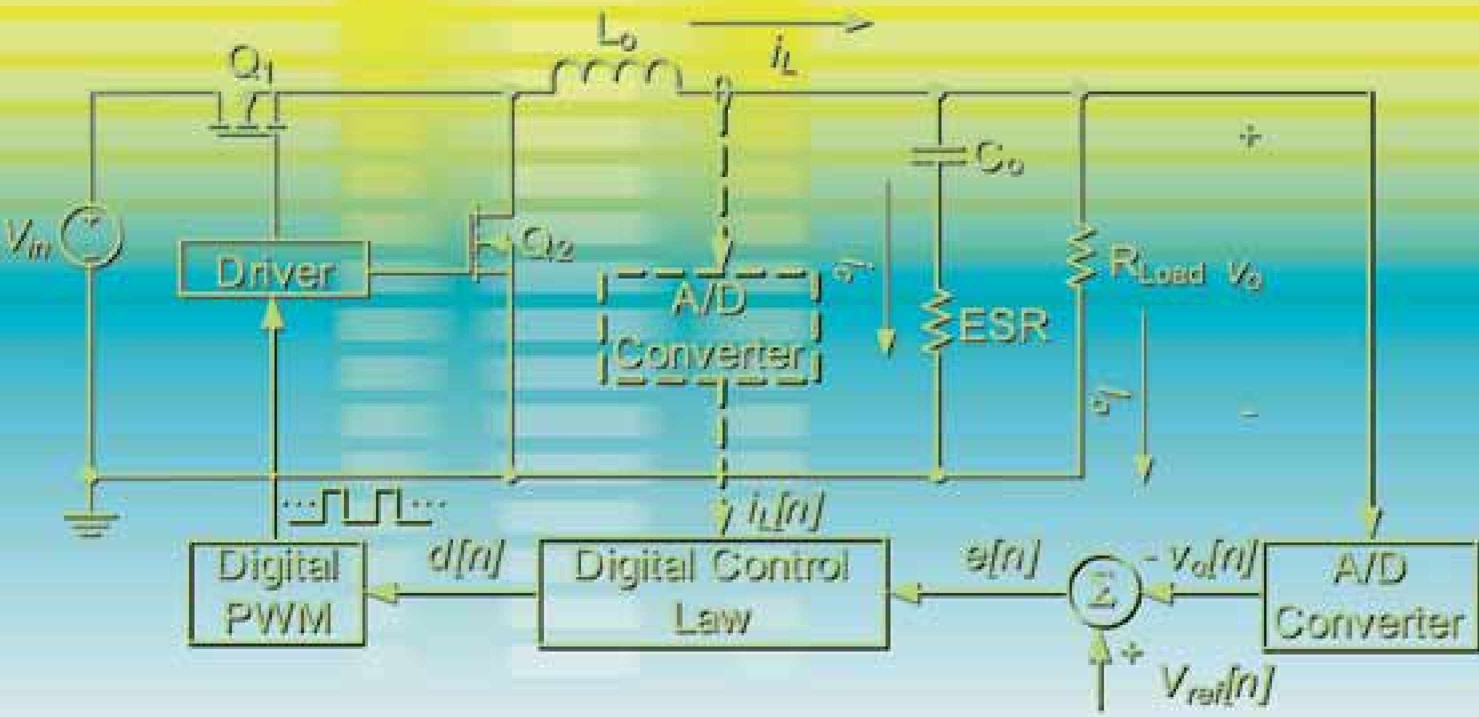
Fall / Automne 2009, No. 61

IEEE Canadian Review

La revue canadienne de l'IEEE

Switching Mode Power Supplies



First External Cardiac Pacemaker

Photovoltaics: System Control Technology

Creation of IEEE Canada

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IEEE Canada
The Institute of Electrical and Electronic Engineers Inc.

IEEE Canadian Review General Information

The *IEEE Canadian Review* is published three times per year. 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	5 - Power
2 - International Affairs	6 - Communications
3 - Industry	7 - Computers
4 - Education	8 - Electronics

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Editorial / *Éditorial*

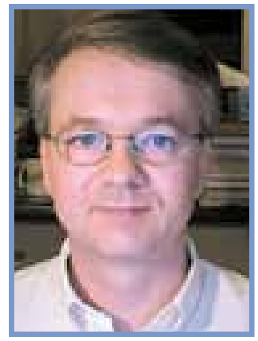
Eric Holdrinet SMIEEE, Rédacteur en chef / Editor-in-Chief

Ce numéro de *la Revue canadienne de l'IEEE* se penche sur l'électronique de puissance, plus particulièrement sur les blocs d'alimentation électrique. Ces composantes, qui sont actuellement des convertisseurs de courant électrique et non des sources de courant, sont omniprésentes dans l'industrie et notre environnement quotidien. Notre article principal "Recent Developments in Switching Mode Power Supply Technologies" s'intéresse aux blocs d'alimentation à découpage, une évolution bienvenue par rapport aux blocs d'alimentation de régulation linéaire plus volumineux et moins efficaces. Ces avantages s'accompagnent par contre d'une complexité accrue, un défi qui ne peut qu'intéresser nos chercheurs et ingénieurs d'applications!

L'article technique "Photovoltaic Energy Systems — System Control Technology" est la deuxième partie d'un article commencé au numéro précédent. Tout ingénieur électricien ou électronicien distinguera aisément un lien direct avec le domaine des convertisseurs de courant.

Ce numéro de notre *Revue* présente un article sur le "Pacemaker" et la reconnaissance par l'IEEE des contributions essentielles apportées par John Hopps et son équipe à une invention qui d'innombrables vies à chaque année. Ces chercheurs et médecins canadiens ont prouvé définitivement le principe de la stimulation cardiaque électrique et établi son application pratique. Les étapes suivantes, la miniaturisation et l'implantation interne, ont nécessité l'arrivée du transistor, le développement de nouveau biomatériaux, et des progrès dans —je vous le donne en mille— les technologies d'alimentation électrique.

Nous tenions à célébrer à notre manière les 125 ans de l'IEEE en consacrant une bonne portion de la *Revue* à la contribution historique des ingénieurs canadiens à l'IEEE et à la communauté. Vous y trouverez un article sur la genèse de l'IEEE Canada, l'article sur le "Pacemaker," et nous intégrons quelques pages de la brochure officielle sur l'histoire du IEEE Canada parue l'an dernier; les pages suivantes paraîtront dans les prochains numéros de notre revue. Je vous souhaite une bonne lecture.



This issue of the *IEEE Canadian Review* looks at power electronics, in particular switching mode power supplies. Those components, which are actually power converters and not power sources, are omnipresent in the industry and our daily lives. Our feature article "Recent Developments in Switching Mode Power Supply Technologies" is studying this much-welcome evolutionary step compared to linear regulators, which were bulkier and less efficient. Those improvements are accompanied, however, by increased complexity, a challenge that can only titillate our researchers and application engineers!

The technical article "Photovoltaic Energy Systems — System Control Technology" is the second part of an article published in the last issue. Electrical and electronics engineers will easily spot a direct link with the field of power converters.

This issue of the *Review* presents an article on the Pacemaker and the recognition by IEEE of the essential contributions brought about by John Hopps and his team to an invention that saves countless lives each year. Those Canadian researchers and physicians proved definitely the principle of electrical cardiac stimulation and established its practical application. The subsequent steps, miniaturization and internal implementation, required the discovery of the transistor, the development of new biomaterials, and advances in —guess what — power supply technologies.

Dr. John Hopps' pacemaker/defibrillator prototype, 1950-1952. Photo courtesy of Canada Science and Technology Museum, Artifact # 1997.0366

We wished to celebrate the 125th Anniversary of the IEEE by devoting a good portion of the *Review* to Canadian engineers' historical contribution to the IEEE and the community. You will find an article on the genesis of IEEE Canada, the Pacemaker article, and we integrate a few pages from the official booklet on IEEE Canada history published last year; additional pages will appear in the next issues of the *Review*. I wish you Good Reading.

Table of Contents / *Table des matières*

As expected, the past few months have been busy for IEEE Canada. In March 2009 I was invited to IEEE Vancouver Section to represent IEEE Canada at both the IEEE Control System Society Chapter and the IEEE International Systems Conference. The Vancouver Section's Power & Energy Society (PES) Chapter ranked on top as the 2008 PES High Performance Chapter among 190 PES chapters world-wide and received a $1000 award. This is the third year in a row that Vancouver Section PES chapter has scored among the top chapters in the world. This Chapter is also the winner of the PES Membership Contest (second year in a row) in the Large Chapters Category with 23 percent membership increase in 2008, and awarded an additional $1000. Congratulations to all Area West for this great achievement that brings Vancouver Section to the forefront in the year when IEEE and PES are celebrating 125th year of the tradition of excellence.

Central Area of IEEE Canada again hosted the Annual TELUS Student Competition and Branch Workshop in mid-September, with much help from our capable student volunteers. My congratulations also go to the Toronto Section for taking the lead in the preparations for the highly successful Science and Technology for Humanity International Conference, also held in September. This is in addition to a number of other IEEE/ International Conferences held in the Central Area.

Down East has been busy with so many events and commitments that Area East has undertaken to accomplish for this year. We had a very successful Spring Region Board Meeting in St. John's, May 2009, that started with a successful day of Spring Training Sessions, conducted by prominent Guest Speakers. Following the Spring Region Meeting was the Annual IEEE Canadian Conference on Electrical and Computer Engineering (CCECE'2009) that was well attended and high-lighted by the Awards presentation to eleven recipients (Canadian Achievement and Service Awards) at the Conference Banquet. Congratulations to all and well deserved.

I am very proud of both Ottawa and Montreal Sections for teaming up and engaging with IEEE/EAB to accomplish the project that I had initiated on Pre-University Education Program. I participated as Invited Speaker and all IEEE Canada Sections Leaders with student representatives from each section, in addition to some School Teachers, School Board representatives and representatives from the Ministry of Education (Province of Quebec)—all contributed to the success of IEEE Canada Teacher In-Service Program and Training Workshop that was held in Montreal May 15-16, 2009. More than 100 participants attended with excellent feedback about the workshop. A web-page has been created that contains the agenda, slide presentations, evaluation results, lesson plans, pictures and more. Please visit: http://www.ieee.org/web/education/preuniversity/TISPMontreal.html

During my visit to the Montreal Section I represented IEEE Canada at the National Engineering Summit in Montreal, May 2009. The Summit's aim was to discuss the future of engineering in Canada and the roles of engineers in society over the next few decades as the Engineering Profession seeks to collaborate with other professions for a safer, cleaner, healthier and more Competitive Canada. It was concluded with a signing by all six members of a Memorandum of Understanding formalizing their collaboration. The engineering profession will use the results to guide its future direction particularly in the areas of engineering education and public policy as it impacts Canadian society. These issues are very important to the Engineering Institute of Canada (EIC) and its 12 constituent Society members including IEEE Canada. That is why EIC, as a leading engineering institution in Canada, became an organizer of the Summit along with the five other main Canadian Engineering Organizations. For more information, please visit:

http://www.engineeringsummit.ca

Tel que prévu, les derniers mois ont été très occupés pour IEEE Canada. En mars 2009 dernier, pour l'occasion de la conférence internationale portant sur les systèmes de l'IEEE, je fus invitée par la section de Vancouver de l'IEEE ainsi que par son chapitre sur les Systèmes de Contrôle pour y représenter l'IEEE Canada. Le chapitre de la Société de Puissance et Énergie (Power & Energy Society (PES)) de Vancouver s'est classé au premier rang 2008 des chapitres les plus performants en ce secteur, et ce, parmi plus de 190 chapitres en Puissance et Énergie à l'échelle planétaire. Ce chapitre s'est ainsi mérité un prix de 1000$. Il s'agit de la troisième année consécutive que le chapitre PES de Vancouver se positionne en tête de liste mondiale. De plus, pour une seconde année, il a remporté le concours d'effectifs du PES dans la catégorie des chapitres à grand effectif grâce à une augmentation de 23% des adhésions, lui concédant du même coup un prix supplémentaire de 1000$. Félicitation à toutes les délégations de l'ouest pour ce formidable succès qui a su mettre en vedette la section de Vancouver à l'occasion de la célébration des 125 ans d'excellence de l'IEEE et de la Société de Puissance et Énergie.

La zone centrale de l'IEEE Canada a présenté à nouveau la Compétition étudiante annuelle TELUS et l'Atelier étudiant à la mi-septembre, avec l'aide de nos talentueux bénévoles étudiants. De plus, de nombreuses conférences de l'IEEE international se sont tenues. Finalement, je tiens à remercier la section de Toronto pour avoir pris les rênes de la préparation de la conférence sur l'Humanité (septembre 2009) pour souligner les 125 années d'existence de l'IEEE.

L'est a été très occupé avec plusieurs événements et engagements entrepris en cours d'année. Une excellente rencontre printanière du conseil d'administration de la région a eu lieu à St.John's en mai 2009, incluant des sessions de formation données par d'éminents conférenciers. La 22e Conférence canadienne de génie électrique et informatique (CCGEI) s'est ensuite tenue avec un bon nombre de participants, et la remise de onze prix de service lors du banquet de la conférence. Félicitations à tous.

Je suis très fière des sections d'Ottawa et de Montréal pour leur collaboration et leur engagement dans l'IEEE/EAB pour mettre de l'avant le programme d'éducation préuniversitaire qui fût initié quelques années auparavant. Les dirigeants de sections de l'IEEE Canada, les associations étudiantes, les enseignants, les représentants des comités scolaires et le ministère de l'Éducation du Québec ont contribué au programme des enseignants en service qui s'est tenu le 15-16 mai dernier à Montréal. Une excellente rétroaction a été retenue de l'activité à laquelle plus de 100 personnes ont participé. Une page web contenant l'agenda, les diapositives de la présentation, les résultats des évaluations, les plans de leçon, photos et autres a été mise en ligne : http://www.ieee.org/web/education/preuniversity/TISPMontreal.html

Au cours de ma visite de la section montréalaise en mai 2009, j'ai représenté IEEE Canada au Sommet national du génie. Les discussions portaient sur l'avenir de l'ingénierie au Canada, le rôle de l'ingénieur dans notre société au cours des prochaines décennies et comment la profession d'ingénieur pourrait collaborer avec les autres professions pour l'obtention d'un Canada plus sécuritaire, plus propre, plus en santé et aussi plus compétitif. La signature d'un mémorandum des six organisations d'ingénierie a permis d'officialiser leur collaboration. La profession d'ingénierie utilisera ces résultats pour donner les lignes directrices, particulièrement dans le domaine de l'éducation et des politiques publiques afin d'influencer la société canadienne. Ces sujets sont très importants pour l'Institut canadien des ingénieurs (ICI) ainsi que pour les 12 sociétés qui la constituent, telle l'IEEE Canada. Voilà pourquoi l'ICI, à titre de chef de file de l'ingénierie au Canada, travaille en partenariat avec les cinq autres organisations d'ingénierie canadienne pour la mise en place du sommet. Pour plus d'informations, visitez le site Internet : http://www.engineeringsummit.ca

J'ai assisté à la série des rencontres de comités de l'IEEE qui s'est tenue à Los Angeles en juin 2009. Voici les points importants soulignés au cours de cette rencontre, lesquels j'aimerais partager avec vous :

- Le comité de direction de l'IEEE a approuvé l'augmentation prévue pour 2010 des frais pour les membres. La hausse sera de 5 $ pour les membres de haut niveau et de 2 $ pour les membres étudiants (la dernière hausse des frais remonte à 2003).

I attended the IEEE Board Meeting series in L.A., in June 2009 and I would like to share with you some of the Highlights:

The IEEE Board of Directors approved a member dues increase for 2010, raising dues by $5 for higher grade members, and $2 for students (the first increase in student dues since 2003).

The IEEE Member and Geographic Activities (MGA) Board made the following decisions which will be of interest to our members:

- Approved the 2008 recipients of the Awards for Student Branch, Section, and Sustained Section Membership Growth
- Approved the IEEE Sections Congress 2011 theme, "Empowering members to create the future"

The IEEE-Sections Congress aims to obtain feedback from the IEEE Members through their Section delegates and to follow up on the priorities identified. The top ten SC'08 recommendations have been presented to the IEEE Board of Directors and the MGA Board has agreed to take ownership of the recommendations.

A communication plan has been developed and the MGA Board intends to create a response summarizing the action being taken or justification for why action was not taken, to be provided at each MGA Board Meeting. Updates on SC08 recommendations will be provided quarterly in the SCOOP newsletter, and it will be published in *The Institute* late 2009 and 2010. A final report on the top 10 recommendations will be completed by December 2010.

A progress report on each of the recommendations is available on the IEEE Sections Congress web page.

- Le comité des membres et des activités géographiques de l'IEEE (IEEE Member and Geographic Activities (MGA)) a pris les décisions suivantes qui risquent d'intéresser les membres :
- L'approbation des récipiendaires 2008 des prix de branches étudiantes, sections, et sections ayant eu une croissance soutenue.
- L'approbation du thème du congrès 2011 des sections de l'IEEE : « Empowering members to create the future ».

Le congrès des sections de l'IEEE vise à obtenir les rétroactions des membres de l'IEEE par l'entremise des délégués des sections ainsi que de poursuivre les priorités identifiées. Le top 10 des recommandations du congrès des sections 2008 a été présenté au comité de direction de l'IEEE et le comité des membres et des activités géographiques de l'IEEE (IEEE Member and Geographic Activities (MGA)) a accepté de prendre en charge ces recommandations.

Un plan de communication a été développé et le comité MGA prévoit composer un communiqué résumant les actions prises et justifiant l'absence d'action concernant une recommendation, ceci présenté à chaque réunion du comité. Les mises à jour 2008 des recommandations seront présentées dans le bulletin périodique le SCOOP ainsi que publiées dans The Institute à la fin 2009 et 2010. Le rapport final du top 10 des recommandations sera achevé pour décembre 2010. Un rapport de progression sur chacune des recommandations est disponible sur la page web du congrès des sections de l'IEEE.

J'aimerais profiter de l'opportunité pour vous souhaiter à toutes et à tous mes meilleurs vœux pour cette saison automnale.

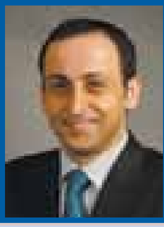
Dr. Ferial El-Hawary, P.Eng., F.IEEE, F.EIC, F.MTS
2008-2009 IEEE Canada President and Region 7 Director
http://www.ferial.ca

Group photo following IEEE Canada Awards Banquet, May 4, 2009, St. John's NL

Back Row from Left: Bob Alden—Awards Chair, David Dodds—CHECE, John Cartledge, David Whyte, Rajni Patel, Dave Michelson, Lorry Wilson, Wolfgang Hoefer, Dave Kemp, Husseon Mouftah—Awards Vice Chair

Front Row from Left: Wally Read—ICF, KC Smith, Ferial El-Hawary—President, Bill McDermid, David Falconer

Newslog Editor



Rédacteur des Coupures de presse

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

Veuillez faire parvenir les coupures de presse proposées par e-mail à alexandre.abecassis@ieee.org

SANTA CLARA, CA. Jun. 22, 2009. A call for patents has been made by the Open Patent Alliance. The Open Patent Alliance is a group dedicated to offering intellectual property rights. The call for patents is made with the intention of building a pool of essential WiMax patents. The purpose of the patent pool is to sell licenses for the technology at a single desk. WiMax is a 4G IP-based wireless broadband technology based on IEEE 802.16e specification.

CALGARY, AB. Jun. 23, 2009. Raytheon has been awarded a $180 million contract from the Canadian Navy. The contract is for conducting 30 sets of overhauls and for converting 21 rapid-fire, computer-controlled radar and 20 mm Gatling-gun system that automatically acquires, tracks and destroys enemy threats that have penetrated all other ship defense systems. This is the largest contract obtained ever for the company in Canada.

MONTREAL, QC. Jun. 9, 2009. An online diabetes tool specifically designed for use by family physicians for chronic disease patients has been launched today by Dr. Ouellet of the Canadian Medical Association. The portal will enable patients to efficiently share various informations related to this condition with their doctor in a secure environment. For instance, it will be possible to share blood sugar readings, intensity and duration of exercise completed as well as lab results. While over two million Canadians currently suffer from diabetes, it is expected that this number will grow to reach three million by 2010.

MISSISSAUGA, ON. May 7, 2009. Microsoft Canada has just made its largest ever software donation. Over $3 million in software and licensing have been donated to the Canadian Red Cross to help the non-profit organization focus humanitarian efforts in Canada and around the world. Over 2000 computers and 15 servers from the organization will be updated.

TORONTO, ON. Apr. 2, 2009. Dyadem has announced that its software is now used by Wyeth, a global leader in prescription pharmaceuticals and non-prescription consumer health care products. Dyadem has built a software that delivers industry standard Process Hazard Analysis capabilities. The purpose of the Process Hazard Analysis is to obtain safer and more predictable production processes.

TORONTO, ON. Jul. 14, 2009. Mr. Marcel Breton, a researcher at Xerox Research Centre of Canada, has just received its 100th US Patent. The patent, US Patent No7,531,033, is entitled “Pre-Treatment compositions, oil-based ink compositions and processes for ink-jet recording”. It is interesting to note that at Xerox, 19 individuals have each more than 100 patents with their name as one of the inventors.

LONGUEUIL, QC. Jun. 29, 2009. Clemex technologies has announced today that it has created a new division for developing medical instruments based on its expertise in quantitative microscopy systems. The purpose of the research project will be to develop a microscopy blood cells analyzer. The hematology application represents a potential market of $2 billions.

TORONTO, ON. Jun. 18, 2009. The University of Toronto’s SciNet Consortium has announced today that a new supercomputer has been built based on IBM technology. The new supercomputer has a capacity of 300 trillion calculations per second. This is the most powerful supercomputer in Canada and one of the top 15 fastest supercomputers in the world. It currently uses 30240 Intel 2.56 Ghz processor cores and is water cooled. It will be used for many applications such as research in aerospace, astrophysics, medical imaging, chemical physics, climate change predictions, bioinformatics, etc.

TORONTO, ON. Mar. 31, 2009. Sirit, a provider of radio frequency identification (RFID) technology has announced that its RFID technology has been selected for deployment at Pacific Gas & Electric’s Diablo Canyon Nuclear Power Plant in California. The technology will be used to identify and locate critical parts in a warehouse having $65 million of inventory. The technology will be of great interest since the Nuclear Regulatory Commission requires a complete physical count of the inventory at given time intervals. It is expected that inventory processing costs will be reduced by 60%.

MONTREAL, QC. Jul. 20, 2009. VoiceAge has announced today an initiative for creating a pool of essential patents in the AMR-WB/G.722.2 technology. AMR Wideband is the only speech codec to date to be standardized for both wireless (3GPP) and wireline applications. The AMR Wideband is, inter alia, the mandatory codec in GSM and WCDMA networks for wideband speech and for multimedia services when wideband speech is supported.

TORONTO, ON. Jul. 14, 2009. TerreStar Networks has announced that its satellite has successfully been placed into an assigned orbital position. It has further deployed a 18-meter 2GHz S-band reflector. This antenna is the largest commercial satellite antenna ever deployed. The satellite will be used as part of a system to deliver voice, data and video services using an all-IP mobile broadband network to satellite-terrestrial smartphones. ❖

Engineers Canada Gold Medal Student Award

Engineers Canada awarded this medal for 2009 to Frédérick Ammann, MIEEE, who leads the Eclipse Project at École de technologie supérieure de Montréal. This award reflects his remarkable leadership and the achievements reached by a multi-disciplinary team of students in electrical, mechanical and computer engineering who pushed the envelope of automotive engineering and mobile solar power. The project, started in 1992, helped train a whole generation of students, the latest crop of whom is now hard at work on Eclipse VI. See http://eclipse.etsmtl.ca/ .

Frédérick Ammann, MIEEE (third from left, front row) with some of his fellow members of the Éclipse VI solar car team.

REGIONAL AWARDS FOR SECTIONS

Region 7 (IEEE Canada) recognized three sections for exemplary performance May 2, 2009 in St. John's (NL). Newfoundland & Labrador and London Sections won 2008 Exemplary Small Section Awards. Montreal Section won the Exemplary Large Section Award for 2008. Section representatives received the awards from Dr. Ferial El-Hawary, President of IEEE Canada.

Exemplary Small Section (<501 members) and Large Section (>500 members) Awards recognize sections' activities and accomplishments of the preceding year. For more information please visit http://www.ieee.ca/awards/2009.php

Eric Gill and Maike Luiken (N&L and London Section Chairs) receive Exemplary Small Section Awards

Eric Gill et Maike Luiken (Prés. sections N&L et London) recoivent des prix "Petite section exemplaire

Dr. El-Hawary presents the Exemplary Large Section Award to A. Benyamin-Seeyar, Montreal

Dr. El-Hawary présente le prix "Grande section exemplaire" à A. Benyamin-Seeyar, Montréal

PRIX RÉGIONAUX POUR SECTIONS

La Région 7 (IEEE Canada) a célébré trois sections pour performance exemplaire le 2 mai 2009 à St.John's (NL). Les sections de Terre-Neuve & Labrador et de London ont remporté des prix 2008 de Petites Sections Exemplaires. La section de Montréal a eu le prix Grande Section Exemplaire pour 2008. Les représentants des sections lauréates ont reçu les prix des mains de la présidente d'IEEE Canada, Dr. Ferial El-Hawary.

Les prix de Petite Section (<501 membres) et Grande Section (>500 membres) Exemplaire célèbrent les activités et réalisations des sections pour l'année complétée. Pour plus d'informations veuillez visiter http://www.ieee.ca/awards/2009.php

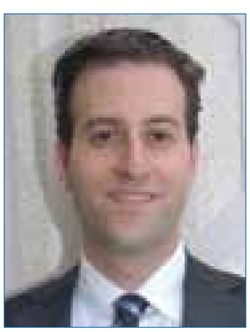
MGA AWARDS

The awards and recognition program of the IEEE Member and Geographic Activities Board (MGA) is designed to promote, recognize and reward excellence in the MGA operations and IEEE Geographic Unit Activities (Regions, Geographic Councils and Areas, Sections, Chapters, Student Branches, and Student Branch Chapters). Region 7 is proud to have had three members honoured with individual awards for their contributions in 2008.

PRIX du MGA

Le programme des prix du "IEEE Member and Geographic Activities Board (MGA)" est conçu pour promouvoir, reconnaître et récompenser l'excellence dans les opérations du MGA et les activités des unités géographiques (régions, conseils et zones géographiques, sections, chapitres, branches étudiantes et chapitres de branches étudiantes). La Région 7 est fière d'avoir eu trois membres honorés par des prix individuels.

MGA Achievement Award

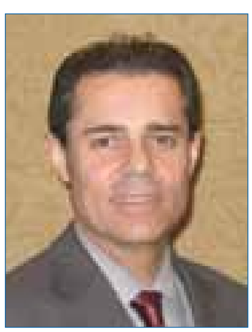


Rami Abielmona,
Ottawa Section

For exemplary contributions and energetic leadership towards increasing the participation in the IEEE Ottawa Section Robotics Competition, and actively engaging the local students.

Pour contributions exemplaires et leadership énergique envers l'accroissement de la participation à la compétition de robotique d'IEEE Ottawa, et avoir activement impliqué les étudiants locaux.

MGA Larry K. Wilson Transnational Award



Marcelo Mota,
Toronto Section

For 20 years of IEEE volunteerism, and significant contributions to the development and promotion of global activities and services to IEEE members.

Pour 20 ans de bénévolat IEEE, et contributions significatives au développement et à la promotion d'activités et services globaux aux membres de l'IEEE.

MGA Leadership Award

Anader Benyamin-Seeyar,
Montreal Section

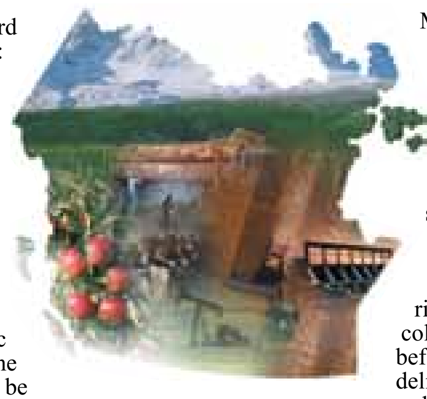
For dedicated leadership and significant contributions to serve IEEE and the engineering profession through continuous engagement efforts in the Montreal Section.

Pour leadership dévoué et contributions significatives au service de l'IEEE et à la profession d'ingénieur par un engagement soutenu envers la Section de Montréal.

A View from the West

By Terrance Malkinson
School of Health and Public Safety
SAIT Polytechnic. Calgary, Alberta

On: Innovation, Child-friendly Work Environments, Developing Foreign Markets, Carbon Capture, University of Regina's Renaissance, Lessons Learned for Canadian Business Leaders



- The ten most innovative companies in British Columbia as chosen by a panel of senior business leaders are provided by Jeffrey Bichard in: "The Innovators." (BC Business. 37(4): 69-81, April, 2009 www.bcbusinessonline.ca). Leading the ranking is MacDonald Detwiler and Associates Ltd. a high-technology company that has a proven long-term record of consistent innovation. While on the topic of innovation, an article in BusinessWeek "Innovation Interrupted." (#4135. pp. 34-40 June 15, 2009 www.businessweek.com) by Michael Mandel discusses the drop-off in innovative technological breakthroughs over the past decade in the United States and how this may have contributed to current economic challenges. Although the article focuses on the United States there are important lessons to be learned for Canadian innovation. A link is provided to interesting information on the topic of innovation globally (http://bx.businessweek.com/innovation-economics/reference). Michael Richarme's article: "Ten Forces Driving Business Futures" (The Futurist. 43(4):40-43. July-August, 2009. www.wfs.org) discusses some of the most important trends that he believes will unfold over the next 20 years. It is important for personal and career success that we all remain future vigilant.
- As is the case with other areas of the country, British Columbia is experiencing the retirement of many workers of the baby boomer generation. Vanessa Richmond discusses the issue and suggests that there may be a need to create kid-friendly work environments to attract needed workers ("Oh, Baby!" BCBusiness. 37(5): 49-53. May 2009. www.bcbusinessonline.ca). A case study of the benefits to a software development company who created an in-house child-care facility by renovating office space that closed the gap between a mother's desire to work and their actual ability to go to work is provided. Deanne Stone describes the story of the multicultural Yochlowitz family, who grew their business from its scrap-peddling roots into the largest recycling firm in British Columbia in: "Communication and Commitment. "(Family Business. 20(3):36-40. Summer, 2009. www.familybusinessmagazine.com).
- Winners and finalists in the 2009 Alberta Export Awards (www.albertaexportawards.com) are provided by Wes Lafortune and Noemi Lopinto in: Alberta Venture. (13(4): 41-53, April, 2009. www.albertaventure.com). This award honors companies and individuals who successfully grow new foreign export markets with value-added products and services. Winners of a selection of the various categories of awards include: Wmode Inc. (new media award) who offer technologies and services as a managed service to enable triple and quad play service providers, broadband operators, mobile carriers, MVNOs, content providers and media companies to deliver a broad range of digital content and services to their consumers. Waterworks Technologies (sustainability award) who specializes in supplying compact and sustainable, packaged water and wastewater treatment plants and equipment through its turnkey treatment systems and solutions.
- Carbon capture and storage is important, urgently needed, and seen to be vital to the future of Alberta's Energy driven economy. ("The Upside Underground". Alberta Venture. 14(4):32-37. April, 2009.). Jeff Gailus discusses the important issues associated with carbon capture and the perspectives of David Keith, one of Canada's foremost experts on climate change and carbon capture and storage. In: "Live & Learn:" (Canadian Business. June 15, 2009 www.canadianbusiness.com) Harley Hotchkiss a leading Canadian business man and philanthropist provides his perspectives on what he has learned from his career path, oil exploration, and the unifying power of ice hockey.
- Saskatchewan is experiencing economic and population growth. One contributor to this success is an emphasis of keeping and attracting resident and non-resident students. The University of Regina has recently appointed a new President Vianne Timmons. ("A Higher Degree". Saskatchewan Business Magazine. 30(2):26-29. March, 2009). www.sunrisepublish.com/saskbusiness_magazine Keith Moen describes how the university is experiencing a renaissance with its new President and strategic plan. Phenomenome Discoveries is a ten-year-old company that has developed a mechanism for detecting a wide range of diseases well before the illness is evident in the body. Their story is told by Paul Martin in: "Developing a Healthy Bottom Line." (*Saskatchewan Business Magazine*. 30(4): 39-41. June 2009.) Their scientists have discovered 12 markers that can detect the risk of disease. In Manitoba, it is expected that a colon cancer detection system will be on the market before the end of this year and plans are in the work to deliver processes to identify diseases such as prostrate and ovarian cancer and multiple sclerosis.
- Innovative canvas solutions and customer service are the focus of Winkler Canvas's operations. Bernard Kruchak describes the 30-year story of product innovation, service excellence and hard work in this Manitoba based company that has become one of the largest tarp suppliers in Western Canada. ("Terrific Tarps". Commerce and Industry Magazine. 59(4): 17-20. 2009. www.commerceandindustry-online.co.uk/#/1). Res/Op Technologies Company and its entrepreneurial owners Ron Giercke and Ken Smith is the winner of Manitoba Business Magazines Entrepreneur of the Year Award. (Manitoba Business Magazine. 32(4): 6-8. May/June, 2009. www.manitobabusinessmagazine.com). Their product is a high heat incineration furnace that destroys contaminated organic waste such as BSE infected waste. The process is considered greenhouse gas neutral and is predicted to eventually generate up to $100 million in annual sales. The process also has applications to other waste such as sewage sludge, municipal landfill waste, and bio-medical waste.
- Joe Castaldo et al. provide a ranking of industry leaders, financiers, and policy personnel who to lead Canada's business in: "The 25 Most Influential People in Business". (Canadian Business. 82(10): 47-54. June 15, 2009. www.canadianbusiness.com). Leaders such as Elyse Allen (GE Canada), Jim Balsillie (Research in Motion), Paul Desmaarais (Power Corporation) are but a few of the many individuals profiled. We can all learn strategies for managing our own careers from the stories of lessons learned by well respected Canadian business leaders.

About the Author

Terrance Malkinson is a communications specialist, business analyst and futurist. 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 an associate editor for *IEEE Canadian Review*. He was an elected Senator of the University of Calgary and an elected Governor of the IEEE Engineering Management Society, as well as an elected Administrative Commitee member of the IEEE Professional Communication Society. He has been the editor of several IEEE conference proceedings, and past editor of *IEEE Engineering Management*. Currently, he is with the School of Health and Public Safety/Applied Research and Innovation Services at SAIT Polytechnic in Calgary.

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Recent Developments in Switching Mode Power Supply Technologies

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Abstract

Switching mode power supplies are used in nearly all electronic devices in our daily lives and in industry. This paper reviews recent developments in switching mode power supplies including technologies to reduce power loss, and digital control strategies to improve the dynamic and system performance.

Sommaire

Les blocs d'alimentation à découpage sont utilisés dans presque tous les appareils électroniques à la maison et dans l'industrie. Cet article examine les développements récents dans ce domaine, incluant des technologies pour réduire les pertes de courant et des stratégies de contrôle digital pour améliorer la performance dynamique et systémique.

1.0 Introduction

With the rapid development of digital devices and semiconductor technology, switching power supplies are used in almost all applications with output power level above one watt including communications equipment, data centers, wireless base stations, computers, cell phones, and various types of battery chargers. Two types of commonly used switching power supplies are AC-DC and DC-DC. With AC-DC power supplies, the input voltage is from the AC utility and the output is a DC voltage, for loads such as a computer power supply, or battery chargers. With DC-DC power supplies, the input voltage is DC and the output voltage is another DC level for loads such as a USB charger, or Voltage Regulator (VR) in a computer motherboard.

The Distributed Power Architecture (DPA), shown in Fig. 1, is widely used in data center and communication power systems [1]. The Power Factor Correction (PFC) module converts the AC voltage to 400V DC, which is then converted by a front end converter to 48V DC. The 48V DC is distributed across the back plane of the system.

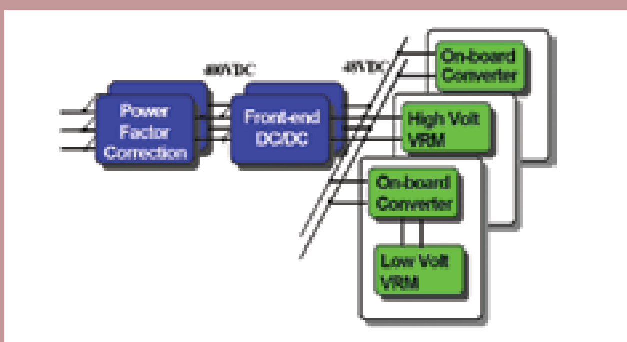

Figure 1: Distributed Power Architecture

More recently, the electronic ballast power supply for Compact Fluorescent Lamps (CFLs) has been developed. This application requires a special AC-AC converter, where the 60Hz low frequency AC voltage is converted into high frequency AC at several tens of kHz.

Solar cell inverters are another class of power supplies which convert the DC voltage from photovoltaic cells to 60Hz low frequency AC to send the energy to the grid.

Power conversion efficiency is a very important performance feature for a switching power supply. Small size is another important specification. High efficiency not only means less energy loss, but also means lower temperature rise and therefore, more compact mechanical design. Presenting challenges to designers, a power supply is a supporting component, so cost is always under pressure.

Closed loop control is used to ensure stable operation of the switching power supply. It also determines the dynamic performance of switching power supplies. Recently, digital control has begun to find its way into switching power supplies due to reduced silicon costs and technology development.

In this paper, major advances in the topologies and digital control of switching power supplies are summarized.

2.0 HIGH EFFICIENCY CONVERTER TOPOLOGIES

2.1 Zero Voltage Switching

Switching loss occurs due to simultaneous overlap of voltage and current in power MOSFET switches during switching transitions as illustrated in Fig. 2(a).

Zero Voltage Switching (ZVS) is a technique that nearly eliminates turn on switching loss, P_{sw}, in power MOSFETs by allowing the voltage across the switch, V_{ds}, to go to zero before the switch turns on. This technique requires a negative current, I_{ds}, at turn on as illustrated in Fig. 2(b). The negative current is used to discharge the capacitor across drain to source to zero before the MOSFET is turned on. The turn-off loss can be significantly reduced by adding a small snubber capacitor across drain and source terminals.

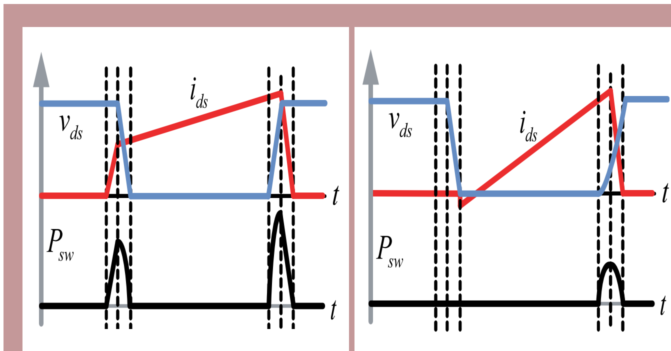

Figure 2(a): Switching Loss **Figure 2(b): Negative Current**

2.2 Bridgeless AC-DC Rectifier

In order to reduce the power loss in the utility lines and to reduce the Electro-Magnetic Interference (EMI), the harmonic current drawn from the AC line is limited. Power Factor Correction (PFC) circuits are required for most power supplies to minimize EMI and harmonic current. Fig. 3 shows a full bridge diode rectifier followed by a Boost converter. Using average current mode control, this circuit is widely employed to achieve PFC.

By forcing the current in inductor L_B to follow the AC voltage, the input current is sinusoidal with the same shape and in phase with the input voltage. Therefore, high power factor is achieved.

A drawback of this circuit is that when the input voltage is positive, or negative, two diode voltage drops (i.e. D_1 and D_4, or D_2 and D_3) plus the voltage drop across D_B or S_B is in the current path, which increases the power loss. This is especially problematic at lower end of the input voltage range.

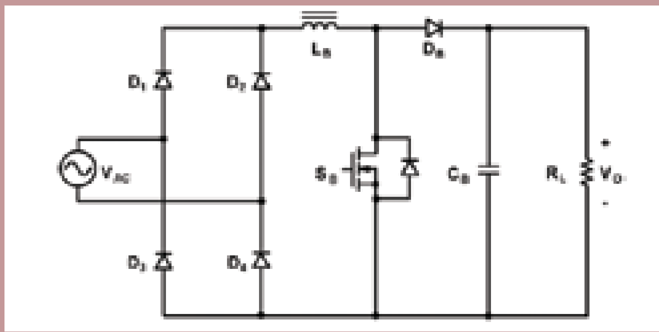

Figure 3: Conventional Boost PFC circuit

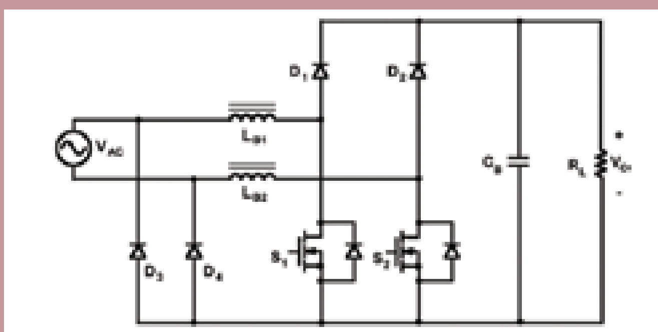

Figure 4: Bridgeless Boost PFC circuit

In order to further improve the efficiency, the Bridgeless PFC Boost converter, shown in Fig.4 was proposed [2], [4].

It is noted that only one diode voltage drop across D_3, or D_4 plus one MOSFET voltage drop across S_1, or S_2, (when MOSFET is on), or two diode voltage drops across D_1, D_4 or D_2, D_3 (when MOSFET is off) will appear in the current path. The reduced conduction loss enables the efficiency to be 97%, or 1% higher than the conventional Boost PFC circuit at low input voltage and full load [2], [3]. Although the Bridgeless Boost PFC circuit requires two inductors and two MOSFETs, the thermal performance will be improved since the heat is more widely distributed. The increased cost will be well compensated by the improved efficiency and therefore, lower operating expenses [2].

2.3 LLC DC-DC Converter

The output DC voltage of the PFC circuit is normally regulated at 400V, which should be converted to 48V, or 12V DC. 48V DC is widely used in communications equipment and 12V DC is used in data centers and computer power supplies.

Again, efficiency and size are the major driving force for the technical innovation occurring through research. Traditionally, the Phase Shift Full Bridge (PSFB) converter is widely used for this application, as shown in Fig. 5 [5].

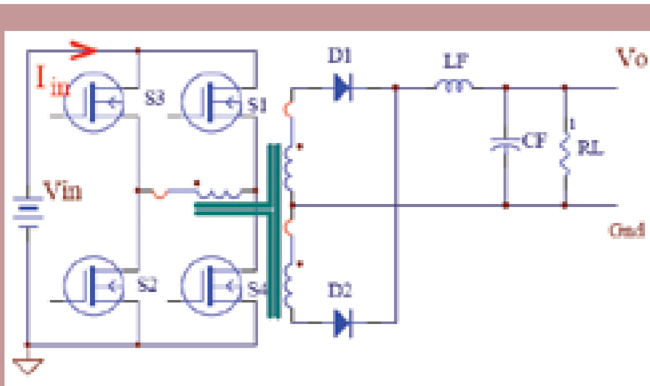

Figure 5: Phase Shift Full Bridge converter

In this converter, pairs S_2/S_3 and S_1/S_4 operate at 50% duty cycle with a small amount of dead time between the pairs and out of phase with each other. The output voltage is regulated by adjusting the phase shift between S_1 and S_3. ZVS for S_1-S_4 can be achieved using the energy stored in the leakage inductance of the transformer. At 12V output, it is beneficial to replace the rectifier diodes, D_1 and D_2, with power MOSFET synchronous rectifiers to reduce conduction loss.

This circuit is well suited for high input voltage applications since ZVS can be achieved. The main drawback of this circuit is that at light load, ZVS is lost. In addition, the leakage inductance resonates with the parasitic capacitance of the rectifier diodes which increases the voltage stress on the diode and therefore introduces additional loss when higher voltage rating diodes are used.

In order to improve the power conversion efficiency, the LLC resonant converter, shown in Fig. 6, was developed in [6] and [7].

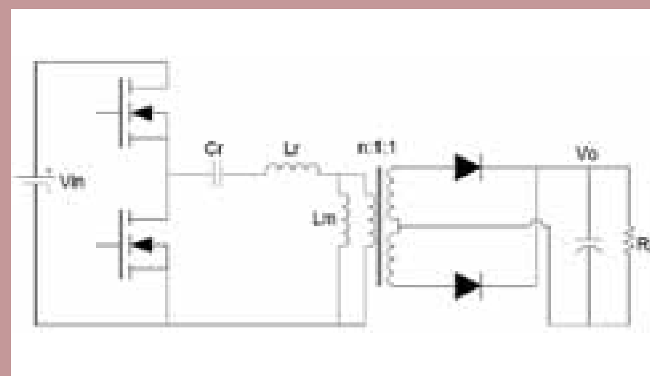

Figure 6: Half Bridge Resonant LLC converter

For the LLC converter, two MOSFETs operate at 50% duty cycle with short dead time. The output voltage is regulated by adjusting the switching frequency. ZVS can be achieved if the current through the resonant tank lags the voltage at the input of the tank. Another advantage is that the voltage stress of the rectifier diode is limited to double the output voltage. Additionally, the converter size can be smaller than the PSFB since no output filter inductor is needed and due to ZVS operation, the switching frequency can be higher than the PSFB, which enables potential integration of the leakage inductance (Lr) and parallel inductance (Lm) into transformer.

Synchronous rectifiers (SRs) can also be used to replace the diodes in order to reduce the rectifier loss for low voltage outputs, such as 12V. In addition, the gate drive signal for the SRs must be carefully designed since the primary side current information is needed [6]. At 400V input, 48V/40A output, and a switching frequency of 1MHz, 96% peak efficiency has been reported [7].

2.4 Non-Isolated DC-DC Converters

On a data communications circuit card, or on a computer motherboard, the input voltage is 12V DC, but the integrated circuits require voltages ranging at logic levels typically of 2.5V, 1.2V and 0.8V. The DC-DC Buck converter is used almost exclusively to step down the voltage for these applications. However, with 12V input and 1.2V output, the Buck converter suffers from problems such as high switching loss, poor dynamic performance and large size.

Numerous topologies have been proposed (such as [8]) to solve the problems inherent to the Buck converter. Among them, the Non-Isolated Full Bridge (NFB) converter with direct input-to-output energy transfer (see Fig. 7), has potential to replace the Buck converter [9].

The unique aspect of the NFB is that the common end of the high side switches (i.e. sources of Q2 and Q4) are connected directly to the output voltage node. Therefore, some of the energy is transferred directly from input to output without passing through the transformer secondary side and synchronous rectifiers. Therefore, the conduction loss for the transformer secondary side winding and synchronous rectifiers is reduced enabling efficiency improvement [9].

In addition, the high side switches, Q1-Q4, operate in phase shift mode, so ZVS can be achieved. Another benefit is that the voltage stress for the synchronous rectifiers is only 3-4 times the output voltage (4 - 5V for

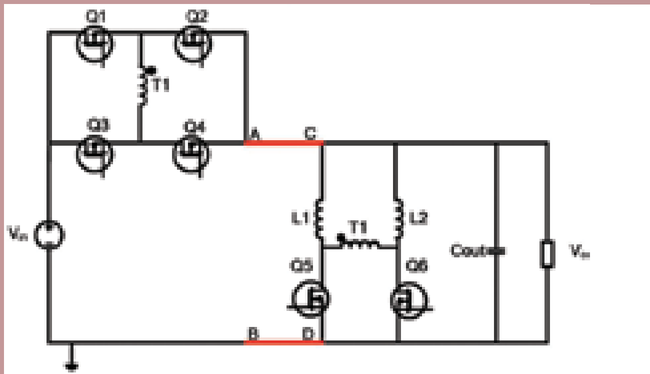

Figure 7: NFB converter with direct energy transfer

1.2V output) rather than a multiple of the input voltage. This enables lower voltage rating MOSFET synchronous rectifiers, which tend to have lower gate charge and on resistance [9].

2.5 Current Source MOSFET Driver

Conventionally, power MOSFETs are turned on by charging the gate capacitor through a voltage source. They are turned off by discharging the gate capacitor to ground through a resistor. A power MOSFET including parasitic with conventional voltage source driver is shown in Fig. 8.

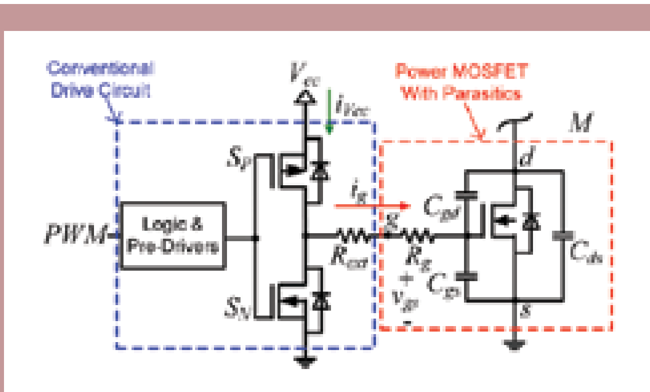

Figure 8: Conventional voltage source MOSFET driver

One problem of the conventional voltage source driver is that the gate energy is lost during the charging and discharging process. However, more importantly, parasitic inductance in the MOSFET leads and circuit reduces the switching speed, and therefore, increases the switching loss. Presently, the switching frequency using a voltage source driver is limited to 300-500 kHz.

Three different Current Source Drivers (CSDs) have been proposed [10]-[12]. Fig. 9 shows the circuit proposed in [12].

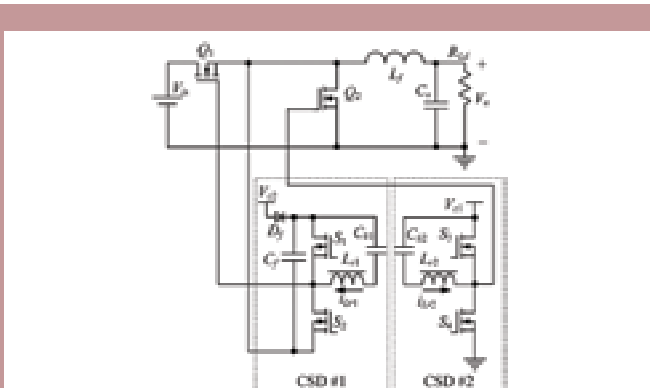

Figure 9: Current source MOSFET driver with the Buck converter

With a CSD, a constant current is used to charge and discharge the MOSFET gate capacitance during turn on and turn off interval. The current source can be implemented using an inductor and two small switches, which direct the current flow. With this approach, some of the gate drive energy can be recovered. More importantly, the impact of the parasitic inductance can be reduced, enabling the switching time and switching loss to be reduced. It has been demonstrated that with CSDs, the efficiency at 1MHz is same as that of voltage source drive at 500 kHz.

3.0 DIGITAL CONTROL FOR SWITCHING POWER SUPPLIES

Traditionally, switching mode power supplies have been almost exclusively controlled by analog circuits, including operational amplifiers, analog comparators, resistors and capacitors. With ever increasing system complexity, including more voltage rails and complicated timing sequencing, monitoring among the rails is needed. However, analog controllers cannot meet these requirements effectively. Fortunately, due to the steady cost reductions of integrated circuits, the feasibility of digitally controlled switching power supplies has increased significantly. Fig. 10 shows the block diagram of a digitally controlled Buck converter.

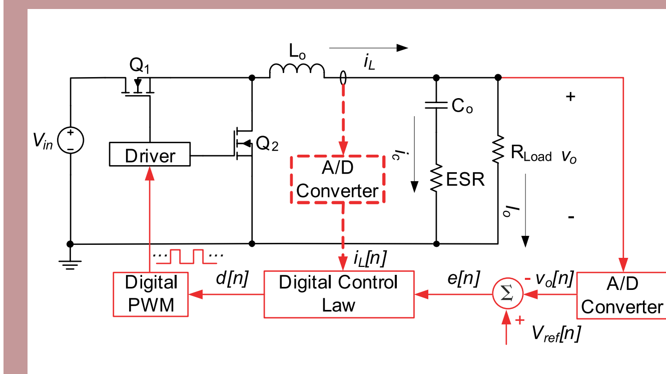

Figure 10: Block diagram of a digitally controlled Buck converter

Three issues should be resolved before digital control of switching power supplies is widely accepted. The first one is the Digital Pulse-Wide-Modulation (DPWM) technique. The second one is achieving a stability analysis method that appeals to power supply designers. The third one is establishing improved control methods that are optimized for digital implementation.

3.1 DPWM Technologies

The output voltage of a Buck converter and other PWM converters are controlled by the duty cycle, which is the on time of the control MOSFET, T_{on}. With analog control, T_{on} is determined by comparing a saw-tooth waveform signal and an error signal using a comparator. Therefore, T_{on} can have any value between 0 and one switching period T_s.

With digital control, T_{on} is discrete. If its resolution is not fine enough, Limit Cycle Oscillation (LCO) can occur. LCO is not caused by instability of the feedback loop. In [13] a detailed analysis of how to avoid LCO is provided. Generally speaking, a resolution of 5-10ns for T_{on} is sufficient to avoid LCO in most applications.

The tapped delay line method [14], or ring oscillator method [15] may be used to create finely controlled DPWM signals. However, these methods require large amounts of silicon area to implement the string of delay elements, or a large multiplexor of size 2N:1, where N is the number of DPWM bits.

In [16], two clocks with similar frequencies are utilized with a dual-edge modulation scheme in order to increase the effective system clock frequency, as shown in Fig. 11.

A Phase Lock Loop (PLL) can also be used to phase shift a clock signal by 360°/N to produce N number of clocks [17] and thus effectively increase the DPWM resolution by a factor of N, as shown in Fig. 12. In the figure, N = 4.

Dithering is another method to effectively increase the DPWM resolution [18]. It involves applying a pattern to successive DPWM signals in order to generate an effectively higher DPWM resolution. In the example illus-

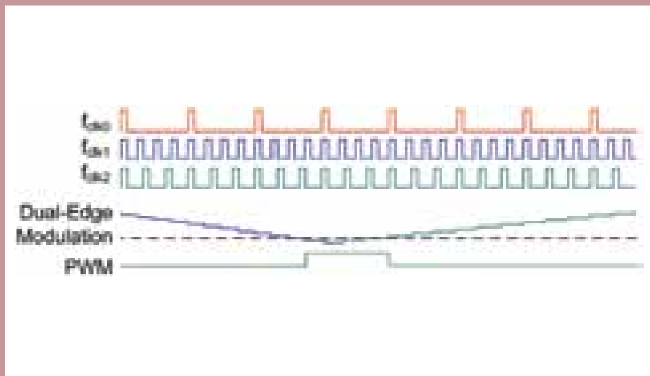

Figure 11: Dual-Clock Dual-Edge DPWM Method

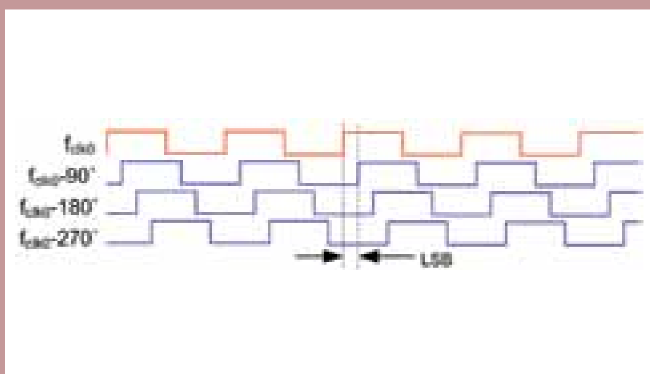

Figure 12: PLL phase shifted clock DPWM

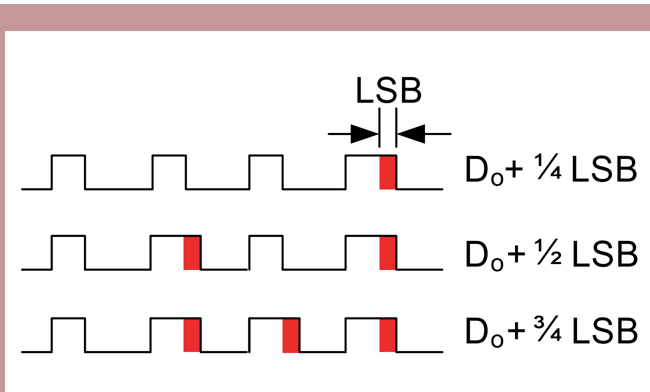

Figure 13: Dither method increasing DPWM resolution by 2 bits

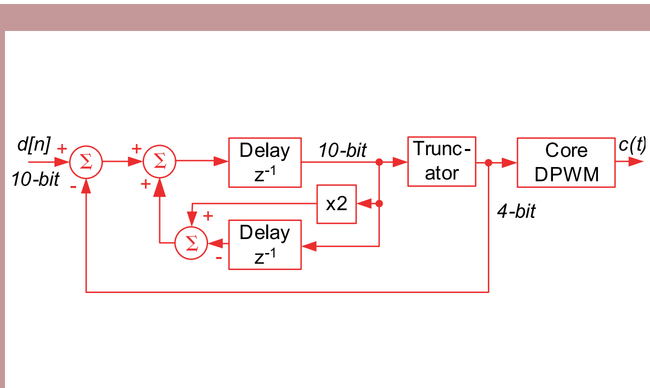

Figure 14: Second-order multi-bit Σ–Δ DPWM generator

trated in Fig. 13, the effective resolution is increased by 2 bits (the acronym "LSB" in the figure represents Least Significant Bit). It is noted that a low frequency tone will be present in the spectrum of the output voltage. Therefore, high bit dithering (i.e. larger than 3 bits) is not advisable.

A second order multi-bit Σ–Δ generator has been proposed to increase the effective resolution of the DPWM with the benefit of reduced magnitude of the low-frequency spectral content compared to dithering, as in Fig. 14 [19].

In the past decade, a significant amount of quality research work has been done in this area. At the present time, it is the authors' opinion that sufficient DPWM resolution has been achieved to meet the output voltage accuracy requirements and to avoid LCO. Recently, the research focus has shifted toward implementing unique features that can only be accomplished using digital circuits.

3.2 Digital Feedback Loop Design Method

Feedback control is critical to maintain stable operation of power supplies and to achieve satisfactory dynamic response. Power supply engineers are accustomed to analog design where zeroes and poles introduced in the feedback loop and open loop transfer functions are used to determine the stability using Bode plots.

In [20], a new digital controller design method based on the analog parameters is proposed. The paper relates the pole and zero frequencies to digital implementation. In this way, digital zeros and poles can be placed at the desired frequencies using the transfer function of the converter power train. In addition, multiple zeroes can be introduced to further boost the phase.

3.3 Dynamic Performance Enhancement

The dynamic performance of switching power supplies can be significantly improved using digital control strategies that can perform complicated arithmetic and logic manipulation. One example is Charge Balance Control (CBC) proposed in [21], which can also be implemented using analog circuits [22]. The key waveforms of the control strategy are illustrated in Fig. 15.

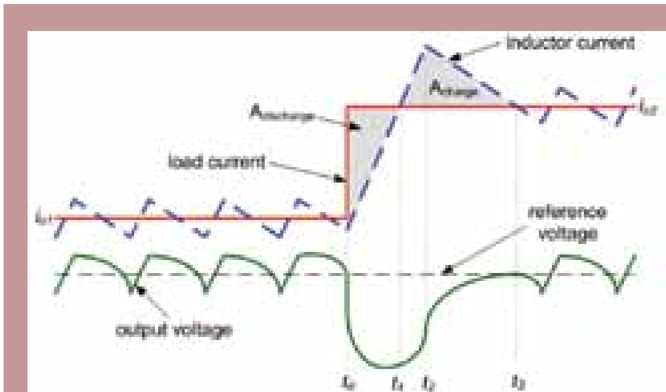

Figure 15: Waveforms for Charge Balance Control

Using CBC, the controller will respond to load current transients immediately at t_0. It has been demonstrated that with CBC, near-optimal dynamic performance can be achieved including smallest overshoot/undershoot and shortest response time. The key point is how to determine time t_2 to turn off the control MOSFET so that the inductor current will reach the new steady state value at the same time, t_3, when the output voltage also recovers from the undershoot. With CBC, this problem has been solved.

3.4 Other Performance Enhancement with Digital Control

Digital control can also be used to improve the converter efficiency under different load conditions. The dead time between the control switch and synchronous rectifier can be dynamically controlled to minimize the body diode loss [23]. In addition, the number of phases in a multi-phase buck voltage regulator can be dynamically changed during operation so that each Buck converter phase operates at its highest efficiency point [24].

Digital auto tuning has tremendous potential for switching power supply design. The idea of a "plug-and-play" controller that can automatically identify and control a converter has attracted interest from both industry and academia. Paper [25] proposes a digital control strategy that can automatically estimate the power train parameters and then design the digital compensating network automatically to achieve stable operation. The significance is that the complicated procedure of digital feedback controller design can be done automatically. The power supply designers can focus on the power circuit design. Therefore, the design cycle can be reduced.

4.0 CONCLUSION

This paper summarizes recent developments in the switching power supply area. The research is focused on two areas, improving conversion efficiency and digital control technologies. In Canada, researchers at the University of Toronto and Queen's University have made significant contributions in these areas.

5.0 REFERENCES

[1] B. Yang, Fred C. Lee, A.J. Zhang and G. Huang, "LLC Resonant Converter for Front End DC/DC Conversion", in Proc. IEEE Applied Power Electronics Conference, 2002, pp. 1108 1112.

[2] L. Huber, Y. Jang and M.M. Jovanovic, "Performance Evaluation of Bridgeless PFC Boost Rectifiers", IEEE Trans. Power Electronics, vol. 23, no. 3, May 2008, pp. 1381 1390.

[3] P. Kong, S. Wang and F.C. Lee, "Common Mode EMI Noise Suppression for Bridgeless PFC Converters", IEEE Trans. Power Electronics, vol. 23, no.1, Jan. 2008, pp. 291 297.

[4] A.F. Souza and I. Barbi, "High Power Factor Rectifier with Reduced Conduction and Commutation Losses", in Proc. Int. Telecommunication Energy Conference, Jun. 1999, pp. 8.1.1–8.1.5.

[5] J. A. Sabate, V. Vlatkovic, R. Ridely, F.C. Lee and B.H. Cho, "Design Considerations for High-voltage High-power Full-bridge ZVS-PWM Converter", in Proc. IEEE Applied Power Electronics Conference, 1991, pp. 158 163.

[6] Bing Lu, Wenduo Liu, Yan Liang, Fred C. Lee and J.D. van Wyk, "Optimal Design Methodology for LLC Resonant Converter", in Proc. IEEE Applied Power Electronics Conference, 2006, pp. 533 538.

[7] D. Fu, B. Lu and F.C. Lee, "1MHz High Efficiency LLC Resonant Converters with Synchronous Rectifier", in Proc. Power Electronics Specialist Conference, 2007, pp. 17 21.

[8] K. Yao, M. Ye, M. Xu and F.C. Lee, "Tapped-inductor Buck Converter for High-step-down DC-DC Conversion", IEEE Trans. Power Electronics, vol. 20, no. 4, Jul. 2005, pp. 775 780.

[9] S. Ye, W. Eberle and Y.F. Liu, "A Novel Non-Isolated Full Bridge Topology for VRM Applications", IEEE Trans. Power Electronics, vol. 23, no. 1, Jan. 2008, pp. 427 437.

[10] Z. Yang, S. Ye and Y.F. Liu, "A New Resonant Gate Drive Circuit for Synchronous Buck Converter", IEEE Trans. Power Electronics, vol. 22, no. 4, Jul. 2007, pp. 1311 1320.

[11] W. Eberle, Z. Zhang, Y.F. Liu and P. C. Sen, "A High Efficiency Synchronous Buck VRM with Current Source Gate Driver", in Proc. IEEE Power Electronics Specialists Conference (PESC), 2007, pp. 21 27.

[12] Z. Zhang, W. Eberle, P. Lin, Y.F. Liu, and P.C. Sen, "A 1-MHz High-Efficiency 12-V Buck Voltage Regulator with a New Current-Source Gate Driver", IEEE Trans. Power Electronics, vol. 23, no. 6, Nov. 2008, pp. 2817 2827.

[13] H. Peng, A. Prodic, E. Alarcon and D. Maksimovic, "Modeling of Quantization Effects of Digitally Controlled DC-DC Converters", IEEE Trans. Power Electronics, vol. 22, no. 1, Jan. 2007, pp. 208 215.

[14] A.P. Dancy and A.P. Chandrakasan, "Ultra Low Power Control Circuits for PWM Converters", IEEE Power Electronics Specialists Conference (PESC), vol. 1, 2007, pp. 22 27.

[15] A.V. Peterchev, J. Xiao, and S.R. Sanders, "Architecture and IC Implementation of a Digital VRM Controller", IEEE Trans. Power Electronics, vol. 18, no. 1, Jan. 2003, pp. 356 364.

[16] Y. Qui, J. Li, H. Ming and D.S. Ha and F.C. Lee, "Proposed DPWM Scheme with Improved Resolution for Switching Power Converters", in Proc. IEEE Applied Power Electronics Conference (APEC), 2007, pp. 1588 1593.

[17] J. Quintero, M. Sanz, A. Barrado and A. Lazaro, "FPGA Based Digital Control with High-Resolution Synchronous DPWM and High Speed Embedded A/D Converter", in Proc. IEEE Applied Power Electronics Conference (APEC), 2009, pp. 1360 1366.

[18] A. Peterchev and S.R. Sanders, "Quantization Resolution and Limit Cycling in Digitally Controlled PWM Converters", IEEE Trans. Power Electronics, vol. 18, no. 1, Jan. 2003, pp. 301 308.

[19] Z. Lukic, N. Rahman and A. Prodic, "Multibit Σ Δ PWM Digital Controller IC for DC-DC Converters Operating at Switching Frequencies Beyond 10MHz", IEEE Trans. Power Electronics, vol. 22, no. 5, Sep. 2007, pp. 1693 1707.

[20] H. Al Atrash and I. Batarseh, "Digital Controller Design for a Practicing Power Electronics Engineer", in Proc. IEEE Applied Power Electronics Conference, 2007, pp. 34 41.

[21] G. Feng, E. Meyer, and Y.F. Liu, "A New Digital Control Algorithm to Achieve Optimal Dynamic Performance in DC-to-DC Converters", IEEE Trans. Power Electronics, vol. 22, no. 4, Jul. 2007, pp. 1489 1498.

[22] E. Meyer, Z. Zhang and Y.F. Liu, "An Optimal Control Method for Buck Converters Using a Practical Capacitor Charge Balance Technique", IEEE Trans. Power Electronics, vol. 23, no. 4, Jul. 2008, pp. 1802 1812.

[23] A. Peterchev and S.R. Sanders, "Digital Multimode Buck Converter Control with Loss-Minimizing Synchronous Rectifier Adaptation", IEEE Trans. Power Electronics, vol. 21, no. 6, Nov. 2006, pp. 1588 1599.

[24] L.T. Jakobsen, O. Garcia, J.A. Oliver, P. Alou, J.A. Cobos and M.A.E. Andersen, "Interleaved Buck Converter with Variable Number of Active Phases and a Predictive Current Sharing Technique", in Proc. IEEE Power Electronics Specialists Conference (PESC), 2008, pp. 3360 3365.

[25] Z. Zhao and A. Prodic, "Limit-Cycle Oscillations Based Auto-Tuning System for Digitally Controlled DC-DC Power Supplies", IEEE Trans. Power Electronics, vol. 22, no. 6, Nov. 2007, pp. 2211 2222.

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Photovoltaic Energy Systems

Part 2: System Control Technology

By Ahmad Yafaoui, Bin Wu, Richard Cheung
Ryerson University, Toronto, Ontario, Canada

Abstract

Solar energy has always been vital for mankind. With the increase in anxiety regarding conventional energy sources, renewable energy sources such as solar energy are gaining enormous significance. Photovoltaic (PV) technology is a means to convert solar energy to electrical energy through solar cells.

PV is implemented as a stand-alone energy source or connected to the grid as distributed electric generation. A key element for efficient and reliable PV operation is proper overall system control. This can be achieved through the following: utilizing the Maximum Power Point Tracking Algorithm to match load impedance to PV array impedance for maximum power transfer; preventing isolation of inverters from the rest of the grid (islanding); and, remote methods of detecting/preventing incipient islanding.

Sommaire

L'énergie solaire a toujours été vitale pour l'humanité. Avec l'accroissement de l'anxiété concernant les sources d'énergies conventionnelles, les sources d'énergies renouvelables telles le solaire ont acquis une importance énorme. Les technologies photovoltaïques (PV) sont un moyen de convertir l'énergie solaire en énergie électrique au moyen de cellules solaires.

Les PV sont implantées comme sources d'énergies autonomes ou reliées au réseau en tant que production distribuée d'électricité. Un élément clé pour une opération PV efficiente et fiable est un système de contrôle global adéquat. Cela peut être obtenu en utilisant l'algorithme de poursuite de points de puissance maximale pour faire correspondre l'impédance de charge à l'impédance du champs de panneaux PV pour un transfert d'énergie maximal; en prévenant l'isolation des onduleurs du reste du réseau (îlotage); et par des méthodes de détection/prévention à distance de début d'îlotage.

1.0 Introduction

The technology of PV features free solar source, little maintenance, no audible noise, and greenhouse gas emission free, which makes it one of the best sustainable energy sources. With global warming and environmental issues, sustainable energy sources are becoming so vital.

In Part One of this article (last issue) we looked at global utilization of PhotoVoltaic Energy, as well as Canada's own utilization. We also examined the charecteristics of various types of PV arrays and compared the performances of four different types of inverters: Central, String, Multi-String and Module.

In Part Two we look at various systems for PV control. In recent years, there have been many improvements in inverter technology, which have led to advances in reliability, efficiency and cost reduction [2]. In addition to these advances, research is heavily conducted in areas such as maximum power point tracking (MPPT) and anti-islanding to ensure high energy yield and safe operation.

2.0 Maximum Power Point Tracking Algorithms

A MPPT algorithm tries to match the load impedance with the PV array impedance at maximum power point in order to ensure maximum power transfer. The MPPT control of the PV system ranges from simple hill-climbing algorithms to fuzzy logic and neural network algorithms. This paper will only present some of the most commonly used ones.

2.1 Hill Climbing (Perturb & Observe) Algorithm

Hill Climbing algorithm (or Perturb & Observe) is an iterative process to reach the maximum power point (MPP). The operating point is perturbed and then the system response is measured to determine the direction of the next perturbation. This process is repeated till the system reaches MPP and oscillates around it [3].

One of the drawbacks of this method is that it fails under rapidly variation in irradiance and environmental conditions [4, 5]. This happens when the change in power due to atmospheric conditions is larger than the changes due to perturbation invoked by the algorithm and in the opposite direction, which results in the operating point shifting in opposite direction [6]. This can be avoided by estimating the change caused by atmospheric conditions separately and then perturbing the system to decide the direction of the next perturbation [7, 8].

2.2 Incremental Conductance

This method is similar to Perturb & Observe algorithm and was proposed for rapidly changing atmospheric conditions [1, 9]. The slope of the power curve is positive on the left side, negative on the right side and zero at the peak as shown in Figure 17 [1, 10, 11]. The slope of the power curve can be found from equation 1 [1, 9, 11].

$$\frac{dP}{dV} = \frac{d(IV)}{dV} = I + V\frac{dI}{dV} \qquad (1)$$

Equating the slope dP/dV to zero yields

$$\frac{dP}{dV} = 0 \qquad \frac{dI}{dV} = -\frac{I}{V} \qquad (2)$$

The right-hand side of equation (2) represents the negative of the conductance while the left hand-side represents the incremental conductance [1, 9, 11]. Thus, by comparing the conductance I/V to the incremental conductance dI/dV the algorithm can track the MPP and stay there until a change of dI or dV occurs as a result of changes in atmospheric condition [4, 9, 11].

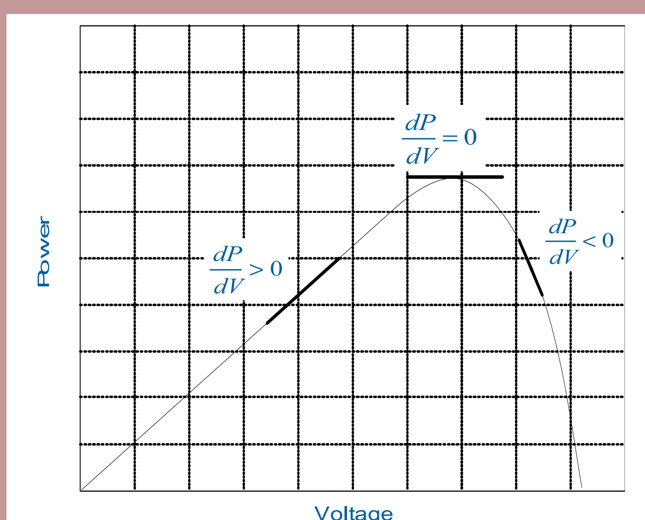

Figure 1: Variation of dP/dV

2.3 Open Circuit Voltage Method

The I-V characteristics of the PV array in Figure 1 suggest a linear relation between the open circuit voltage (Voc) and the maximum power point voltage (VMPP) at different irradiance and temperature conditions [4, 10]. This relation can be described by [1, 11]:

$$V_{MPP} = k_1 V_{OC} \qquad k_1 < 1 \tag{3}$$

The proportionality constant k1 depends on characteristics of the PV array and is determined by measuring the VMPP and Voc at different irradiance and temperature conditions [4]. The momentarily but frequently shutdown of the system in order to measure Voc causes some power loss, which can be avoided by using a separate PV cell to do the measuring [4].

2.4 Short Circuit Current Method

Short circuit current method, which is similar to open circuit voltage method, is based on the fact that the maximum power point current IMPP is linearly proportional to the short circuit current Isc under different environmental conditions [1, 4]. Measuring the short circuit current Isc during operation increases the complexity of the circuit and may require additional components. Furthermore, the power loss associated with finding Isc makes this simple method less popular [1, 4, 11].

3.0 Anti-islanding

Islanding is a phenomenon at which the inverter and some of the load are disconnected from rest of the grid and form an island that is energized by the inverter as shown in Figure 2 [12, 13].

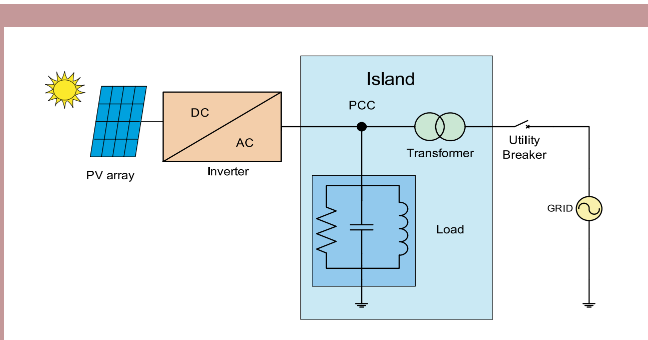

Figure 2: Grid connected PV system

This situation is undesirable since it imposes dangerous conditions for the maintenance personnel, and may cause damage to the inverter and loads in the case of unsynchronized re-connection of the grid [12-14].

Grid connected PV systems are required to implement methods to detect the formation of island and force the inverter to cease energizing it [12, 14]. These methods can be divided into three categories: passive methods, active methods and remote methods [15-17].

3.1 Passive Methods

Passive methods use the grid parameters such as voltage, frequency and harmonics to detect the island formation [15-17]. IEEE 929-2000 standard defines the limits for these parameters at the Point of Common Coupling (PCC) to ensure power quality [12]. These limits are shown in Table 1.

Grid Parameters at PCC	Limit
Voltage	88%<V<110%
Frequency	59.3<F<60.5 Hz
Total harmonic distortion (THD)	THD<5%

Table 1: Grid parameters limits

These limits permit the inverter to operate in between, in order to minimize the unnecessary disconnection of the inverter. The boundary of these limits is called the Non-Detection Zone (NDZ) [13].

3.1.1 Under/Over Voltage Methods

Under/Over-voltage protection is a requirement for all grid connected inverters, and can be used as an anti-islanding method. At the instant of island if the real power generated by the inverter (Pinv) is not equivalent to the power absorbed by the load (Pload), the amplitude of the voltage at PCC will change. The inverter may detect the island if the voltage is beyond limit [13, 16].

3.1.2 Under/Over Frequency Method

Under/Over-frequency protection is another requirement for the grid connected inverters and also can be used as an anti-islanding method. At the island instant if the reactive power delivered by the inverter (Qinv) does not equal the reactive power demanded by the load (QLoad) the voltage at the PCC will experience a sudden jump in phase with respect to the inverter current. As a consequence the inverter control will try to minimize the error by changing the frequency until the reactive power difference (Q) is zero at the resonance frequency of the load [16]. If this frequency exceeds the limit set by IEEE929-2000 standard, the island is detected [12, 13, 15, 16].

3.1.3 Sudden Change in Phase

The sudden change in phase mentioned in the previous method can be used to detect the island formation [15, 16]. After the island formation if the phase change in current is larger than a certain predefined limit $\theta_{threshold}$ the island is detected. This method is rarely used due to the difficulty of setting the threshold to provide reliable islanding detection since the switching of certain loads may result in false tripping [15, 16, 18].

3.1.4 Voltage Harmonic Detection

The harmonics generated by the inverter current is limited to 5% by the IEEE 929-2000 standard [12] and will generate negligible change in the grid voltage THD when the low impedance grid is connected. However, when the grid is disconnected, the inverter current will flow through the load, which has much higher impedance, and thus this harmonic distortion can be measured at the voltage waveform [16]. If the THD of the voltage exceeds some predefined limit the inverter will cease to energize the load [15, 17].

3.2 Active Methods

Active methods inject a perturbation in the current waveform to drive one of the grid parameters out of its limits when an island is formed [15-17]. These perturbations should be small in order not to degrade the power quality when the grid is connected [19].

3.2.1 Impedance Measurement Method

Impedance measurement method changes the amplitude of the current waveform in order to detect the island. One way to do this is to change the amplitude of the current waveform so that the change in the power delivered to the load results in driving the PCC voltage out of its limit [15, 17]. Another method is to make a notch in the current waveform [20]. When the grid is connected, the voltage waveform is undisturbed by the current notch whereas in the island situation the voltage will have a similar notch if the load is resistive; else a distortion in the waveform occurs enabling the detection of the island. If the time constant of the load is much larger than the time length of the notch, this method fails to detect the island [20].

3.2.2 Slip Mode Frequency Shift Method

In slip mode frequency shift method (SMS) the phase angle of the output current of the inverter is a function of the frequency of the voltage at the PCC instead of being always zero [15-17, 21]. When the grid is connected, the system works at the utility frequency, but when an island is formed a small disturbance will force the system to work at the other intersection points, where the island can be detected. For some loads which have their phase increases faster than the inverter, this method fails [16].

3.2.3 Active Frequency Drift

Active frequency drift is achieved by altering the current waveform so that the frequency is determined by the grid voltage when the grid is connected; however during an island situation the operating frequency is drifted up or down. The current waveform is generated by changing the frequency of the sine waveform between $\pi/2$ and π, and between $3\pi/2$ and 2π as show in Figure 4 [15-17, 22].

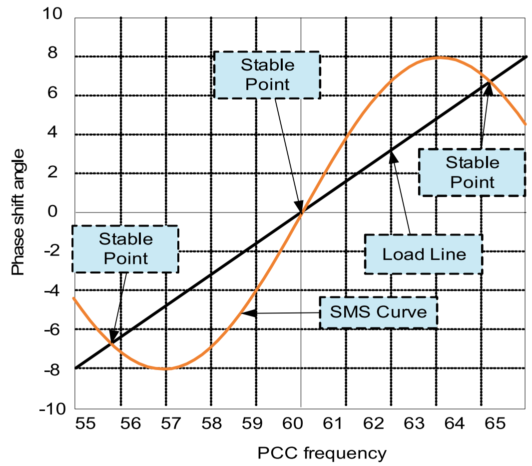

Figure 3: Frequency response of slip mode frequency shift method

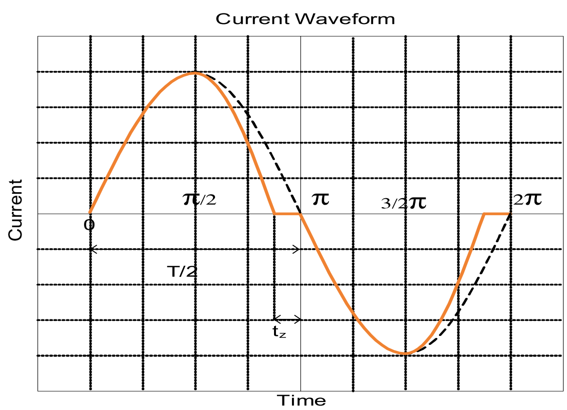

Figure 4: Waveform of active frequency drift method

The time t_z is the zero current time while T is the period of the original signal. The chopping factor C_f is defined as [19, 23]:

$$C_f = \frac{2t_z}{T} \tag{4}$$

3.2.4 Sandia Frequency Drift

Sandia frequency drift, also known as active frequency drift with positive feedback, is the same as the previous method with the chopping factor being a function of the frequency error as expressed by the following equation [15, 17, 19]:

$$C_f = C_{f0} + K(f - 60Hz) \tag{5}$$

When the grid is connected the frequency error is zero; thus, the inverter works at constant chopping factor. However, when an island is formed the frequency is changed due to the distortion in the current waveform, and the error is not zero anymore. Consequently, this leads to a larger Cf and more frequency drift until the frequency is out of limit and the island is detected [15-17].

4.0 Remote Methods

Remote methods usually use a communication means between the utility and the inverter to detect and prevent Islanding [15-17, 24]. These methods usually have no NDZ and are very reliable; but they are expensive and hard to implement thoroughly [17, 24].

4.1 Power Line Carrier Communications

Power line carrier communication method uses a transmitter to send low energy signals through the power line, and eventually theses signals are picked up by a receiver at the inverter side. In case of signal loss (e.g. islanding due to circuit breaker opening) the receiver commands the inverter to cease energy or open a switch to isolate the inverter and the load from the PCC [15, 17].

4.2 Supervisory Control and Data Acquisition

Supervisory control and data acquisition (SCADA) system is widely used in electrical power system to monitor the grid parameters (voltage, frequency, etc.). They are also used to monitor the status of all circuit breakers and re-closers [15-17, 24]. This system can detect unintentional islanding after a loss of grid and issues a transfer trip scheme to isolate the inverter. This method might be very effective but it is highly expensive [15-17, 24].

5.0 Conclusion

This paper offers a comprehensive overview of the photovoltaic systems and their utilization around the world and in Canada. Different types of the PV systems and applications have been discussed with an emphasis on the grid-connected PV systems, which are widely installed in the world. This paper also provides a state-of-the-art review of power converter technologies and control schemes used in a variety of PV systems.

6.0 References

[1] V. Salas, E. Olias, A. Barrado and A. Lazaro, "Review of the maximum power point tracking algorithms for stand-alone photovoltaic systems," *Solar Energy Mater. Solar Cells,* vol. 90, pp. 1555-1578, 2006.

[2] P. P. Barker and J. M. Bing, "Advances in solar photovoltaic technology: an applications perspective," *Power Engineering Society General Meeting, 2005. IEEE,* pp. 1955-1960 Vol. 2, 2005.

[3] N. Femia, G. Petrone, G. Spagnuolo and M. Vitelli, "Optimizing sampling rate of P&O MPPT technique," *Power Electronics Specialists Conference, 2004. PESC 04. 2004 IEEE 35th Annual,* vol. 3, pp. 1945-1949 Vol.3, 2004.

[4] T. Esram and P. L. Chapman, "Comparison of Photovoltaic Array Maximum Power Point Tracking Techniques," *Energy Conversion, IEEE Transactions,* vol. 22, pp. 439-449, 2007.

[5] Y. Jung, J. So, G. Yu and J. Choi, "Improved perturbation and observation method (IP&O) of MPPT control for photovoltaic power systems," in *Photovoltaic Specialists Conference, 2005. Conference Record of the Thirty-First IEEE,* 2005, pp. 1788-1791.

[6] D. Sera, T. Kerekes, R. Teodorescu and F. Blaabjerg, "Improved MPPT algorithms for rapidly changing environmental conditions," in *Power Electronics and Motion Control Conference, 2006. EPE-PEMC 2006. 12th International,* 2006, pp. 1614-1619.

[7] C. Liu, B. Wu, and R. Cheung, "Advanced algorithm for MPPT control of photovoltaic systems," in *1St Canadian Solar Buildings Research Network Conference,* Aug. 2006,

[8] A. Yafaoui, B. Wu and R. Cheung, "Implementation of Maximum Power Point Tracking Algorithm for Residential Photovoltaic Systems," in *2nd Canadian Solar Buildings Conference,Calgary,* 2007,

[9] K. H. Hussein, I. Muta, T. Hoshino and M. Osakada, "Maximum photovoltaic power tracking: an algorithm for rapidly changing atmospheric conditions," *IEE Proceedings: Generation, Transmission and Distribution,* vol. 142, pp. 59-64, 1995.

[10] D. P. Hohm and M. E. Ropp, "Comparative study of maximum power point tracking algorithms using an experimental, programmable, maximum power point tracking test bed," in *Photovoltaic Specialists Conference, 2000. Conference Record of the Twenty-Eighth IEEE,* 2000, pp. 1699-1702.

[11] D. P. Hohm and M. E. Ropp, "Comparative study of maximum power point tracking algorithms," *Prog Photovoltaics Res Appl,* vol. 11, pp. 47-62, 2003.

[12] Anonymous "IEEE Recommended Practice for Utility Interface of Photovoltaic (PV) Systems," *IEEE Std 929-2000,* 2000.

[13] M. Begovic, M. E. Ropp, A. Rohatgi and A. Pregelj, "Determining the sufficiency of standard protective relaying for islanding prevention in grid-connected PV systems," in *2nd World Conf. Exhibition on Photovoltaic Solar Energy Conversion,* 1998, pp. 2519–2524.

[14] Anonymous "IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems," *IEEE Std 1547-2003,* pp. 0_1-16, 2003.

[15] I. J. Balaguer, Heung-Geun Kim, F. Z. Peng and E. I. Ortiz, "Survey of photovoltaic power systems islanding detection methods," *Industrial Electronics, 2008. IECON 2008. 34th Annual Conference of IEEE,* pp. 2247-2252, 2008.

[16] W. Bower and M. E. Ropp, "Evaluation of islanding detection methods for photovoltaic utility-interactive photovoltaic systems," Tech. Rep. IEA-PVPS T5-09:, 2002.

[17] J. Yin, L. Chang and C. Diduch, "Recent developments in islanding detection for distributed power generation," in *Power Engineering, 2004. LESCOPE-04. 2004 Large Engineering Systems Conference on,* 2004, pp. 124-128.

[18] Z. Ye, A. Kolwalkar, Y. Zhang, P. Du and R. Walling, "Evaluation of anti-islanding schemes based on nondetection zone concept," *Power Electronics, IEEE Transactions on,* vol. 19, pp. 1171-1176, 2004.

[19] Y. Jung, J. Choi, B. Yu, J. So and G. Yu, "A novel active frequency drift method of islanding prevention for the grid-connected photovoltaic inverter," in *Power Electronics Specialists Conference, 2005. PESC '05. IEEE 36th,* 2005, pp. 1915-1921.

[20] M. E. Ropp, J. Ginn, J. Stevens, W. Bower and S. Gonzalez, "Simulation and experimental study of the impedance detection anti-islanding method in the single-inverter case," in *Photovoltaic Energy Conversion, Conference Record of the 2006 IEEE 4th World Conference on,* 2006, pp. 2379-2382.

[21] B. Yu, M. Matsui, Y. Jung and G. Yu, "Modeling and design of phase shift anti-islanding method using non-detection zone," *Solar Energy,* vol. 81, pp. 1333-1339, 2007.

[22] M. E. Ropp, M. Begovic and A. Rohatgi, "Analysis and performance assessment of the active frequency drift method of islanding prevention," *Energy Conversion, IEEE Transaction on,* vol. 14, pp. 810-816, 1999.

[23] A. Woyte, R. Belmans and J. Njis, "Testing the islanding protection function of photovoltaic inverters," *Power Engineering Society General Meeting, 2003, IEEE,* vol. 4, 2003.

[ ] P. Mahat, Zhe Chen and B. Bak-Jensen, "Review of islanding detection methods for distributed generation," *Electric Utility Deregulation and Restructuring and Power Technologies, 2008. DRPT 2008. Third International Conference on,* pp. 2743-2748, 2008.

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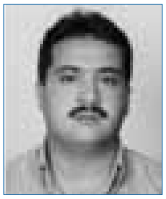

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Community News / ***Nouvelles de la communauté***

Jane Goodall Speaks of Hope

By Rosalyn Seeton, Carleton University, Ottawa

I was invited to attend Jane Goodall's lecture "Reason for Hope" in Ottawa last April as a member of IEEE Ottawa Women In Engineering - a co-sponsor to the event. Walking into the lobby, the buzz of anticipation that precedes a performance seemed greater than usual, as if everyone knew they were in for a once-in-a-lifetime treat. We found our seats, and were surprised to find a complimentary package of Fair Trade coffee in each, provided in honour of the special guest's visit.

I felt a little surge of pride when IEEE WIE was thanked as a sponsor in the opening remarks and then, in no time, there she was, walking onto the stage with her stuffed monkey. She put him down on the table beside the podium and waited patiently for the applause to subside before responding with a hooting greeting from the chimps.

She started by talking about her childhood and first interests in worms, chickens, Dr. Doolittle and Tarzan. She spoke about her mother, who had to patiently explain to her that the worms had to live outside and couldn't sleep in her bed. Her mother also reacted calmly when a very young Jane went missing for several hours because she was hiding inside the chicken roost trying to find out how the hens laid their eggs.

Dr. Goodall went on to talk about her determination to get to Africa despite her humble background, an extraordinary goal for a young woman at that time. Nevertheless she persisted, worked very hard, and managed to get there. She emphasized how much support her mother provided in order for her to pursue her dreams. She spoke about going back to school eventually, skipping right to a PhD and being told that she had done many things wrong: She should not have named the chimps, and they certainly did not have personalities. Jane Goodall was not persuaded. This would certainly not be the last time she opposed traditional views; her career is marked by groundbreaking discoveries such as her observation that chimps create and use tools. The world had to catch up with her and recreate the definition of "man".

She finished by talking about the Roots and Shoots program managed by the Jane Goodall Institute and the work needed to save wildlife habitats and keep the world sustainable. She took questions from the audience, took the time to autograph books, have her picture taken, and have a few words with those willing to wait for the opportunity. Thanks to her stamina and patience, she was able to communicate on a personal basis with many of us in the audience; it is at this point, speaking to her face-to-face, that one remembers that she is just a regular person too and that each of us can make as much of a difference in our world as she has. Everyone leaving the theatre was excited by the hope that she radiates.

Left to right: Sandra McGuire, Ottawa Carleton University WIE Affinity Group Vice-Chair; Carolyn MacIsaac, Ottawa Section WIE Vice-Chair; Preeti Raman, Ottawa Section WIE Chair 2007-2008; Dr. Jane Goodall; and, Rosalyn Seeton, Ottawa Carleton University EMBS Chapter Vice-Chair and WIE member.

2009 IEEE Canada–TELUS Innovation Contest Winners

1st Place ($10,000) Concordia University
Sam Sadighi, Issa Al-Fanek, Eric Louise
Multi-touch, multi-user interactive surface using computer vision

2nd Place ($5, 000) University of Alberta
***Front Row:* Noel Tsang, Tammy Chen, Taban Rizvi**
***Back Row:* Michael Choi, Michael Gysel**
Wireless respiratory rate monitor

3rd Place ($2,000) University of Manitoba
Mark Roy, Paul Klassen
A road quality measurement system using GPS technology

TELUS

The 2009 Awards were presented September 18 at the IEEE Canada Student Conference, at the Toronto Delta Airport Hotel.

Congratulations to the winning teams and to all participants. The top three entries are awarded $10,000, $5,000 and $2,000, respectively. Many thanks to TELUS for its continued support of the Contest; 2009 marked the fifth time the Awards have been presented.

The presentations were jointly made by Ferial El-Hawary, President of IEEE Canada (far left in photos) and Jerome Birot, Manager of Services Architecture, Chief Technology Office, TELUS (at far right in top photo). Two runner-up teams are also selected each year, each of which receives $500. This year's runners-up were from Carleton University and the University of Victoria.

Previous Award Finalists

	Award	School	Project Title
2008	1st	Queen's University	Speech Synthesis Through Gesture Recognition
	2nd	University of British Columbia	The dScrybe Digital Receipt System
	3rd	University of Alberta	Foresight: Distributed Monitoring for a Forestry Environment
2007	1st	University of Alberta	Compressor Monitoring Unit
	2nd	McMaster University	The CPR Glove
	3rd	University of Saskatchewan	WiFi Positioning System
2006	1st	Memorial University of Newfoundland	Scribe: A Real-Time Transcription Tool
	2nd	University of Saskatchewan	iHold Music on Hold Device
	3rd	Conestoga College	DigiPhase Acoustic Processor
2005	1st	Lakehead University	Stabilization of an Inverted Pendulum on a Mobile Robot
	2nd	University of Toronto	Eight Element Beam-Steerable Antenna Array at 5.2 GHz
	3rd	Dalhouse University	The Nice Rack

IEEE Canada

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2008 IEEE Canadian Foundation Honour Roll of Donors

This Honour Roll of Donors celebrates those of you who have generously given to the IEEE Canadian Foundation (ICF) in 2008. Your gifts have enabled our foundation to continue to enhance the learning experience of engineering students through our programs of IEEE McNaughton Centres and Scholarships, and Special Grants.

An Evolving Organization

While our predecessor organization IEEC Inc. (owner of the Toronto based conference) and more recently MCI (owner if the Montreal based conference) have supported IEEE activities in Canada since 1955, we have been steadily evolving into a national foundation with bilingual services. Since we have excellent relations with the IEEE Foundation, we have recently approved a mission statement to more clearly align our activities with the IEEE and the IEEE Foundation mission, and we are able to take advantage of their experience and assistance, while retaining our unique Canadian approach. No donations are spent on staff or travel – we use the Internet to conduct business, augmented by minimal telephone use.

What's New in Grants

We are in the process of emphasizing our new goal of encouraging projects that apply technology for the benefit of humanity.

What's New in Endowed Scholarships and Grants

Starting in 2004, we are able to offer annually: two Vehicular Technology Awards, one Power Quality Scholarship, one Women-In-Engineering Prize, and two Quebec Science Fair Prizes. Starting this year, three of the IEEE Canada major awards have been endowed; the R.A. Fessenden Medal (Telecommunication) is sponsored by TELUS, the Outstanding Engineering Educator Medal is sponsored by the Canadian Heads of Electrical and Computer Engineering, and the W.S. Read Outstanding Service Medal is sponsored by the IEEE Canadian Foundation.

IEEE Canadian Foundation
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Four Ways to Donate - In addition to making a donation when you renew your IEEE membership, (at any time) you can use our secure Canadian online donations website (from our home page) which gives you a tax receipt by return email, or you can phone using a credit card or mail a cheque to our treasurer.

Planned Giving - You can name the IEEE Canadian Foundation as your beneficiary or donate an existing policy that you no longer need, or make a charitable bequest to the IEEE Canadian Foundation in your will or living trust.

Matching Gifts – Our Donations web page has links to lists of corporations that have a policy of matching individual donations with an equal corporate contribution, thereby increasing the value of your donation.

Mission Statement

The IEEE Canadian Foundation cultivates resources and relationships to advance IEEE's core purpose to foster technological innovation and excellence to benefit humanity.

The IEEE Canadian Foundation fulfills its purpose:

- by awarding special grants to new and innovative projects within Canada that seek to apply technology for the benefit of humanity, and
- by awarding grants to IEEE student branches in Canada to support IEEE McNaughton Learning Resource Centres and related scholarships, and
- by serving as the fund administrator for peer recognition programs and scholarships within Canada

Foundation Funds - Unless specified all donations are placed in our General Fund which supports McNaughton Centres, ICF Scholarships and Special Grants. Life Members can now give to our new Canadian Life Members Fund. Our Endowed funds include the Judy Clift Fund, the MCI Fund, the TELUS Fund, and the ECE Department Chairs Fund. Any person, company, or IEEE unit can create a similarly unique fund to establish an annual scholarship or prize by making a directed donation. A one-time donation of $20,000 funds a $1,000 award. A $60,000 donation funds a $3000 award, etc.

Updated Website – we have recently added a new home page to recognize our donors and show how your donations - which translate into grants - make a difference. We tell eight success stories, each taken from an ICF Grant report from 2002 to 2009.

Success Stories from ICF Grants

These include upgrading a McNaughton Centre at Red River College, a Dalhousie University Student Branch arranged tour of five Nova Scotia companies, Winnipeg Section WIE affinity group constructing a robot to showcase women in engineering and present engineering as a fun and interesting career choice for young people, a multidisciplinary team of undergrads from U of Saskatchewan that won first place in NASA's 2010 space elevator contest in Salt Lake City, undergrads from U Laval winning third place in a soccer contest for robots in Georgia, and several others. These stories illustrate the determination, inventiveness, and entrepreneurship developed by our young people when given the chance.

Investment Performance Report

Despite the horrible performance of investments worldwide over the past year or two, our new investment strategy which is overseen by our new investment advisory committee – consisting of three investment professionals with long term experience on the IEEE investment committee – our investments returns are staying relatively constant. We use a conservative portfolio mix of 50% fixed income, 25% equity income and 25% stocks.

Disbursements Policy

The foundation is required by Revenue Canada to disburse at least 80% of undirected donations and at least 3.5% of our general fund. We normally budget to allocate all of our previous year's undirected donations and 5% of our investment income. Broadly this means one third of our expenditures come from undirected donations.

Opportunities for Donors

Our General Fund is crucial to our ability to operate each and every year, so please continue with your undirected donations and keep our base strong. If there are special circumstances, please consider an additional significant gift to endow an IEEE Canada award or create a new award of your choosing. IEEE Canada major awards such as the Electric Power, Computer, and Outstanding Engineer awards are available for endowment – these require a $20,000 one-time directed donation and are ideal for corporate sponsorships. The IEEE has identified the general area of using technology for the benefit of humanity as the one that resonates most closely with IEEE members. We would like to expand our special grants program in this area beyond IEEE Student Branch projects which tend to be limited in scope so we welcome additional gifts for this purpose.

I am proud of the work the IEEE Canadian Foundation does to support IEEE in Canada, and very appreciative of your past support and earnestly urge you to continue to do so and increase your contributions where possible. If you have not yet made a donation, I urge you to please do so – we could do so much more with your financial support. If there are ways you feel we can do better, please contact me – I welcome your suggestions.

Yours sincerely,

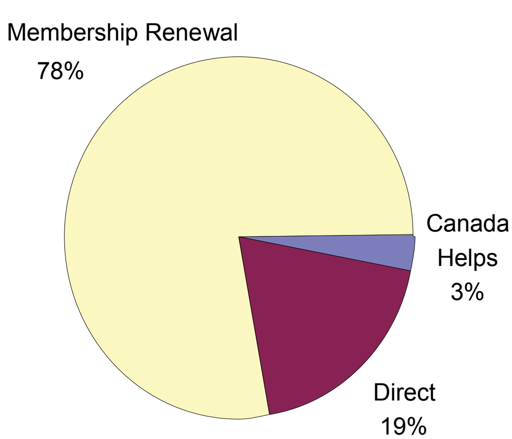
Robert T.H. (Bob) Alden
President
IEEE Canadian Foundation

2008 Year in Review

Below is an overview on two aspects of 2008 donations, where 299 donors gave a total of $18,059. We sincerely thank every one of you for your generosity. On the next page, we are using the same two sets of gift associations and donation categories as the IEEE Foundation, more details can be found on our website under Donations.

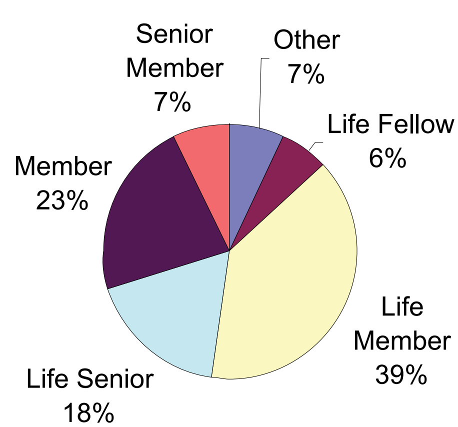
2008 Method of Giving

This pie chart shows the percentage of donations contributed using the membership renewal process, credit card or cheque direct to the foundation treasurer, or our Canadian online donations portal – Canada Helps.



2008 Giving by Individuals

This pie chart shows the percentages of contributors in each IEEE membership grade.



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The theme for the 3rd Annual IEEE Canada Electrical Power and Energy Conference is "*Sustainable/Renewable Energy Systems and Technologies*". This year's conference will host academics, consumers, industries, and governments, to showcase research and advancement in the technological areas of solar, wind, tidal, hydrogen, biomass, and electric/hybrid electric vehicles. The 2-day event will feature keynote dialogues with simultaneous special presentations, workshops, and tutorials.

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- **Hydrogen Power**
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- **Novel Power Generation**
- **Energy Storage**
- **Energy Management**
- **Wind Power**
- **Energy Systems for Buildings**
- **Urban Environment**
- **Electric/Hybrid Electric Vehicles**
- **Energy Conservation**
- **Technology Trends**

For registration and further information, contact tonkoski@ieee.org **or visit the following website:**

http://www.ieee.ca/epec09

IEEE Montréal · IEEE Ottawa Section · Concordia University · IEEE PES Power & Energy Society · IEEE

Historical Achievements and Milestones

by Dave Kemp

As a lead-up to IEEE's 125th anniversary in 2009, in the Fall of 2008 IEEE Canada published *A 25-Year History of IEEE Canada: Advancing Engineering Across Borders*. You can view this publication at http://www.ieee.ca/history/index.html. This booklet was distributed to delegates attending Sections Congress 2008 and the IEEE Honors Ceremony at Quebec City in September 2008. With this issue of the *ICR* we begin to make this same material available to the general membership of IEEE Canada in an expanded format.

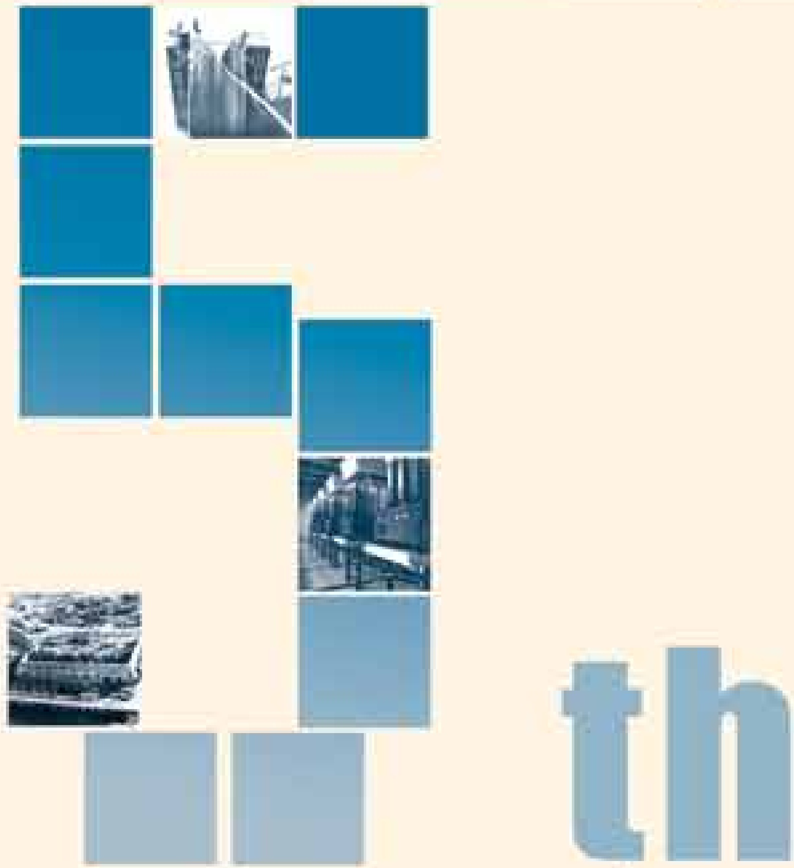
Canada has a long and rich history of achievement. Ten items have met the criteria to be designated an IEEE Milestone. This is statistically significant in that Canada's portion of IEEE membership is 4 percent, while we have 10 percent of milestones.

Featuring the people, events, places, and accomplishments of electrical, electronic, and computer engineers with a Canadian flavor is not new. With IEEE celebrating its 125th it seems appropriate that we give it a little more emphasis. In this issue we kick off the series with a few items:

- We portray the timelines of the creation of IEEE and then IEEE Canada.
- Dr. Bob Alden describes his involvement on the formal steps within Canada and IEEE to have Region 7 officially recognized as what we now know as IEEE Canada.
- IEEE Canada's most recently dedicated Milestone—First External Cardiac Pacemaker

History buffs will find a wide array of content at the following sites on the Web:

- IEEE Canada History — ieee.ca/history/
- Showcase of Canadian Engineering Achievement — ieee.ca/showcase/
- IEEE Global History Network — ieeeghn.org/wiki/
- IEEE History Center — ieee.org/web/aboutus/history_center/



by Bob Alden, Professor Emeritus,
McMaster University

Great Expectations, Great Achievements

The Creation of IEEE Canada

This story is quintessentially Canadian, heavily influenced by our neighbours to our south, unable to agree among ourselves, but tortuously progressing to a made-in-Canada solution that is unique and works very well. This is the first of a series of articles that highlight historical accomplishments that relate to the IEEE sphere of influence.

Of the 382,000 IEEE members worldwide, 16,000 plus live in Canada and we Canadians have a unique situation within IEEE.

IEEE Canada is a Canadian entity within two organizations, IEEE Inc. incorporated in the United States with a worldwide mandate in the advancement of technology, and the Engineering Institute of Canada with a mandate across all branches of engineering in Canada. This situation has formally existed since 1995 and is a marked change from the situation in 1969 as described by Gordon Slemon in the next page. I begin with his assessment of the early days (pre-1970) of engineering organizations in Canada.

1.0 The Early Days in Canada: 1887 to 1969

The Canadian Society of Civil Engineers (which at that time implied non-Military Engineers) was formed in 1887 and became the Engineering Institute of Canada (EIC) in 1918. On three occasions, in 1925, 1935 and 1953, the EIC attempted to unify all engineering disciplines in Canada under its umbrella but none of these attempts was successful. EIC also attempted unsuccessfully to merge with the professional regulatory bodies and with the Canadian Council of Professional Engineers.

There were branches of the American Institute of Electrical Engineers (AIEE) in Canada starting in 1903 and branches of the Institute of Radio Engineers (IRE) from 1925. Branches of the UK-based Institution of Electrical Engineers (IEE) have operated in Canada since about 1958. [Note: the IEE merged with the Institution of Incorporated Engineers (IIE) in 2006 to form the Institution of Engineering and Technology (IET)]. In 1963 the AIEE and IRE merged to form the Institute of Electrical and Electronics Engineerers (IEEE).

By 1969 the memberships in these organizations were about 8000 for IEEE Region 7, 1200 for IEE and about 2000 for the Electrical, Communications and Automation Divisions of EIC. Very few belonged to more than one of these bodies. Each had an argument for exclusive terrain.

- EIC felt that it was the historic Canadian society deserving of the support of all Canadian engineers.
- IEEE policy had been to recognize EIC as the national organization in Canada. It refrained from establishing branches here until 1958. The Canadian IEE membership was largely immigrants from UK or from the former British Empire. Their branches were successfully maintaining the link with UK and providing personal interaction.
- IEEE members generally felt that they were receiving the services that they valued from their well-established IEEE publications, conferences and sections. They felt that EIC was dominated by civil engineers.

There was a limited amount of local cooperation among the societies, usually accompanied by a degree of mutual antagonism. At the same time the fragmentation of the Canadian electrical community was deplored by many and there was a growing mood of nationalism in the country.

It was with this background that a number of interested individuals held an informal meeting at the International Electronics Conference in Toronto in September 1969. Three models were discussed:

- an independent Canadian Society of Electrical Engineers,
- a more autonomous IEEE Region 7, and
- an EIC-constituent Canadian Society of Electrical Engineers.

It was an omen of things to come that the support for these three models was almost evenly divided at that meeting.

Acronyms used for Organization and Publication Names

AIEE	American Institute of Electrical Engineers
EIC	Engineering Institute of Canada
CEEJ	Canadian Electrical Engineering Journal
CJECE	Canadian Journal of Electrical and Computer Eng.
CSEE	Canadian Society for Electrical Engineering
CSECE	Canadian Society for Electrical and Computer Eng.
ICR	IEEE Canadian Review
ICF	IEEE Canadian Foundation
IEEE	Institute of Electrical and Electronics Engineers
IRE	Institute of Radio Engineers

About IEEE Canada

IEEE Canada (Region 7) is the Canadian arm of IEEE, as well as the constituent society of the Engineering Institute of Canada (EIC) for the technical fields of electrical, electronics and computer engineering. While both organizations provide educational services and products, IEEE provides technical information through its member societies and EIC focuses on the professional component. By bringing together both entities, IEEE Canada can provide its members with quality information on the latest technology and important networking opportunities.

Early Milestones of AIEE/IRE/IEEE History in Canada

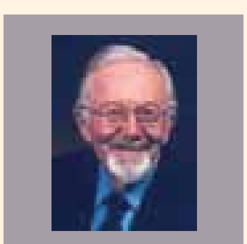
1884	AIEE* formed in Philadelphia, USA
1887	Canadian Society of Civil Engineers (CSCE) formed
1901	Marconi's first transatlantic wireless reception in St. John's, Newfoundland
1903	AIEE Toronto Section formed at the Engineers Club in Toronto
1912	IRE** formed by merging the Society of Wireless Telegraph Engineers and the Wireless Institute
1912	CSCE becomes the Engineering Institute of Canada (EIC)
1921	AIEE District 10 (Canada) formed
1925	IRE Canadian Section formed at Canadian General Electric in Toronto
1944	Ralph Hackbush becomes first Canadian to be IRE Vice President
1957	John Henderson becomes first Canadian to be IRE President
1963	IEEE Region 7 created out of AIEE District 10 (Canada) and IRE Region 8 (Canada) during the merger of AIEE and IRE
1972	Bob Tanner becomes first Canadian to be IEEE President
1976	CSEE formed
1990	CSEE renamed CSECE
1995	IEEE Region 7 and CSECE merge to form IEEE Canada

John Hendersen
First Canadian IRE President

*American Institute of Electrical Engineers
** Institute of Radio Engineers

2 A 25-YEAR HISTORY OF IEEE CANADA

2.0 The Committee & Birth of CSEE: 1970 to 1973



Gordon Slemon

During this time frame, a "steering committee" emerged and a series of about 20 meetings in Toronto and elsewhere was held. Initially the intent was to attempt to rationalize and coordinate the activities of EIC, IEE and IEEE. When the EIC decided in Oct. 1972 to create its own constituent society CSEE, the steering committee morphed into a CSEE-IEEE Joint Committee. The steering committee was initiated in 1969 by Gord Slemon. He was appointed as intersociety relations chair for IEEE Region 7, CSEE and IEE, and he was elected chair of the steering committee. He worked tirelessly throughout these 20 or so meetings and beyond (to the late 80s) to encourage cooperation among the "competitors". These meetings included those of the steering committee as well as meetings with IEE, EIC, IEEE Region 7 and the IEEE leadership. I will come back to the role of the IEEE leadership in decentralizing the IEEE structure later on. It is fair to say that EIC was interested in promoting the Canadian entity and that virtually all IEEE members were satisfied to retain their IEEE services. One of Gordon Slemon's key contributions was in keeping the various organizations aware of the fact that a problem did exist—a non-trivial problem with the constantly changing membership of volunteer committees.

IEEE Canada History

In 1969, there were three technical organizations with a focus on electrical engineering in Canada: IEEE, which included 31 technical groups spanning a wide range of interests and 10 regions across the world; the Engineering Institute of Canada (EIC), which had members in various disciplines including civil and electrical engineering; and the Institution of Electrical Engineers (IEE), a licensing body for British electrical engineers. Despite obvious interest in the field, there was no single Canadian organization for electrical engineering.

According to Bob Alden, IEEE Vice President of Regional Activities, 1990-1991, it took 25 years of hard work from dedicated individuals for IEEE Canada, which serves as both Region 7 of a decentralized IEEE and a member society of EIC, to be formed in 1995.

Two such individuals, Bob Tanner, IEEE Region 7 Director, 1968, IEEE President, 1972; and Bill Thomson, IEEE Region 7 Director, 1970-1971, were pivotal in creating the environment for the future IEEE Canada. Tanner's contribution was as the principal author of the first IEEE long-range planning report, while Thomson obtained important funding for the startup of the first IEEE Region 7 office. George Armitage, who served as Manager for the original office in Thornhill, Ontario, also made important efforts to realize the vision of IEEE Canada. Alden, who served as IEEE Region 7 Director, 1988-1989, oversaw the official naming of IEEE Canada and the publishing of the region's magazine, IEEE Canadian Review.

In 1995, the Canadian Society of Electrical and Computer Engineering (CSECE), previously the Canadian Society of Civil Engineering (CSCE), joined with IEEE Region 7 and officially formed IEEE Canada in order to better serve the needs of engineering professionals across Canada.

Guglielmo Marconi (left), a pioneer in wireless telephony, with his assistant George Kemp.

Marconi workers at Signal Hill in St. John's, Newfoundland, with antenna kite for transatlantic signal.

A 25-YEAR HISTORY OF IEEE CANADA 3

3.0 The Doldrums: 1974 to 1987

I choose this title only to emphasize that very little happened on the transitional journey to IEEE Canada except that both CSEE and IEEE Region 7 continued on their separate ways. CSEE started officially in 1976 with first president Tom Pavlasek and produced its own journal CEEJ in the same year with George Holbrook as its first editor and funding from NRC (the National Research Council) as well as a start-up grant from IEEC Inc (now the IEEE Canadian Foundation). IEEE Region 7 and its 20 Sections continued to provide excellent services for its members. In many cases IEEE Section meetings were offered as being "joint" with the fledgling CSEE.

4.0 The Shaping of the Merger: 1988 to 1994

Both "competitors" (IEEE Region 7 and CSEE) started to develop specific strengths that led, in the early 1990s, to the state where a merger was desirable by all sides.

These developments are about long-term dedicated volunteer commitment. Many volunteers, working for both organizations, dedicated to improving their profession—in this case, from an organization and service perspective. The leadership comes from those elected to serve as CSEE President or IEEE Region 7 Director, supplemented in large measure by countless additional volunteers who provide the actual member services.

	CSEE, CSECE Presidents
1994	Tony Eastham
1992, 93	Jean-Rémi Giroux
1990, 91	John Plant
1988, 89	Cam Blachford
1986, 87	Mo El-Hawary
1983, 84, 85	Tas Venetsanopoulos
1981, 82	Dinkar Mukhedkar
1978, 79, 80	Chuck Campling
1977	Colin diCenzo
1976	Tom Pavlasek

	IEEE Regional Directors (1968-1995)
1994-1995	Ray Findlay, (2002 IEEE President)
1992-1993	Vijay Bhargava
1990-1991	Tony Eastham
1988-1989	Bob Alden
1986-1987	Gord English
1984-1985	Wally Read (1996 IEEE President)
1982-1983	Fred Heath
1980-1981	Jean-Jacques Archambault
1978-1979	Ted Glass
1976-1977	Frank Creed
1974-1975	George Sinclair
1972-1973	Doug Hinton
1970-1971	Bill Thompson
1968-1969	Bob Tanner (1972 IEEE President)

I have the privilege to have known all of the volunteers noted in the two lists of volunteer leaders. It is interesting to observe that all (both lists) are dedicated IEEE volunteers—serving their profession in one organization or the other. This fact suggests that eventually the merger will occur—if it is the right thing to do. These are part of our IEEE family.

For the rest of this part of the story, I write it as a personal account of my volunteer family's efforts to do the right thing. I hope it will tell the story of how things were at that time and how we collectively worked to improve member services and develop our Canadian solution.

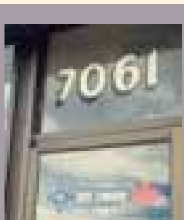
My involvement with engineering organizations began in a typical small way in 1958 as a student member of both the AIEE and the IRE, and increased in 1971 when I was drafted as my employer's representative on the local IEEE section executive committee. One of my first assignments was to run a technical training program, which I mistakenly thought was to educate my fellow IEEE members. After proposing a naive program which would likely lose money, I was very directly instructed that my objective was to produce a training program for non-members that local industry would want to support so that the program surplus would enable the section to fund the newsletter (which in those days involved the postal service) and other member benefit activities. I learned quickly and my revised plan met with executive committee approval and did the job! The next year, I was "promoted" to section vice-chair and had the opportunity to attend my first region committee meeting, representing my section chair who was unable to attend.

4.1 Decentralizing IEEE

That 1973 IEEE Region 7 meeting of all section chairs and other volunteers (Doug Hinton was the Director) was held in New York City at the IEEE headquarters in the United Engineering Centre (opposite the United Nations building) and run by very nice Americans who were the IEEE headquarters staff. While these folks were very welcoming and competent, in my view they were not particularly interested in Canadian activities other than we were number 7 out of 10 regions and the focus seemed to be on the first six (the U.S. regions). There seemed to be a lot of U.S. politics and viewpoints, including discussions about the creation of a United States Activities Board. While the meeting location and staff approach indicated a very centralized IEEE operation, I came to realize that the IEEE was changing, due to a number of dedicated volunteers—especially some with Canadian ties.

Robert Tanner

Two of these Canadians were pivotal in creating the environment for the future IEEE Canada: Bob Tanner (who served as Region 7 Director in 1968 and 1969, then as IEEE Secretary in 1970, IEEE Vice President in 1971, and IEEE President in 1972); along with Bill Thompson (who succeeded Bob as Region 7 Director for 1970 and 1971). Bob Tanner was the principal author of the first IEEE long range planning report. It spelled out an evolution for IEEE regions to become self governing. Bob provided the concept and Bill provided the mechanism. Bill Thompson obtained special funding for the startup of an office in Region 7—this was one of two such experiments, the other was in Los Angeles in Region 6.



Canadian Office

Bill hired George Armitage as the manager who set up the office at 7061 Yonge Street in Thornhill, Ontario (just north of the North York boundary) where it existed for twenty two years. The physical office closed in 1993 and was replaced in 1994 by a virtual office run by Cathie Lowell using the various electronic/internet services which were emerging at that time.

The decentralization of IEEE and the creation of the Canadian Office were, in my view, the basis for the Canadian entity we know today. George hired an assistant, first Ila Worsdale, then Dorothy Millman, to be in the office and began a process of visiting sections and giving technical training courses —the content for these courses was in white three-ring binders with the name "IEEE Canada" on the cover— together with a blue IEEE logo on the left and a red maple leaf on the right. This was the first time that I saw the "IEEE Canada" concept in existence. The Canadian Office created a physical focus for a distinctly Canadian operation. At the end of 1983 both George and Dorothy retired and Fred Heath (1982-83 Region 7 Director) became the office manager (from 1984-87), with Pam Woodrow hired to replace Dorothy. At that time a major office activity was selling IEEE Standards and Sandy Artinger was hired to help

George Armitage

with this venture—which was profitable for the office and convenient for Canadian members and companies until IEEE changed its way of distributing standards in the early 90s. When Fred Heath retired at the end of 1987, I promoted Pam to be Manager of Canadian Member Services. As part of that mandate, Pam became very involved with supporting Student Branches—attendance at the annual Student Branch Workshop was the highest in those years. Shown below is a photo I took of Pam Woodrow with Hazel Scott (Regional Student Representative) and Gerald Karam (Student Activities Coordinator), taken in the office in 1988.

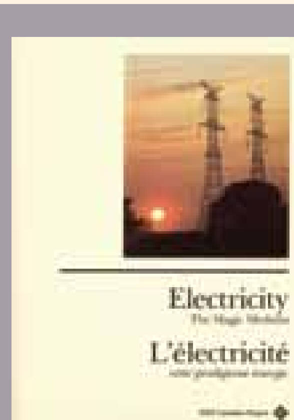
Pam Woodrow, Hazel Scott and Gerald Karam

It was also the time that other Canadians were attempting to rationalize the desire for the Engineering Institute of Canada to develop a meaningful component in Electrical and Electronics Engineering. Gordon Slemon has accurately documented the frustrations from the absence of any Canadian EE society (due to the success of the AIEE and IRE activity in Canada since the very beginning of the electrical and electronics industries), followed by the creation of a Canadian Society within EIC that had lots of nationality but little membership.

Wally Read

During the 70s and early 80s I was active as an IEEE volunteer, moving from section to region interests, and then to my technical society, learning about the various ways and idiosyncrasies of IEEE governance. During that time I participated in the IEEE Region 7-CSEE working group (from the perspective of believing that Region 7 must become the Canadian society) and observed the startup of the CSEE in 1976 along with its Journal, which was initially subsidized by NRC (the National Research Council of Canada). In the early 80s I was out of regional activities and active on the administrative committee (now the governing board) of the IEEE Power Engineering Society.

1984 was the IEEE Centennial year, marked by then Region 7 Director Wallace S. (Wally) Read's decision to celebrate the centennial by commissioning and publishing a book to commemorate the achievements of the Electrical Industry in Canada over the past 100 years and longer. Harry Prevey, a long-time Toronto Section volunteer was the editor.



Centennial Book

In 1986 I was surprised to be asked by Wally Read to become a candidate for Region 7 Director, and even more surprised when I won the election. As the director-elect in 1987, I was fortunate to have Gordon English as my current director—he gave me a lot of freedom and responsibility, and being based in Vancouver often assigned me tasks in the eastern part of our region. This was the year in which I thought about how to make Region 7 into IEEE Canada. Since I followed my two-year term as regional director with a two-year term as IEEE vice-president for regional activities, I was able to complete or assist on some of the actions we started at that time.

4.2 The Building Blocks

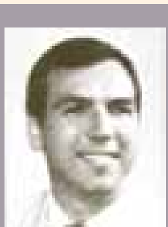
In 1988 I had the opportunity to meet with Cam Blachford, whose role as CSEE President coincided with mine as IEEE Region 7 Director. It was an historic meeting between two stubborn volunteers with two different points of view—likely one of the best examples of the rivalry that Gordon Slemon so accurately describes. We both left that meeting determined to promote our separate agendas, but we also were very much aware of the weaknesses inherent in the two organizations.


Vijay Bhargava

I believe that Cam decided to stop competing for sections and their activities, since CSEE did not seem able to increase its membership significantly above its initial core EIC member count, and instead focus on the Journal and a mechanism for covering the cost. Fortunately for CSEE, Vijay Bhargava decided to create the Canadian Conference on Electrical and Computer Engineering and run it in his unique way so that it generated the annual surplus needed to subsidize the Journal—urgently needed since NRC had phased out its initial financial support. Vijay was also the creator of the CSEE logo that later became part of the IEEE Canada logo.

It was clear to me that if IEEE Region 7 was to evolve into a truly Canadian organization we needed more than an office which acted as a buffer between Canadian members and the American IEEE staff. We decided to formally use the name IEEE Canada and create a magazine, the *IEEE Canadian Review*, designed and published in Canada as a member benefit. The name "IEEE Canada" was proposed as an alternate name for "IEEE Region 7", passed at the annual regional meeting, and subsequently and successfully submitted to the IEEE Regional Activities Board and the IEEE Executive Committee for their approval. We created business cards and letterhead with the new name and logo and used them in future correspondence with IEEE boards and staff. Shortly afterwards, the IEEE USA letterhead appeared. At that point, I knew that our new name would stay.

I had known Richard Marceau as an enthusiastic IEEE volunteer in the Montréal section, who was primarily involved with producing technical publications for conferences sponsored by Montréal Conférences Inc. (MCI). I enlisted his support and he became the first editor of the fledgling magazine, the *IEEE Canadian Review—La Revue canadienne de l'IEEE*. Our first issue was published in September 1988 with a special grant from IEEC Inc. This was the Toronto-based corporation that organized a trade show and conference under various names—initially the "IRE Canadian Electronics Conference" in 1955, and later "Electronicom". This regional conference ran in alternate years to MCI's Montech.


Richard Marceau


Miro Forest

About this time, and with the demise of these regional conferences in Toronto, Montreal and across the United States, I broached the concept of evolving IEEC Inc. (with its 30 plus year history of supporting IEEE activities in Canada) into the IEEE Canadian Foundation. The original name proposed was IEEE <u>Canada</u> Foundation but that was rejected by the government approval body. The legal process culminated in Revenue Canada granting a charitable foundation status in 1994. Miro Forest, the last president of IEEC Inc., and the first president of the IEEE Canadian Foundation, was the driving force in this long and often frustrating legal process, involving many government oversight bodies, for transforming IEEC Inc. into the ICF. Later and over a two-year period starting in 2002, discussions between the directors of MCI and the IEEE Canadian Foundation culminated with the joining of resources (MCI contributed funds and experienced bilingual volunteers) that enabled the IEEE Canadian Foundation to offer bilingual services.


Bob Alden

In the March 1989 issue (#3) of the *IEEE Canadian Review*, my director's column was entitled *"A Single Canadian Electrical Engineering Society: An Achievable Goal?"* I ended that article with: *Can we conceive of an IEEE Canada which is viewed by IEEE as Region 7; and, for example, by the Engineering Institute of Canada and the Canadian Council of Professional Engineers as the Canadian Society of IEEE? One technical Society, with appropriate ties transnationally within IEEE, and nationally within Canada. I believe this to be an achievable goal! Let's make it a reality.*

As the outgoing Director in 1989, it was my responsibility to nominate candidates for Region 7 Director-Elect. Vijay Bhargava was one of my nominees and the winner in the subsequent election. While we had often apparently been in opposition, he for CSEE, me for IEEE, he was clearly a volunteer leader of very high quality. Tony Eastham had succeeded me as Director, and together they set the stage for a renewed look at formally combining the two societies.

4.3 The Stage is Set for a Successful Merger

CSEE had been renamed in 1990 to CSECE (as had the journal from CEEJ to CJECE). The stage was now set. Both organizations had non-competing complimentary assets: CSECE was the constituent society of EIC and had a journal and a conference; the IEEE entity was Region 7 of IEEE with 20 sections, 60 student branches, 14,000 members, a magazine, a developing foundation, and legal title to the name IEEE Canada (and an acceptance of that name within IEEE). When Tony was the Region 7 Director, John Plant was the CSECE president (and a former IEEE Central Canada Council chair), so they began the discussions that Vijay Bhargava and Ray Findlay concluded.

In the Fall of 1991 Region 7 Director-Elect, Vijay Bhargava, established a "Blue Ribbon Committee" consisting of outgoing Region 7 Director Tony Eastham and outgoing CSECE president John Plant. This committee was charged with reviewing the relationship between IEEE Region 7 and CSECE and preparing a discussion paper to be considered by both organizations.


Tony Eastham


John Plant

They identified three options: maintain separate organizations with no common activities; develop collaboration and engage in cooperative programs and ventures; and, amalgamate to form a single organization. Their recommendation was for amalgamation.

At the spring 1992 meetings of both organizations, the amalgamation proposal was presented and approved in principle—subject to financial and operational plans being developed. To inform the memberships, Tony and John prepared an article "IEEE Region 7 and CSECE—is a merger desirable and feasible?" for the fall 1992 issue (#14) of the *IEEE Canadian Review* (*ICR*).

In January 1993 Vijay appointed a working group for the amalgamation of IEEE Region 7 and CSECE consisting of Tony Eastham, John Plant, Bob Alden and Ray Findlay. In February 1993, the proposal was presented to the IEEE Transnational Committee (TC) and the IEEE Regional Activities Board (RAB); the following motion was passed "TC, RAB welcomes and supports the initiative to merge IEEE Region 7 with the CSECE and urges IEEE to work with CSECE towards determining ways and means to bring about this merger by January 1, 1994."

In May 1993 draft bylaws and a draft budget for 1994 were presented and approved at the IEEE Region 7 meeting in St. John's. It was agreed to hold discussion in all Section committees, and to inform and seek approval by the IEEE Region 7 membership in the next *ICR*. In August 1993 the IEEE Executive Committee and the IEEE Board of Directors approved this process.

In November 1993, a special CSECE Annual General Meeting approved that CSECE would be dissolved and its assets transferred to IEEE Canada on the condition that the membership of IEEE Region 7 and the IEEE Board of Directors approve the merger. In consulting the membership, the fall 1993 *ICR* (#17) carried an article "IEEE Canada—the decision is yours" containing the background, the process, the features and budget, and a ballot to approve the merger. By the end of 1993 both IEEE Region 7 and CSECE had approved the merger.

The start of 1994 saw both organizations operating in complete collaboration pending the remaining approvals

- IEEE Region 7 Director Ray Findlay was also the IEEE representative on the CSECE board
- CSECE President Tony Eastham was also vice-chair of IEEE Region 7
- Louis-André Poulin was Treasurer of both organizations

At the May 1994 Region 7 meeting in Ottawa, the modified draft bylaws were approved and forwarded to the IEEE board with a request to approve the formation of IEEE Canada and recognize the new organization as Region 7 of the IEEE.


Ray Findlay

With the fall 1994 IEEE election ballot mailing, a ballot for the merger was included. Following a positive vote, the merger was approved by the IEEE Board of Directors at its November 1994 meeting, with Ray Findlay (IEEE Region 7 Director) making the presentation and convincing the Board of the merits of the merger. As of January 1, 1995—IEEE Canada formally exists and Ray Findlay becomes the first IEEE Canada President.

5.0 Merger Achieved: 1995

In 1995 we all won with a unique Canadian solution to the need to develop a single appropriate organization for electrical and computer engineering professionals in Canada.

In terms of current operation in Canada, IEEE Canada is the name of the organization. IEEE Canada is governed by a Board of Directors whose chair is the President of IEEE Canada. There are no longer any regional meetings. All 20 Canadian IEEE Section chairs are Directors of IEEE Canada. The official logo of IEEE Canada is shown here and consists of the IEEE logo on the left and the CSECE logo on the right—representing the official 1995 merger that was approved by IEEE and with the blessing of EIC. The form of the new logo follows the precedent set by the merger of AIEE and IRE in 1963, wherein the IEEE logo contains elements of both predecessor organizations' logos.

IEEE Canada

IEEE Canada is one of (currently) 12 constituent societies within the EIC. EIC does not have individual members as such but members of its constituent societies may be elected EIC Fellows or be awarded EIC Medals. The IEEE Canada President is a director of the EIC and attends the EIC Board meetings held twice each year. The IEEE Canada Awards and Recognition Committee Chair is a member of the EIC Honours, Awards, and Fellowships Committee.

When IEEE Canada is represented at IEEE Board meetings, our president attends as the Region 7 Director. All IEEE members in Canada are full members of IEEE and any technical societies and councils they elect to join.

Acknowledgements

I would like to express my thanks to the many volunteers and IEEE staff members who have assisted me in the gathering of historical material over many years. I must single out a few of these: Gordon Slemon—whose words I have used in Section 1 and elsewhere; Mary Ann Hoffman—former IEEE staff member in Regional Activities and the History Center; George Armitage—the first office manager and long time volunteer treasurer of IEEC Inc. who introduced me to the name IEEE Canada in 1972; Cathie Lowell—the IEEE Canada Administrator; and, legendary IEEE volunteers Ray Findlay and Vijay Bhargava. There are many other superb volunteers who have contributed to the IEEE, both here in Canada and worldwide, but I have tried to focus on those who have contributed directly to the creation of IEEE Canada. Much of the material used for this article is archived on the IEEE Canada website—select the "history" link on the left hand side of the home page. The back issues of the *IEEE Canadian Review* record many events and personalities of historical interest, these are also archived on the IEEE Canada website—select the "*Review*" link at the top of the home page.

About the Author

Robert T.H. (Bob) Alden retired from McMaster University in Hamilton, Ontario as Professor Emeritus, after a 32-year career in which he was the founding director of the Power Research Laboratory and published 85 papers, 35 of them in fully refereed journals. He is a licensed professional engineer in Ontario, Canada, a Fellow of the Engineering Institute of Canada and a Life Fellow of IEEE.

His IEEE volunteer service includes the following. He is currently President of the IEEE Canadian Foundation and a Director of the IEEE Foundation. He has just completed a three-year term as the Awards and Recognition Chair of IEEE Canada and is the Publications Chair of the IEEE Toronto Section. He served as IEEE Vice President for Regional Activities in 1990 -1991, Director of IEEE (Region 7) in 1988-1989, Secretary of the IEEE Power Engineering Society in 1980-1981, Chair of the Hamilton Section in 1974 - 75. He was the IEEE Canada Webmaster in 2002 - 2006 and founding chair of the Toronto Section Life Members Committee in 2002. Between 1992 and 2002 he wrote 75 articles in IEEE's *The Institute* as a regular column entitled "Traveling the information highway with Bob Alden."

He has received several IEEE awards: 2002 IEEE Haraden Pratt Award "For outstanding and sustained leadership in many areas of the IEEE especially in the use of electronic communication"; 2000 IEEE Third Millennium Medal "In recognition and appreciation of valued services and outstanding contributions"; 1999 William W. Middleton Distinguished Service Award "For challenging IEEE volunteers and staff to maximize their use of electronic communications in all IEEE activities"; 1999 IEEE Canada's Outstanding Service Award "For outstanding service as Region 7 Director and for pioneering efforts in establishing the *IEEE Canadian Review*, the IEEE Canadian Foundation and IEEE Canada"; 1992 IEEE Larry K. Wilson Transnational Award "For exceptional leadership in the promotion of electronic mail worldwide and promoting IEEE as a leader in the use of communications technology"; and, 1984 IEEE Centennial Medal "For extraordinary achievement", nominated by the IEEE Hamilton Section.

The External Cardiac Pacemaker

A Canadian Invention and an IEEE Milestone

By Visda Vokhshoori, IEEE Toronto Section

1.0 Introduction

"There was no intent to sit down and develop a pacemaker. As so often happens, one piece of research spins off into something else." These are Dr. Jack Hopps' words from his 1984 interview with panelists of CBC quiz show "Front Page Challenge". [1]

The development of the external cardiac pacemaker came about through Dr. Hopps assisting Toronto-based Dr. Wilfred Bigelow in studies related to hypothermia and surgery. The doctors realized that one of the problems was to keep the heart beating in the cold state. So they developed a technique to stimulate the heart, to keep it going.

In 1950, Dr. John Hopps designed the first catheter electrode for cardiac simulation. Hopps' Pacemaker-Defibrillator, a reconstruction of which is seen in Figure 1, operated with a vacuum tube design. About a decade later transistors replaced the vacuum tube. This resulted in considerable decrease in the size of the pacemaker. Overtime, advancements in semiconductor and battery technology have helped develop an implantable pacemaker in humans.

Figure 1: Reconstruction of the Hopps pacemaker prototype. Photo courtesy of George Szarka, whose reconstruction of the above, along with a replica of the Hyman pacemaker, helped medical historians understand and chronicle the various stages of development that have led to the modern implantable pacemaker. Mr. Szarka painstakingly pieced together the circuitry and form of the Hopps prototype from patent filings, photographs and scientific papers.

2.0 The Pump

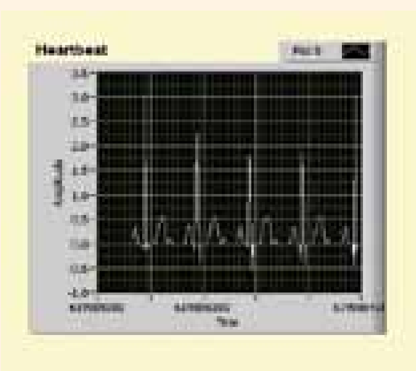


Figure 2: In the cardiac cycle's four stages upper and lower chambers contract then rest.

The human heart is the center of a complex system designed to help the body nourish its organs with life-giving oxygen and to remove waste products in the form of carbon dioxide from the body. A healthy heart beats about 70 times a minute. It regulates its own activities, beating more rapidly during times of increased oxygen consumption and more slowly during rest and sleep. A heartbeat is caused by an electrical impulse traveling through the heart, triggering the cardiac cells to depolarize and contract. It is a four-part cycle consisting of contraction (systole) and rest (diastole) of upper and lower chambers. A heartbeat may seem like a simple event repeated over and over. As simple as it may seem, it is in fact a series of very complicated and precisely coordinated events that take place inside and around your heart. When the cycles are precisely timed, the heart is able to pump very effectively.

As you can see in figure [2], there are four parts in each cardiac cycle. The first peak indicates the start of the electrical impulse generated by the hearts natural pacemaker, sinoatrial (SA node). This area, (P wave), is smooth and positive and usually lasts less than 0.12 seconds. This is followed by a valley-peak-valley, otherwise known as QRS complex. QRS complex, in simple terms, is the definite indicator of a heartbeat. During the 0.04-0.12 seconds that it takes, the ventricles depolarize. From the bottom of the valley to the onset of the next peak, no electrical activity is recorded, hence the flat line. However, during this period the ventricles are contracting. The last part, T wave, represents repolarization or recovery of the ventricles. At times the natural pacemaker may be defective, causing the heartbeat to be too fast, too slow, or irregular. The artificial pacemaker helps the heart to beat in regular rhythm. [2]

3.0 Pacemakers prior to Hopps

Beginning in the eighteenth century, physicians realized that electrical stimulation could cause muscles to contract—and they knew perfectly well that the heart was a muscle. Charles Kite recommended electrical discharges to the chest for resuscitation in "An Essay Upon the Recovery of the Apparently Dead", (London, 1788). Kite's invention was more of a precursor to defibrillation, than to pacing.

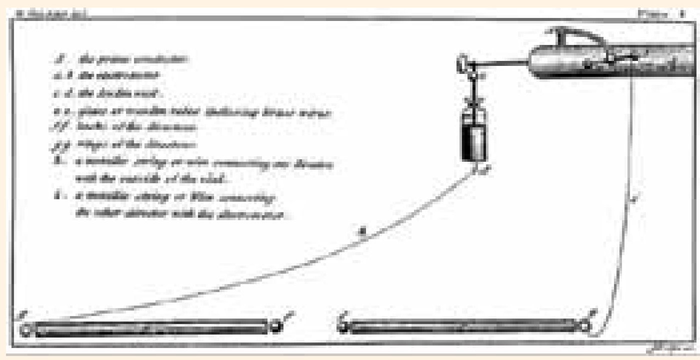


Figure 3: Leyden jar capacitor & attached electrodes for cardiac resuscitation.

The apparatus as shown in Figure 3 is from Kite's article. An electrostatic generator charges a Leyden jar capacitor, which can discharge its accumulated electrical energy through the electrodes below. Energy will build up until the voltage is high enough to jump the spark gap.

The idea of a "pacemaker" is attributed to Dr. Albert Hyman of New York. Hyman's apparatus, based on his notes of April 6, 1930 [4], included:

Figure 4: photo of Hyman's pacemaker.

(1) a small source of electric current, i.e., a common flashlight battery;

(2) an interrupter mechanism;

(3) a timing device;

(4) a method of regulating the duration of the injected current; and,

(5) a suitable insulated needle to carry the current only to the right atrial area of the heart. The instrument would, of course, be easily portable, and small enough to fit into a doctor's bag.

Figure 5 shows a flow diagram of Hyman's pacemaker. The needed electrical current was supplied through winding the hand-crank attached to a spring motor, which drove a magneto-generator and produced the desire current. Each time this current came into contact with the disc interrupter an electrical surge passes to the needles and then to the heart.

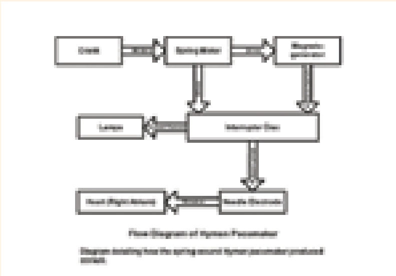
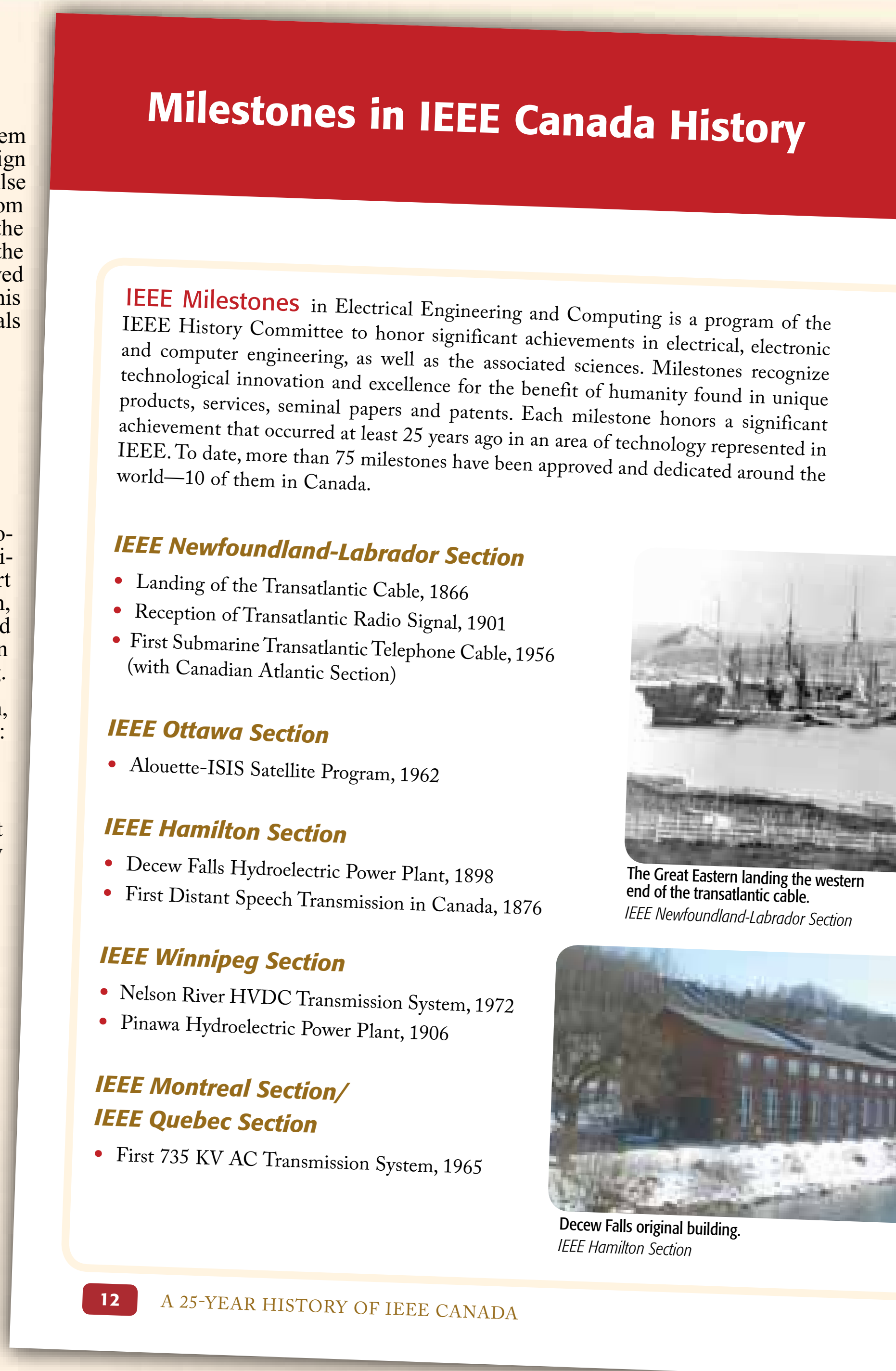


Figure 5: Flow Diagram of Hyman Pacemaker

One major problem cited with this design was the uneven pulse rate that resulted from having to rotate the crank to generate the current. It is believed that Hyman tested this instrument on animals only. [4] [5]



Milestones in IEEE Canada History

IEEE Milestones in Electrical Engineering and Computing is a program of the IEEE History Committee to honor significant achievements in electrical, electronic and computer engineering, as well as the associated sciences. Milestones recognize technological innovation and excellence for the benefit of humanity found in unique products, services, seminal papers and patents. Each milestone honors a significant achievement that occurred at least 25 years ago in an area of technology represented in IEEE. To date, more than 75 milestones have been approved and dedicated around the world—10 of them in Canada.

IEEE Newfoundland-Labrador Section

- Landing of the Transatlantic Cable, 1866
- Reception of Transatlantic Radio Signal, 1901
- First Submarine Transatlantic Telephone Cable, 1956 (with Canadian Atlantic Section)

IEEE Ottawa Section

- Alouette-ISIS Satellite Program, 1962

IEEE Hamilton Section

- Decew Falls Hydroelectric Power Plant, 1898
- First Distant Speech Transmission in Canada, 1876

IEEE Winnipeg Section

- Nelson River HVDC Transmission System, 1972
- Pinawa Hydroelectric Power Plant, 1906

IEEE Montreal Section/ IEEE Quebec Section

- First 735 KV AC Transmission System, 1965

The Great Eastern landing the western end of the transatlantic cable.
IEEE Newfoundland-Labrador Section

Decew Falls original building.
IEEE Hamilton Section

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4.0 Hopps' Pacemaker Circuit

The end of world war promised new beginnings. Interest in hypothermia began in that era when field surgery under cold conditions seemed to have better outcomes. Performing open heart surgery under hypothermic conditions was a logical extension, but the challenge was how to restart the heart should the cold stop it. Electrical stimulation of the heart's chambers was known to cause contraction—electronics could provide the sequencing.

In collaboration with Drs. Wildfred Bigelow and John Callahan, Hopps produced the first external cardiac pacemaker, including:

(1) A stimulator-defibrillator;

(2) A foot-pedal Micro Switch;

(3) Two Electrodes/Foot pedals that allowed the surgeon to control flow of electricity while positioning electrodes by hand on either side of the heart. [5]

The pacemaker was large—30 cm long and several centimeters wide and high. The unit was powered by 60 Hz household current.

Figure 6: Dr. Hopps, testing a pacemaker

When transistors were invented Hopps' pacemaker idea was incorporated into a smaller unit. The first implantable pacemaker was invented in 1958.

Hopps' vacuum tube-based circuit can be seen in Figure 7; schematic provided courtesy of George Szarka.

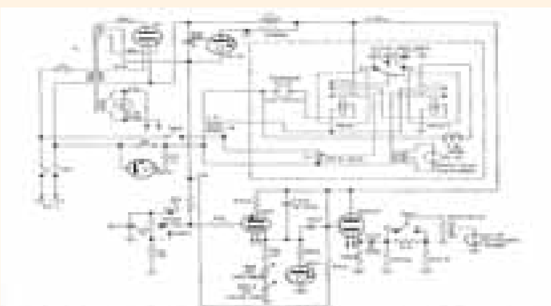


Figure 7: Schematic for the Hopps Pacemaker-Defibrillator, model #3.

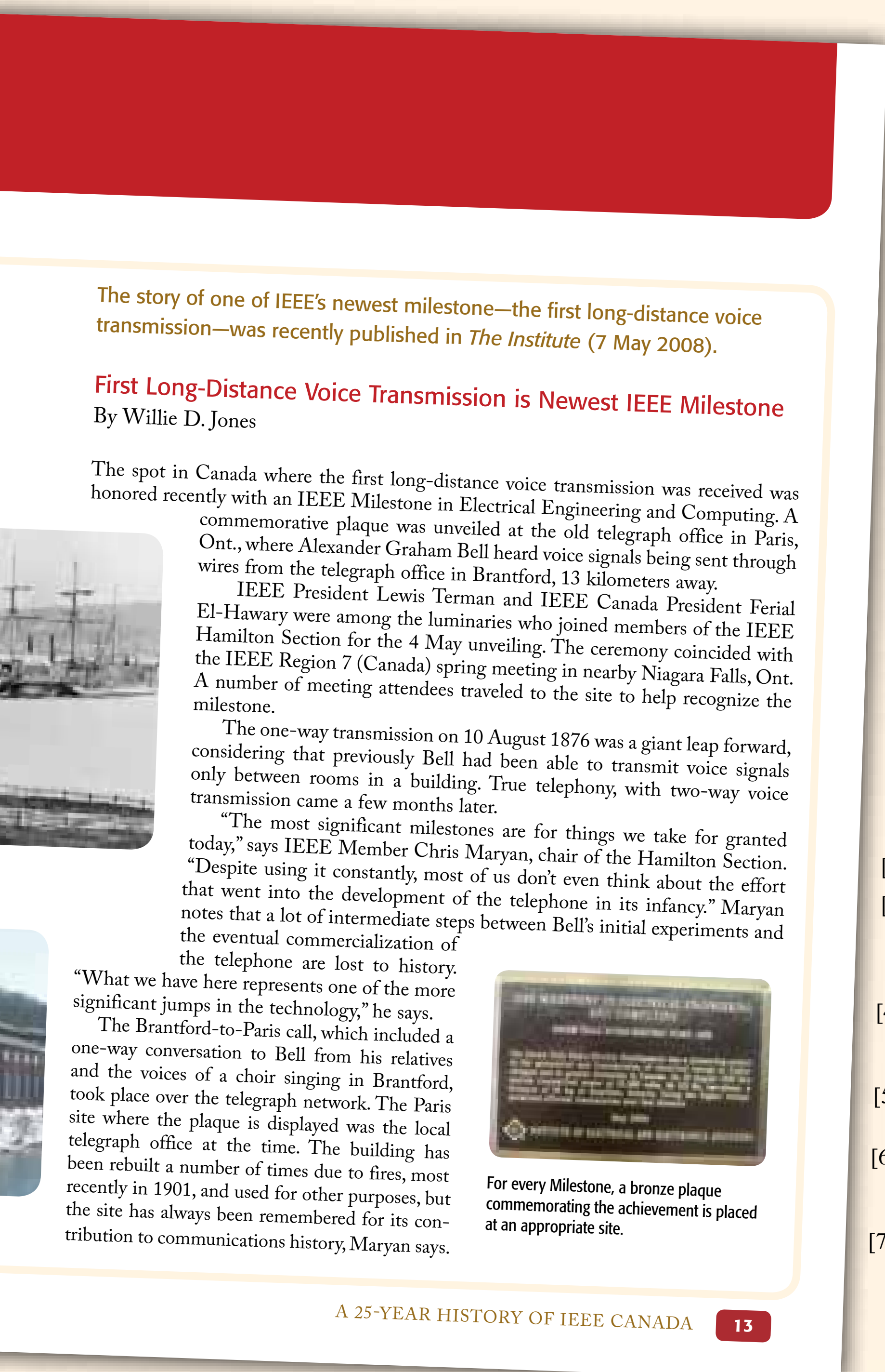
5.0 Pacemaker Advancement

Today the pacemakers are small, compact, mini-computers that are implanted in human's body to keep heart beat in regular rhythm. The advancement in the battery design has made a tremendous difference in the life of a pacemaker. Unlike the first implanted pacemaker that lasted only one day before the batteries conked out, today's pacemakers can last up to ten years.

The first major technological leap in implantable pacemakers occurred when pacemakers stopped just pacing the heart to a preset rhythm and started to offer more "intelligent" therapy.

Sensing is the function that allowed pacemakers to "listen" to the heart and literally record what the heart was doing on its own.

Pacemakers quickly adopted computer and microchip technology to add "brains," so that they were equipped to listen to the heart, "make a decision", and then pace or not. Modern pacemakers monitor every beat of the heart and "fill in the missing beats" when the heart does not beat as it


The story of one of IEEE's newest milestone—the first long-distance voice transmission—was recently published in *The Institute* (7 May 2008).

First Long-Distance Voice Transmission is Newest IEEE Milestone

By Willie D. Jones

The spot in Canada where the first long-distance voice transmission was received was honored recently with an IEEE Milestone in Electrical Engineering and Computing. A commemorative plaque was unveiled at the old telegraph office in Paris, Ont., where Alexander Graham Bell heard voice signals being sent through wires from the telegraph office in Brantford, 13 kilometers away.

IEEE President Lewis Terman and IEEE Canada President Ferial El-Hawary were among the luminaries who joined members of the IEEE Hamilton Section for the 4 May unveiling. The ceremony coincided with the IEEE Region 7 (Canada) spring meeting in nearby Niagara Falls, Ont. A number of meeting attendees traveled to the site to help recognize the milestone.

The one-way transmission on 10 August 1876 was a giant leap forward, considering that previously Bell had been able to transmit voice signals only between rooms in a building. True telephony, with two-way voice transmission came a few months later.

"The most significant milestones are for things we take for granted today," says IEEE Member Chris Maryan, chair of the Hamilton Section. "Despite using it constantly, most of us don't even think about the effort that went into the development of the telephone in its infancy." Maryan notes that a lot of intermediate steps between Bell's initial experiments and the eventual commercialization of the telephone are lost to history. "What we have here represents one of the more significant jumps in the technology," he says.

The Brantford-to-Paris call, which included a one-way conversation to Bell from his relatives and the voices of a choir singing in Brantford, took place over the telegraph network. The Paris site where the plaque is displayed was the local telegraph office at the time. The building has been rebuilt a number of times due to fires, most recently in 1901, and used for other purposes, but the site has always been remembered for its contribution to communications history, Maryan says.

For every Milestone, a bronze plaque commemorating the achievement is placed at an appropriate site.

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ought to. When nothing is needed, the pacemaker merely observes, content to be on stand-by.

Another major advancement in pacemakers occurred with the so-called transvenous lead. Transvenous means "through the vein", and lead is the standard term for the insulated wire that runs from the pacemaker (usually implanted in the upper chest) to the heart itself.

While remote patient monitoring is becoming increasingly sophisticated, pacemakers were actually some of the original devices to offer telemedicine. Even as far back as the 1980s, pacemaker patients could send information from home to their doctor's office over a regular telephone. That technology is still around today, although with some refinements. In fact, pacemakers were some of the very first devices to introduce the whole concept of having a "check-up" with doctor and patient in two different locations!

The pacemaker business is still going strong. Millions of people all over the world have benefited and continue to benefit from this life-enhancing therapy.

6.0 Registration of the Pacemaker as an IEEE Milestone

Due to its significance and strong ties to the Toronto area, IEEE Toronto Section nominated Development of "First External Electronic Cardiac Pacemaker with Internal Electrodes for Continuous Clinical Use" as its first IEEE Milestone.

IEEE Toronto Section Milestone committee was comprised of: Pat Finnigan (SMIEEE), Inci McGreal, Ron Potts (Region 7 Life Members Coordinator), and Bert deKat (IEEE Hamilton Section). "We had a tremendous amount of help and support from IEEE Region 7 staff and the IEEE History Center, as well as the evaluation committee comprised of very senior, experienced, and supportive reviewers," says Pat Finnigan, who led the Milestone application to its successful conclusion.

On April 24, 2007, IEEE Toronto Section made its final submission for the Milestone. The submission was approved June 30, 2008, and the plaque unveiled September 26, 2009 at the Best Institute in downtown Toronto, where the research was performed.

7.0 References:

[1] CBC Digital Archives, Broadcast on May 19, 1984, http://archives.cbc.ca/on_this_day/10/08/

[2] Tom Kenny, The Nuts and Bolts of Cardiac Pacing, Chapter 1

[3] Seymour Furman, MD, Early History of Cardiac Pacing and Defibrillation, Indian Pacing Electrophysiology Journal, 2002 Jan-Mar; 2(1): 2-3, http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1569902

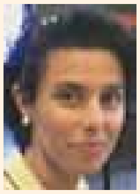
[4] Maulik V Baxi, First Artificial Pacemaker, A Milestone in History of Cardiac electrostimulation, http://www.asmj.netfirms.com/article0903.html

[5] Heart Rhythm Society, http://www.hrsonline.org/News/ep-history/topics-in-depth/hymanspacemaker2.cfm#Problems

[6] Showcase of Canadian Engineering Achievement, IEEE Canada web site, http://www.ieee.ca/millennium/pacemaker/pacemaker_about.html

[7] Jo Ann LeQuang, Pacemaker, Implantable Heart Technology Turns 50, http://www.articlesbase.com/health-articles/happy-birthday-pacemaker-implantable-heart-technology-turns-50-495628.html

About the Author



Currently a developer of the optimizing backend of the IBM XL compiler brand, Visda has been in IT for more than 10 years. She has spent her career since graduation from the EE Department of State University of New York, New Paltz, at four different groups, in two different countries with IBM. With each change, she has set the bar higher for herself, working on more complex set of computing problems. She obtained her MSEE from Columbia University, New York, in 2002. She is the PR Chair for IEEE Toronto "Hopps First External Pacemaker" Milestone Celebration.

IEEE Teacher in-Service Program Workshop – Reports from the Field

May 15 and 16, 2009 an intensive, nationwide "Teacher in-Service Program" (TISP) workshop organized by the IEEE Montreal and Ottawa sections took place in Montreal. This workshop is designed for enthusiastic IEEE members, pre-university teachers, and other volunteers who wish to increase the level of technological literacy in their local schools and encourage pre-university students to pursue technical careers. IEEE members can develop training sessions and present them to teachers, who then use the material with their students. For information and training material, visit: http://www.ieee.org/web/education/preuniversity/TISPMontreal.html .

The following Reports from the Field, written by members of IEEE Ottawa's Women in Engineering (WIE) affinity group, provide a lively picture of the event and its benefits.

How to get local educators interested in TISP? Invite them to dinner!

by Jennifer Ng, Abbott Point of Care

As I sat on the discussion panel at the TISP workshop, one of the attendees asked us: "How do you recommend for us (IEEE) to prepare and get in touch with local education people?" My response: "Ask them out to dinner". And I was quite serious, for that is how it happened for the Ottawa Section.

I attended my first TISP workshop in 2004 in Boston, and I was an invited guest speaker at the Education Summit held in Munich in November 2007. At one of my speaking engagements in Ottawa, a WIE Carleton event, I met Rosalyn Seeton, coordinator of YSTOP (Youth Science and Technology Outreach Program)—a government program that funds projects to connect youth with science and technology mentors. Using her contacts and with funding from the Society on Social Implications of Technology, I invited school board representatives and IEEE volunteers to an informal dinner where I could give them more information about IEEE and TISP.

The dinner was well attended and we were able to casually discuss our common goals and initiatives as well as make plans for the upcoming workshop. I knew that it would be pointless to hold a workshop about education without having the educators themselves introduced, engaged and involved.

My advice to all aspiring TISP champions and volunteers: understand what your local educators need before trying to overwhelm them with the greatness of IEEE and TISP. Non-engineers can be intimidated by us, so be conscious of each other's role in this partnership: theirs is to follow a curriculum set by the government —while engaging the next generations to follow Science, Technology, Engineering and Mathematics careers—and ours is to assist in filling gaps that they might encounter.

The TryEngineering Portal

by Barbora Dej, Carleton University

www.TryEngineering.org is the IEEE pre-university education portal for counselors, teachers, parents, and students. It is the main resource for the TISP program and is available in seven languages. It provides access to:

- Information about the field of engineering including How to become an engineer, What it's like to be an engineer, What are the different engineering disciplines, as well as Engineering Societies.
- A search tool for accredited engineering programs.
- A facility to Ask a Question - to an expert (engineer or undergraduate).
- Lesson Plans for teaching engineering and design, many available in several languages.
- Student Opportunities ranging from summer camps and competitions, to internships and research positions.
- Links to online engineering games, a mailing list and newsletter.

Unfortunately, when I looked the Student Opportunities section contained very few listings in Canada: four pre-university, all in Toronto; no undergraduate nor graduate postings. I am very proud of what Canada offers to engineering students and this bare list just doesn't cut it. We need your help to rectify this situation and take advantage of the millions of hits this website gets yearly. Go to TryEngineering.org and link up students with opportunities in your region by clicking on "Student Listings, "Submit a Listing". So far, as part of her very valuable role as Carleton University WISE outreach officer, I asked Rosalyn Seeton to submit major pre-university opportunities available in Ottawa.

Hands-on TISP activities

by Rosalyn Seeton, Carleton University

TISP workshop participants had the opportunity to try hands-on activities from the lesson plans available at TryEngineering.org. The first activity was called "All About Electric Motors"; suggested age range: 10 to 18. It addresses principles of electric motors, magnetism, and electric

currents. The hands-on activity is only one aspect of the lesson; there is a substantial amount of supporting documents that explore the principles and applications of electric motors.

A toy motor kit is provided to each participant; the main task is assembling the kit appropriately. This may sound simple, but the activity was quite challenging and most participants did not successfully complete their motor in the allotted time. While some students would find this activity quite rewarding, I anticipate that about half of your average high school class would get frustrated or lose interest midway through. I recommend it as an activity for older students (grades 10-12) or for advanced classes. Alternatively, if a class were divided into small groups and each group were given a mentor that had done the assembly before, students could be kept on track and avoid a lot of potentially painful mistakes.

The second activity was "Build Your Own Robot Arm"; age level: 8 to 18. The basic activity is to build a mechanical arm with everyday household materials. We were simply given a set of requirements: the arm should have the ability to pick up objects by way of actuators that can be controlled by an operator at the opposite end of the arm. A sketch of the prototype was also required.

This activity had a very different feel to it; while the electric motor activity required following a very strict set of instructions in order to succeed, the robot arm activity had no right or wrong answers. It relied more on imagination and empirical experimentation with the materials provided. This activity is appropriate for many age groups, though younger children may find the assembly aspect to be challenging.

The activity was presented to our group as a mission from the Canadian Space Agency, but it could easily be adapted to other scenarios such as creating a prosthetic arm for an amputee. When the facilitator decided it was time to add more challenging requirements, he stayed in character and had us witness one side of a phone call from the CSA head office.

The neat thing about this activity is that so many different solutions emerge from the challenge as each group approaches the problem in a unique manner. Teammates must work together and utilize each other's strengths, and while the designing and building requires a certain amount of focus, there is also the opportunity to interact with other groups at the table. This activity positively illustrates what engineers do; it highlights teamwork, communication, and problem solving.

Behind the Scenes

by Laura Mutu, Carleton University

The weather in Montreal was amazing on the first day of the conference. It was ideal for Carolyn, Rosalyn, Barbora, and me to experience the city before the conference. After a few hours exploring we ended up downtown in search of the perfect Montreal chicken place. We *could* share the location, but our guidebook compelled us to keep it a secret! We came back just in time to help at the registration desk, where we were impressed by the diversity of participants and speakers.

During the dinner and the activities we had the chance to meet IEEE volunteers from all over Canada and the world, learn about the different academic structures and the way various people perceive outreach. We all had a positive experience and left thinking about the ways in which we can use and contribute to TISP.

While leaving the beautiful city of Montreal, we suddenly decided to turn back and visit the old port. Unfortunately, heavy rain was pouring at the time and our guide lost her bearing. After an hour or so driving around the outskirts of Montreal, we decided to let go and head back to Ottawa. Next TISP lesson: How to build a GPS.

Authors, from left to right, members of WIE Ottawa Chapter: Barbora Dej, M.Eng. candidate, Carleton University; Laura Mutu, B.Eng candidate, Carleton University; Jennifer Ng, Project Manager, Abbott Point of Care; Rosalyn Seeton, Research Assistant, Carleton University.

Engineering Management: What's New in the Literature?

On: The Future, Competencies Learning, Ditching Lecture Halls, Speaking and Writing, Employee Turnover, Controlling Change, Shaping Strategy and Procurement.

by Terrance Malkinson
School of Health and Public Safety
SAIT Polytechnic, Calgary, Alberta

- We are all interested in what the future might bring and how we might proactively manage our personal and career lives to achieve success. Twenty viewpoints authored by some of the best futuristic thinkers of our time provide insights into practical emerging business trends ("Breakthrough Ideas for 2009," Harvard Business Review, 87(2):19-40, February 2009, www.hbr.org). Topics include the economy, strategic decision making, new markets, human resources, disruptive technologies and business models to name but a few.

- Insights into technologies and their timelines that will radically reshape human life are provided in "Timeline for the Future: Potential Developments and Likely Impacts" (*The Futurist*, 43(2):35-37, March-April 2009, www.wfs.org). The timeline was first developed in 1991, and has been updated every two or three years. This year's version predicts the future to the year 2040. Interesting insights are provided of importance for your career and organizational strategic planning.

- At the same time as innovative new technologies emerge that are driving a transformation of business, society, and global order our existing institutions are increasingly not able to handle change. William Halal, in "Emerging Technologies and the Global Crisis of Maturity" (*The Futurist*, 43(2):39-46, March-April 2009), discusses his belief that a social revolution is needed that will bring institutions and civilization to a higher stage of maturity to handle the change brought about by technology.

- In challenging economic times we all need to be career savvy. A selection of four articles from Harvard Business Review discuss career strategy. Janet Banks and Diane Coutu discuss three survival strategies to protect your job. ("How to Protect Your Job in a Recession," 86(9):113-116, September 2008). Strategies discussed include acting like a survivor by being confident and cheerful while concentrating on the customer, empathizing with your boss, and being a corporate team player.

- Employees are always watching their supervisors carefully for clues to their fate. Robert Sutton provides a framework of four factors that are designed to focus supervisors on what their subordinates need from them most during bad economic times ("How to Be a Good Boss in a Bad Economy," 87(6):42-50, June 2009). Factors discussed include predictability, understanding, control, and compassion. These factors are equally applicable during good economic times. The author believes that attention to these factors will have long-term benefits to the organization as economic growth returns.

- Promotions particularly to high levels of the organization are governed by unwritten rules that are not related to technical or business knowledge. By not understanding these you will find it difficult to advance. John Beeson, in "Why You Didn't Get That Promotion" (87(6):101-105, June 2009), discusses the issue and provides a framework to help you identify and address issues that might be blocking your corporate advancement.

- Research conducted by Claudio Fernandez-Araoz, Boris Groysberg and Nitin Nohria and reported in "The Definitive Guide to Recruiting in Good Times and Bad" (87(5):74-84, May 2009) provide insights into hiring best practices. The authors look past the current economic challenges and discuss their belief that current recruiting practices are not what they should be. They provide recommendations for implementing a seven-step hiring cycle.

- Two articles in *International Small Business Journal* (27(2), 2009) provide perspectives on women entrepreneurs: "Women Entrepreneurs: Jumping the Corporate Ship and Gaining New Wings." (pp. 173-192) and "Female Entrepreneurial Networks and Networking Activity in Technology-based Ventures: An Exploratory Study." (pp. 193-214) In the first article Nicola Patterson and Sharon Mavin examine four case studies of entrepreneurs who successfully left corporate careers for self-employment. In the second article Alison Hampton, Sarah Cooper, and Pauric McGowan discuss the importance of networking to the success of female entrepreneurs. Their research is based on interviews with 18 lead female entrepreneurs of technology-based ventures.

- Enterprise education is learning that develops skills, competencies, understandings and attributes which promote the ability to be creative, innovative and self-reliant. It provides an appreciation for lifelong learning and the adaptability to generate, recognize and seize opportunities that will facilitate career and personal success. In "Measuring Enterprise Potential in Young People" (*Entrepreneurship Theory and Practice*, 33(2): 481-500, March 2009, www.baylor.edu/business/ETP/), Rosemary Athayde discusses a research instrument that is designed to measure enterprise potential in people 25 years and younger as well as factors that enhance entrepreneurial potential.

- What will you need to succeed in the job market of tomorrow? Drew Liming and Michael Wolf use data from the U.S. Bureau of Labor Statistics and the Census Bureau to analyze how education or training relates to job prospects and earnings in: "Job Outlook by Education, 2006-16" [*Occupational Outlook Quarterly*, (52(3):2-29, Fall 2008, www.bls.gov/opub/ooq/ooqhome.htm]. Information provided is useful for learning about projected growth rate and salaries for various occupations as well as participation rates by levels of education. Although based on the United States experience, the information has applications for Canadians.

- An article by Rakesh Khurana and Nitin Nohria published in *Harvard Business Review*, ("It's Time to Make Management a True Profession," 86(10):70-77, October 2008) opens with the statement: *"Managers have lost legitimacy over the past decade in the face of widespread institutional breakdown of trust and self-policing in business"* (pg. 70). The authors continue on making the case that management should become a profession with all of the responsibilities of a profession including codes of conduct, and a governing body that will oversee strict compliance. Managers will therefore be obligated to conduct themselves with the highest standards of professionalism.

- David Rhodes and Daniel Stelter discuss business strategies that can be used to achieve a competitive advantage in an economic downturn ["Seize Advantage in a Downturn," *Harvard Business Review*, 87(2): pp. 50-59, February 2009, www.hbr.org]. Both defensive and offensive strategies are discussed that will help companies not only to survive the recession but also thrive during the subsequent economic recovery. On the same topic of business strategy "How to Rethink Your Business During Uncertainty" (*MIT Sloan Management Review*, 50(3): 25-30, Spring 2009, www.sloanreview.mit.edu) Rita Gunther McGrath and Ian MacMillan discuss the importance of letting go of the old approaches to orient the organization toward a sustainable business future.

About the Author

Terrance Malkinson is a communications specialist, business analyst and futurist. 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 an associate editor for *IEEE Canadian Review*. He was an elected Senator of the University of Calgary and an elected Governor of the IEEE Engineering Management Society as well as an elected Administrative Commitee member of the IEEE Professional Communication Society. He has been the editor of several IEEE conference proceedings, and past editor of *IEEE Engineering Management*. Currently, he is with the School of Health and Public Safety/Applied Research and Innovation Services at SAIT Polytechnic in Calgary, Canada.
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WEST…

2009 10th IEEE/ACM International Conference on Grid Computing (GRID)
2009-10-13...15, The Banff, AB
http://www.gridcomputing.org/

UVS Canada Annual Conference
2009-11-02...05, Victoria, BC
http://www.uvscanada.org/content.php?doc=98&xwm=true

IEEE IAS Electrical Safety, Technical and Mega Projects Workshop
2010-03-29...31, Calgary, AB
http://ewh.ieee.org/soc/ias/tmp/

23rd Canadian Conference on Electrical and Computer Engineering (CCECE 2010)
2010-05-02...05, Calgary, AB
http://www.ieee.ca/ccece10/

IEEE International Conference on Intelligence and Security Informatics (ISI 2010)
2010-05-23...26, Vancouver, BC
www.isiconference.org/

2010 International Communications Quality and Reliability Workshop (CQR)
2010-06-08...10, Vancouver, BC
http://www.ieee-cqr.org/

CENTRE…

IEEE Symposium on Product Compliance Engineering
2009-10-26...28, Toronto, ON
http://www.psessymposium.org

2010 IEEE International Symposium on Antennas and Propagation, and CNC-USNC/URSI Radio Science Meeting
2010-07-11...17, Toronto, ON
www.apsursi2010.org

6th IEEE International Conference on Automation Science and Engineering (CASE 2010)
2010-08-22...24, Toronto, ON
http://case2010.org/

72nd IEEE Vehicular Technology Conference (VTC 2010-Fall)
2010-09-12...15, Ottawa, ON
http://www.ieeevtc.org/

EAST…

2nd Microsystems and Nanoelectronics Research Conference (MNRC 2009)
2009-10-13...14, Ottawa, ON
http://www3.cmc.ca/en/symposium_2009/

3rd Annual Electrical Power & Energy Conference (EPEC)
2009-10-22...23, Montreal, QC
http://www.ieee.ca/epec09/

8th Conference on Communications Networks and Services Research (CNSR 2010)
2010-05-11...14, Montreal, QC
http://www.cnsr.info/cnsr2010/

14th International Symposium on Antenna Technology and Applied Electromagnetics (ANTEM) and the American Electromagnetics Conference (AMEREM)
2010-07-05...09, Ottawa, ON
http://antem.ee.umanitoba.ca/antem_amerem2010/Home.html

2010 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)
2010-07-06...09, Montreal, QC
http://cost.georgiasouthern.edu/aim2010/

4th Annual Electrical Power and Energy Conference (EPEC 2010)
2010-08-23...25, Halifax, NS
http://www.ieee.ca/epec10/

1st International Conference on Applied Robotics for the Power Industry (CARPI 2010)
2010-10-05...07, Montreal, QC
http://www.carpi2010.org/

IEEE Canada

CCECE 2010

23rd Annual Canadian Conference on Electrical and Computer Engineering

May 2-5, 2010, Calgary, Alberta, Canada

http://www.ccece2010.org

"Evolution of Theory: Bringing Theory and Technology into Application"

Preliminary Call for Papers and Proposals

The 2010 IEEE Canadian Conference on Electrical and Computer Engineering (CCECE 2010) will be held in Calgary, Alberta, Canada from May 2-5. CCECE 2010 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: Terrance Malkinson
- Control and Robotics
  Chair: Dr. Amir Aghdam
- Communications and Networking
  Chair: Dr. Yousef Shayan
- Computers, Software and Applications
  Chair: Vincent Chiew
- Power Electronics and Energy Systems
  Chair: Dr. Amirnaser Yazdani
- Signal and Multimedia Processing
  Chair: Dr. Dongliang Huang

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.ccece2010.org before December 4, 2010. 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, 2010 to the Tutorials Chair at tutorials@ccece2010.org.

Important Dates

Full length paper must be received by:	Friday, December 4, 2009
Tutorial or workshop proposals must be received by:	Friday, December 4, 2009
Notification of acceptance will be sent out by:	Friday, February 5, 2010
Authors' Registration ends by:	Friday, March 5, 2010
Advance Registration ends by:	Friday, April 2, 2010

Industrial Exhibits and Sponsorships

For industrial exhibits please contact the Industrial Exhibits Chair at exhibits@ccece2010.org. For sponsorships please contact the Sponsorship Chair at sponsorship@ccece2010.org.

Questions or Comments

For any questions or comments, please contact the Conference Chair: Rob Anderson. Phone: 509 939-5641 Fax: 509 241-6153 Email: rlanderson@ieee.org

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IEEE Canada

CCGEI 2010

23ième Conférence canadienne annuelle de génie électrique et informatique

2-5 mai 2010, Calgary, Alberta, Canada

http://www.ccece2010.org

« Évolution de la théorie : Mettre la théorie et la technologie en application »

Appel préliminaire pour des communications et des propositions

La conférence canadienne de génie électrique et informatique de l'IEEE 2010 (CCGÉI 2010) se tiendra à Calgary, Alberta, Canada le 2-5 mai . La CCGÉI 2010 fournit un forum pour la présentation de la recherche et développement en génie électrique et informatique au Canada et partout dans le monde. Les communications, en français ou anglais, sont les bien-venues pour les symposiums suivants :

- Circuits, dispositifs et systèmes
  Président : Terrance Malkinson
- Commande et robotique
  Président : Dr. Amir Aghdam
- Communications et gestion de réseau
  Président : Dr. Yousef Shayan
- Ordinateurs, logiciel et applications
  Président : Vincent Chiew
- L'électronique de puissance et systèmes énergétiques
  Président : Dr. Amirnaser Yazdani
- Signal et traitement multimédia
  Président : Dr. Dongliang Huang

Les auteurs désirant soumettre leurs communications n'entrant pas dans l'une des catégor-ies citées ci-dessus sont encouragés à le faire dans le cadre du symposium d''intérêt général'.

Soumission d'une communication régulière

Veuillez soumettre les communications intégrales originales (maximum de 6 pages) au Comité de programme technique en utilisant le processus de soumission en ligne sur notre site Web à http://www.ccece2010.org avant le 4 décembre 2010. Cliquez sur le lien «Appel pour des communications » et suivez les instructions fournies.

Soumission de propositions d'atelier et de séance didactique

Les propositions pour une séance didactique ou un atelier d'une demi-journée devraient être soumises avant le 5 décembre 2010 au président responsable des séances didactiques à tutorials@ccece2010.org.

Dates importantes

La communication intégrale doit être reçue avant :	Vendredi le 4 décembre 2009
Les propositions de séance didactique ou d'atelier doivent être reçues avant :	Vendredi le 4 décembre 2009
L'avis d'acceptation sera envoyé avant :	Vendredi le 5 février 2010
Inscription des auteurs avant :	Vendredi le 5 mars 2010
Inscription anticipée avant :	Vendredi le 2 avril 2010

Expositions industrielles et parrainage

Pour les expositions industrielles, veuillez contacter le président en charge des expositions industrielles à exhibits@ccece2010.org.

Pour des parrainages, veuillez contacter le président en charge du parrainage à sponsor-ship@ccece2010.org.

Questions ou commentaires

Pour toutes autres questions ou commentaires, svp contacter le président de la conférence : Rob Anderson. Téléphone : 509 939-5641 fax : 509 241-6153 Courriel : rlanderson@ieee.org

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