgary and a Governor of the IEEE Engineering Management Society. Currently he is Vice-Chair of the IEEE-USA Communications Committee, an international correspondent for IEEE-USA Today's Engineer Online, editor-in-chief of IEEE-USA Today's Engineer Digest, and associate editor for IEEE Canadian Review. He is the author of more than 330 publications and is also an accomplished triathlete. His career path includes medical research at the University of Calgary and North American business proposal management for the General Electric Company. Currently, he is with the School of Health and Public Safety/Applied Research and Innovation Services at SAIT Polytechnic. Opinions expressed are the author's. He can be reached at [malkinst@telus.net](mailto:malkinst@telus.net)







## CCECE 2009

### 22<sup>nd</sup> Annual Canadian Conference on Electrical and Computer Engineering

May 3-6 2009, St. John's, Newfoundland & Labrador, Canada

<http://www.ccece09.org>

*“From Electrons to Oceans: Innovation at Many Scales”*

#### Preliminary Call for Papers and Proposals

The 2009 IEEE Canadian Conference on Electrical and Computer Engineering (CCECE 2009) will be held in St. John's, Newfoundland & Labrador, Canada from May 3-6. CCECE 2009 provides a forum for the presentation of electrical and computer engineering research and development from Canada and around the world. Papers are invited, in French or English, for the following symposia.

- Circuits, Devices and Systems  
*Chair: Stefano Gregori, U. of Guelph*
- Control and Robotics  
*Chair: Andrew Vardy, Memorial U.*
- Communications and Networking  
*Chair: Cheng Li, Memorial U.*
- Computers, Software and Applications  
*Chair: Christian Couturier, NRC IIT*
- Ocean Engineering  
*Chair: Ferial El-Hawary, BH Engr.*
- Power Electronics and Energy Systems  
*Chair: Liuchen Chang, UNB*
- Signal and Multimedia Processing  
*Chair: Octavia Dobre, Memorial U.*

Authors wishing to submit papers that do not fit within any of the above topics are encouraged to do so to the 'general interest' symposium.

#### Regular Paper Submission

Please submit original full length paper(s) (maximum 6 pages) to the Technical Program Committee using the on-line submission process on our web site at <http://www.ccece09.org> before December 5, 2008. Click on "Call For Papers" and follow the instructions provided.

#### Tutorial and Workshop Proposals Submission

Proposals for half-day tutorials and workshops should be submitted before December 5, 2008 to the Tutorials Chair at [tutorials@ccece09.org](mailto:tutorials@ccece09.org).

#### Important Dates

Full length paper must be received by:	Friday, December 5, 2008
Tutorial or workshop proposals must be received by:	Friday, December 5, 2008
Notification of acceptance will be sent out by:	Friday, February 6, 2009
Author's Registration ends by:	Friday, March 6, 2009
Advance Registration ends by:	Friday, April 3, 2009

#### Industrial Exhibits and Sponsorships

For industrial exhibits please contact the Industrial Exhibits Chair at [exhibits@ccece09.org](mailto:exhibits@ccece09.org). For sponsorships please contact the Sponsorship Chair at [sponsorship@ccece09.org](mailto:sponsorship@ccece09.org).

#### Questions or Comments

For any questions or comments, please contact the Conference Secretariat: Nora McEvoy. Ph: 709 737-7467 Fax: 709 737-4042 Email: [contact@ccece09.org](mailto:contact@ccece09.org)

#### Conference Chairs

John Quaicoe  
*Memorial University*  
Wally Read  
*REMAS Inc.*

#### Technical Program Chairs

Eric Gill  
*Memorial University*  
Dennis Peters  
*Memorial University*

#### Tutorials and Workshops

Gerard Dunphy  
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#### Local Arrangements

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#### Publications

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#### CCECE '09

Faculty of Engineering  
Memorial University  
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## CCGEI 2009

### 22<sup>ième</sup> Conférence Canadienne de Génie Électrique et Informatique

3-6 Mai 2009, St. John's, Terre-Neuve & Labrador, Canada

<http://www.ccece09.org>

*“Des électrons aux océans : Innovation à grande échelle”*

#### Appel préliminaire de communications et propositions

La Conférence Canadienne de Génie Électrique et Informatique 2009 (CCGEI 2009) aura lieu à St. John's, Terre-Neuve & Labrador, Canada du 3 au 6 Mai. CCGEI 2009 est un forum où les recherches et développements en génie électrique et informatique élaborés au Canada et dans le reste du monde sont exposés. Il y aura sept symposiums et les communications pourront être présentées aussi bien en français qu'en anglais. La liste des thèmes inclut les suivants. Cette liste n'est pas exhaustive.

- Circuits, dispositifs et systèmes  
*Prés. : Stefano Gregori, U. of Guelph*
- Contrôle et robotique  
*Prés. : Andrew Vardy, Memorial U.*
- Communications and réseaux  
*Prés. : Cheng Li, Memorial U.*
- Ordinateurs, logiciels et applications  
*Prés. : Christian Couturier, NRC IIT*
- Génie océanique  
*Prés. : Ferial El-Hawary, BH Engr*
- Electronique de puissance et systèmes énergétiques  
*Prés. : Liuchen Chang, UNB*
- Traitement du signal et multimédia  
*Prés. : Octavia Dobre, Memorial U.*

Les auteurs désirant soumettre des articles ne se rapportant pas avec aucun des thèmes présentés ci-dessus sont encouragés à le faire dans le cadre du symposium 'intérêt général'.

#### Soumission d'un article régulier

Veillez soumettre votre article complet au Comité de Programme Technique en utilisant la procédure de soumission en ligne sur notre site web <http://www.ccece09.org> avant le 5 décembre, 2008. Cliquez sur "Appel de communications" et suivez les instructions fournies.

#### Soumission d'une proposition de tutorial et d'atelier

Les propositions pour une demi-journée de tutoriaux et d'ateliers devraient être soumises avant le 5 décembre 2008 au comité des tutoriels à [tutorials@ccece09.org](mailto:tutorials@ccece09.org).

#### Dates importantes

Date limite d'envoi d'article complet, le :	Vendredi 5 décembre 2008
Date limite de proposition de tutorial et d'atelier, le:	Vendredi 5 décembre 2008
Date d'annonce des résultats, le:	Vendredi 6 février 2009
Date limite d'inscription des auteurs, le :	Vendredi 6 mars 2009
Date limite d'inscription, le :	Vendredi 3 avril 2009

#### Exposition industrielle et parrainages

Pour l'exposition industrielle, veuillez contacter le chargé d'exposition industrielle à l'adresse [exhibits@ccece09.org](mailto:exhibits@ccece09.org). Pour le parrainage, veuillez contacter le chargé de parrainage à l'adresse [sponsorship@ccece09.org](mailto:sponsorship@ccece09.org).

#### Questions ou commentaires

Pour toutes questions ou commentaires, veuillez s'il vous plaît contacter le Secrétariat de la Conférence: Nora McEvoy. Tél: 709 737-7467 Fax: 709 737-4042 Courriel: [contact@ccece09.org](mailto:contact@ccece09.org).



#### Présidents

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Lori Hogan

C-CORE

#### Webmestres

Brian Kidney

Stratos Global

#### Conseil de conférences

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Dillon Consulting Ltd.

#### Présidente IEEE Canada

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CCECE '09

Faculty of Engineering

Memorial University

St. John's, NL A1B 3X5

WEST ...

**IEEE Vehicular Technology Fall Conference (VTC)**

2008-09-21...24, Calgary, AB

<http://www.vtc2008fall.org>

**40th North American Power Symposium - (NAPS)**

2008-09-28...30, Calgary, AB

<http://www.naps2008.net/>

**IEEE Industry Applications Society Annual Meeting**

2008-10-05...09, Edmonton, AB

<http://www.ieee.org/ias2008/>

**Electrical Power & Energy Conference (EPEC)**

2008-10-06...07, Vancouver, BC

*(See Page 4)*

<http://www.ieee.ca/epec08/>

**12th IEEE Int'l Symposium on Distributed Simulation and Real Time Applications (DS-RT)**

2008-10-27...29, Vancouver, BC

<http://www.cs.unibo.it/ds-rt2008>

**2nd IEEE Int'l Conference on Digital Game and Intelligent Toy Based Learning (DIGITEL 2008)**

2008-11-17...19, Banff, AB

<http://www.ask4research.info/digitel/2008>

**IEEE Electrical Safety, Technical and Mega Projects Workshop (ESTMP)**

2008-11-19...21, Edmonton, AB

<http://ewh.ieee.org/soc/ias/tmp>

**3rd Annual IEEE Int'l Systems Conference**

2009-03-23...26, Vancouver, BC

<http://sysconf09.ieeesystemscouncil.org>

**IEEE/IAS Industrial & Commercial Power Systems Technical Conference (I&CPS)**

2009-05-03...07, Calgary, AB

<http://www-ee.uta.edu/icps>

**IEEE 31st International Conference on Software Engineering (ICSE)**

2009-05-16...23, Vancouver, BC

<http://www.cs.uoregon.edu/events/icse2009>

**IEEE Power Engineering Society General Meeting**

2009-07-26...30, Calgary, AB

<http://www.ieee.org/power>

**IEEE International Conference on Ultra-Wideband (ICUWB)**

2009-09-09...11, Vancouver, BC

<http://www.icuwb2009.org>

EAST ..

**OCEANS 2008**

"2008-09-15...18, Québec, QC

<http://www.oceans08mtsieequebec.org/>

**IEEE Sections Congress**

2008-09-19...22, Québec, QC

<http://www.ieee.org/sc2008>

**6th Annual Privacy, Security and Trust Research Conference (PST)**

2008-10-01...03, Fredericton, NB

<http://www.unb.ca/pstnet/pst2008/>

**33rd IEEE Conference on Local Computer Networks (LCN)**

2008-10-14...17, Montréal, QC

<http://www.ieeelcn.org/>

**1st Microsystems and Nanoelectronics Research Conference (MNRC)**

2008-10-14...15, Ottawa, ON

[http://www.cmc.ca/mnrc\\_2008](http://www.cmc.ca/mnrc_2008)

**Int'l Workshop on Robotic and Sensors Environments (ROSE)**

2008-10-17...18, Ottawa, ON

<http://www.site.uottawa.ca/ROSE2008>

**IEEE Int'l Workshop on Haptic Audio Visual Environments and their Applications (HAVE 2008)**

2008-10-18...19, Ottawa, ON

<http://www.discover.uottawa.ca/HAVE2008/>

**IEEE Conference on Electrical Insulation and Dielectric Phenomena (CEIDP)**

2008-10-26...29, Québec, QC

<http://www.ewh.ieee.org/soc/dei/ceidp>

**UVS Canada Conference**

2008-11-04...07, Ottawa, ON

<http://www.uvscanada.org>

**IEEE International Reliability Physics Symposium (IRPS)**

2009-04-26...30, Montréal, QC

<http://www.irps.org>

**22nd IEEE Canadian Conference on Electrical and Computer Engineering (CCECE- CCGEI)**

2009-05-03...06, St.John's, NL

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<http://www.ccece09.org>

**EIC/ICI 2nd Climate Change Technology Conference**

2009-05-12...15, Hamilton, ON

<http://www.cctc2009.ca>

**IEEE Electrical Insulation Conference (EIC)**

2009-05-31...06-04, Montréal, QC

<http://ewh.ieee.org/conf/eic>

**29th IEEE Int'l Conference on Distributed Computing Systems (ICDCS)**

2009-06-22...26, Montréal, QC

<http://www.cse.ohio-state.edu/icdcs2009/>

**IEEE Nuclear & Space Radiation Effects Conference (NSREC)**

2009-07-20...24, Québec, QC

<http://www.nsrec.com>