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# IEEE Canadian Review

*La revue canadienne de l'IEEE*

## Novel Issues in DSRC Vehicular Communication

- Resonant Micro-Transducers
- Futurology and Career Success
- IEEE Canada Awards

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# IEEE Canada



# IEEE Canadian Review
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(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.

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# Editorial / *Éditorial*

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

If knowledge is power, foreknowledge is safety.

According to a recent report from the World Health Organization* the leading cause of death in 15- to 29-year-old people, worldwide, and the second leading in 5- to 14-year-olds, is road traffic injuries. After infant diseases, this is the biggest thief of human lifespans, whether in low or middle income countries where 90% of those deaths occur, or in rich ones—for who amongst us has not lost dear ones to this plague? There are probably few better causes to which you can apply yourself as an engineer than transportation safety.

The author of our feature article on Dedicated Short Range Communications (as applied mainly to vehicular safety) does not pretend to have discovered a cure for (road) cancer. His research and his work on standards does apply itself to the problem, however. A great many IEEE members are involved as well in making our roads safer through their work on IEEE 802.11p and 1609.x standards. See http://standards.ieee.org/ on how to get involved in standards development.

Foreknowledge comes through signals and sensors, whether organic or mechanical. The second feature article talks about Resonance as a Versatile Transduction Mechanism. The main applications described are about micromachined resonators for signal processing, sensors, and actuators. In line with the qualities targeted in many communication standards, much of the advantages sought from applications of resonators come from their robustness to noise and interference. Given that, I would not be surprised to learn that a multitude of such components are present in our vehicles, and soon will be in even greater numbers.

Finally, there is a specialty in foreknowledge known as Futurology. Our columnist Terry Malkinson demystifies this domain and tells us how it can positively impact our careers and personal lives. You are enjoined to gather information about the future, analyze it, set up a strategy, and develop your own talent for predicting trends.

Now look ahead and drive safely. You are forewarned.

* *Global status report on road safety (2009). World Health Organisation ISBN 978 92 4 156384 0.*

Si la science apporte le savoir, la prescience apporte la sécurité.

Selon un récent rapport de l'Organisation mondiale de la santé* les principales causes de mortalité au monde chez les 15 à 29 ans, et la deuxième chez les 15 à 24 ans, sont les blessures subies lors d'accidents de la route. Après les maladies infantiles, c'est le plus grand voleur de durée de vie, que ce soit dans les pays à revenus faibles ou moyens où 90% de ces décès se produisent, ou dans les pays riches—car qui parmi nous n'a pas perdu des proches à cause de ce fléau? Il y a probablement peu de plus grandes causes auxquelles vous pouvez vous consacrer en tant qu'ingénieur que la sécurité des transports.

L'auteur d'un de nos articles principaux sur les Communications spécialisées à courte portée (tel qu'appliqué principalement à la sécurité des transports) ne prétend pas avoir découvert un remède au cancer (des routes). Sa recherche et son travail sur les normes se penchent sur le problème, cependant. Un grand nombre de membres de l'IEEE sont actifs aussi à rendre nos routes plus sûres via leur travail sur les normes IEEE 802.11p et 1609.x. Parcourez http://standards.ieee.org/ pour voir comment vous impliquer dans le développement des normes.

La prescience nous provient de signaux et senseurs, qu'ils soient organiques ou mécaniques. Le second article principal parle de la résonance comme mécanisme versatile de transduction. Les applications décrites concernent les résonateur micro-usinés pour le traitement de signal, les senseurs, et les actionneurs. Comme dans le cas des normes de communications, un des principaux bénéfices recherchés dans l'application des résonateurs provient de leur robustesse au bruit et aux interférences. Ainsi, je ne serais pas surpris d'apprendre qu'une multitude de telles composantes se trouvent dans nos véhicules, et y seront bientôt en plus grand nombre encore.

Finalement, il existe une spécialité de prescience connue sous le nom de Futurologie. Notre chroniqueur Terry Malkinson démystifie ce domaine et nous indique comme nous pouvons utiliser l'oeuvre de ces experts pour améliorer nos carrières et nos vies. On vous encourage à rassembler de l'information sur le futur, l'analyser, établir une stratégie, et développer votre propre talent à prévoir les tendances.

Maintenant regardez en avant et conduisez prudemment. Vous êtes prévenus.

* *Rapport de situation sur la sécurité routière dans le monde (2009) Organisation mondiale de la santé, ISBN 978 92 4 256384 9*

## Robert H. Tanner Industry Leadership Award/ *Prix d'excellence en leadership industriel Robert H. Tanner*

What's in a name? In the case of IEEE Canada's latest medal, a legacy of solid engineering expertise and leadership at the highest level of IEEE. Through a $20,000 grant from The IEEE Foundation, the Industry Leadership Award has been renamed to honour and remember Robert (Bob) H. Tanner, the first Canadian to be IEEE President and an outstanding acoustical engineer and consultant. Also a skilled manager in both industry and government, Bob was an IEEE volunteer leader at every level of the organization. Among his extensive list of IEEE activities, he was Ottawa Section Chair, Region 7 Director, and one of the founding directors of the IEEE Foundation. The newly named and endowed award will be presented at the IEEE Canada Awards Banquet 2010 to Ibrahim Gedeon, Chief Technology Officer for TELUS. See centre insert for details of all the awards.

Que contient un nom? Dans le cas de la toute dernière médaille de l'IEEE Canada, l'héritage d'une solide expertise en génie et du leadership au plus haut niveau de l'IEEE. Grâce à un don de 20 000 $ de la Fondation de l'IEEE, le Prix de leadership industriel a été renommé pour honorer et commémorer Robert (Bob) H. Tanner, le premier canadien à devenir président de l'IEEE et un remarquable ingénieur et consultant acousticien. Gestionnaire accompli dans l'industrie et au gouvernement, Bob a été un leader bénévole de l'IEEE à tous les niveaux de l'organisation. Parmi la longue liste de ses activités au sein de l'IEEE il a été président de la Section d'Ottawa, directeur de la Région , et un des directeurs fondateurs de la Fondation de l'IEEE. Le prix ainsi renommé et doté sera présenté lors du Banquet des prix de l'IEEE Canada 2010 à Ibrahim Gedeon, directeur de la technologie pour TELUS. Voir l'encart central pour les détails sur tous les prix.


## Table of Contents / *Table des matières*

When our new president, Dr. Om Malik asked me to provide the president's report during this first issue for 2010, I modestly accepted. My next hour was spent in speculation as to what you, the IEEE Canadian membership, would like to know about what is happening with IEEE Canada—and there's a lot going on.

It has been an interesting start to this second decade of the new millennium for IEEE Canada. On January 1st we saw a number of senior leadership positions change hands. We extend our appreciation to outgoing president Dr. Ferial El-Hawary for her two years of dedication and leadership and welcome her to the position of past-president for the next two years. We also saw Dr. Bob Hanna, past president, graciously complete his 6-year term (2 years as vice president; 2 years as president; and 2 years as past president). This achievement is of particular significance to me as your newly elected vice president only a few months into my 6-year journey. And, as previously mentioned, we welcome in Dr. Om Malik as IEEE Canada president for the 2010-11 term.

Rob Anderson, perhaps one of our longest tenured treasurers, has moved up the IEEE corporate ladder to become Member and Geographical Activities (MGA) treasurer. For anyone who has been involved in section activities one cannot stress the importance of having an effective treasurer. It does not matter who is chair or vice-chair because the treasurer is the one who really runs things!! Subsequently, the steering committee has appointed Gerald Dunphy as IEEE Canada treasurer for 2010. Gerald is no stranger to the workings of IEEE Canada, is extremely well qualified, and has the complete confidence of the executive.

Our two national conferences, CCECE and EPEC are well into their planning phases with CCECE 2010 to be held in Calgary in May and EPEC 2010 to take place in Halifax in August. At the time of writing this report there are 24 additional conferences planned for various locations in Canada this year. That is, for any given month there are on average two major IEEE conferences occurring somewhere in Canada. This is outstanding progress.

Also noteworthy is that the Kitchener-Waterloo Section will be turning 50 in May. Congratulations to all Kitchener-Waterloo section members and volunteers.

On the IEEE front, I recently attended the February IEEE Board series meetings in Atlanta, GA and would like to share a few items that I think you will find interesting. First, the board recently unveiled a new tagline: *IEEE—Advancing Technology for Humanity*. This tagline was introduced to provide a memorable statement that captures the vision and mission of the IEEE. More information on the tagline can be found at www.ieee.org/tagline. Second, the IEEE has partnered with the United Nations Foundation to create the Humanitarian Technology Challenge (HTC). The HTC is mandated to develop and implement sustainable, scalable and environmentally adaptable technological solutions in developing countries. See www.ieeehtc.org for more details. Finally, for those of you looking for professional development opportunities www.ieee.tv is expanding with more than 125 programs now available for viewing.

As you have just read, it has been a busy first few months to 2010. Please accept my sincere wishes for all the best to you and your family in all your endeavours.

Quand notre nouveau président Dr. Om Malik m'a demande de rédiger la chronique du président pour le numéro de printemps 2010, j'ai humblement accepté. Ma prochaine heure se déroulera sous l'hypothèse que vous, les membres de l'IEEE Canada, voulez savoir ce qui se passe à l'IEEE Canada—et il se passe beaucoup de choses.

Le début de cette seconde décennie du millénaire a été intéressant pour l'IEEE Canada. Au 1er janvier de nombreux postes de leadership senior ont changé de mains. Nous transmettons nos remerciements à la président sortante Dr. Ferial El-Hawary pour ses deux années de dévouement et de leadership et l'accueillons à son poste de présidente sortante pour les prochains deux ans. Nous avons aussi vu Dr. Bob Hanna, président sortant, compléter avec élégance son terme de 6 ans (2 ans en tant que vice-président, 2 ans président et 2 ans président sortant). Ce résultat est particulièrement significatif pour moi en tant que vice président après seulement quelques mois de mon mandat de 6 ans.

Rob Anderson, peut-être un de nos trésoriers ayant eu le plus long mandat, a gravi l'échelle corporative pour devenir trésorier de Member and Geographical Activities (MGA). Quiconque a été impliqué dans les activités de sections ne peut sousestimer l'importance d'avoir un trésorier efficace. Il n'est pas important de savoir qui est président ou vice-présicent car c'est le trésorier qui dirige vraiment les affaires, n'est-ce pas? Ensuite le comité directeur a désigné Gerald Dunphy comme trésorier de l'IEEE Canada pour 2010. Gerald n'est pas étranger au fonctionnement de l'IEEE Canada, il est extrêmement qualifié, et a la confiance totale de la direction.

Nos deux conférences nationales, CCGEI et EPEC sont entre bonnes mains avec le CCGEI 2010 à Calgary en mai et EPEC 2010 qui se tiendra à Halifax en août. Alors que j'écris ce rapport il y a 24 autres conférences prévues pour plusieurs endroits au Canada cette année. C'est dire que pour chaque mois il y a en moyenne deux conférences majeures de l'IEEE se déroulant quelque part au Canada. Il s'agit un progrès formidable.

À noter aussi le 50e anniversaire de la Section Kitchener-Waterloo en mai. Félicitations à tous ses membres et bénévoles.

Du côté de l'IEEE, j'ai participé récemment aux réunions du conseil de l'IEEE à Atlanta en février, et désire partager quelques éléments que je crois que vous trouverez intéressants. Premièrement, le conseil a récemment dévoilé un nouveau slogan: *IEEE—Advancing Technology for Humanity.* Ce slogan a été conçu pour présenter une phrase mémorable qui englobe la vision et la mission de l'IEEE. De plus amples informations sur le slogan se trouvent à www.ieee.org/tagline. Deuxièmement, l'IEEE s'est associé à la Fondation des Nations Unies pour créer le Défi technologie humanitaire (Humanitarian Technology Challenge, HTC). Le HTC a pour mandat de développer et implanter des solutions technologiques durables, extensibles et adaptable à l'environnement dans les pays en développement. Voir www.ieeehtc.org pour plus de détails. Finalement, pour ceux d'entre vous qui cherchent des occasions de perfectionnement professionnel, www.ieee.tv prend de l'expansion avec plus de 125 programmes maintenant disponibles.

Comme vous venez de le lire, les premiers mois de 2010 ont été occupés. Veuillez accepter mes voeux les plus sincères pour vous et votre famille dans toutes vos entreprises.

Dr. Keith B. Brown, P.Eng., SMIEEE
2010-2011 IEEE Canada Vice President and Region 7 Director-elect

Photo credit: Marc Bourcier

*Dr. Christopher Trueman receives the award from Dr. Om Malik, IEEE Canada President*

## *Friend of IEEE* Award honours Concordia University's Faculty of Engineering & Comp. Science

On April 22, 2010, IEEE Canada President Om Malik joined members of the Faculty of Engineering and Computer Science at Concordia University in Montreal to present a special award honouring the Faculty's longstanding association with IEEE.

Dr. Christopher Trueman, Associate Dean of Academic Affairs and Professor within the Department of Electrical and Computer Engineering accepted the "2010 Supporting Friend of IEEE Member and Geographic Activities Award" on behalf of the Faculty. Amongst the many ways it has backed IEEE internationally and locally, the Faculty has co-sponsored more than 85 IEEE-affiliated seminars since 2002, provided funds and space for conferences, and supported the involvement in Montreal Section of three Secretaries, two Treasurers and several Chapter Chairs. Three Section Chairs have also held their positions while at Concordia, including this Publication's current Managing Editor.

Newslog Editor

Rédacteur des Coupures de presse

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

*Alexandre Abecassis est agent de brevets associé chez Fasken Mar-tineau 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*

MONTREAL, QC. Jan. 12, 2010. **iWeb** announced its plans for a new 31,000 square feet data center with a capacity to host 20,000 dedicated servers—thus boosting the firm's capacity to 35,000 servers. The facility has been acquired through a 30-year lease agreement with options to purchase at regular intervals. iWeb is a provider of Internet hosting services and IT Infrastructure and has three secured data centers in Montreal.

OTTAWA, ON. Feb. 10, 2010. **March Networks** announced that the Maryland Transit Administration (MTA) is deploying the company's mobile video surveillance systems on its 669-vehicle, fixed-route bus fleet. The purpose is to improve investigations and coordinate with police as well as with Homeland Security operations. The solution was selected in particular for its remote wireless downloading and monitoring capabilities. The entire bus fleet is expected to be upgraded in one year with the new solution. Existing systems require a manual retrieval of the video by staff; in the future, the plans are to download the video on the fly using GSM/CDMA/EVDO and WiMax mesh networks.

VANCOUVER, BC. Feb. 23, 2010. **Craig Wireless Systems Ltd** announced that it has just deployed in Vancouver the first 4G WiMAX network, which is expected to handle one million people. Craig Wireless holds or leases licenses for spectrum in the 2.5 GHz, 2.6 GHz or 3.5 GHz bands in Manitoba and British Columbia, Riverside County in Southern California and in Greece.

BURLINGTON, ON. Mar. 16, 2010. **IPICO Inc**. announced that it will provide its Dual Frequency timekeeping solutions for use in the Chinese military fitness training programs via its regional channel partner. The company will provide approximately 150 of its LITE systems along with 10 ELITE systems and 50,000 DF tags in the first year of the multi-year program. The company, a supplier of RFID solutions, also produces smart labels and tags based on the IP-X communication protocol. These products are used to optimize the management of items and processes within the logistic supply chain and other value chains and can be used in the harsh and challenging environmental conditions found in physical training events.

EDMONTON, AB. Mar. 17, 2010. **Telus** announced that it will invest $650 million in its Albertan infrastructure in 2010, in particular to offer high definition digital television. The new platform will provide users with a single personal video recorder (PVR) solution for the whole home. Since 2000, about $21 billion have been invested in Alberta by Telus.

CONCORD, ON. Mar. 22, 2010. **RuggedCom Inc.** announced that it has been ranked as the global market share leader for IEC 61850 routers and switches in Smart Grids according to a recent study by GlobalData. The firm designs and manufactures ruggedized communications equipment capable of handling harsh electrical and climatic environments.

WATERLOO, ON. Mar. 23, 2010. **Open Text Corporation** announced that it is now extending its enterprise content management software to mobile devices. In particular, the company declared that it will make Open Text ECM Suite available to mobile devices. This application will display business processes, content and workplace social collaboration tools via a native application.

TORONTO, ON. Mar. 26, 2010. **Redline Communications Group**, a manufacturer of WiMAX and broadband wireless infrastructure products, announced that it has won a multi-million dollar contract to supply Fixed WiMAX radios in Romania. Radiocom S.A., a provider of communication services in Romania, will deploy a full-service WiMAX network while Omnilogic, a local partner of Redline, will provide the WiMAX radio portion. Redline also announced more recently that it has been selected as a broadband wireless solutions provider for the "Digital Rio" program in the state of Rio de Janeiro, Brazil. The order, in the amount of $1.8 million, is funded by Rio de Janeiro's Department of Science and Technology. The network will reach 1.4 million people. The solution offers 100Mbps capacity with support to outdoor connections of up to 80 kilometers.

MONT-SAINT-HILAIRE, QC. Mar. 26, 2010. A "Léonard" prize in Telecommunications and new technologies was awarded to **BBA**, an engineering consulting firm, during the eighth edition of the Grands Prix du génie-conseil québécois. This event was organized by the Quebec's Association of consulting engineers (AICQ). The prize was awarded for a project related to electrical networks including monitoring of the electrical networks, identifying failures, analyzing causes and providing solutions.

MONTREAL, PQ. 6 avr. 2010. Prof. Sylvain Martel du **Laboratoire de nanorobotique de l'École Polytechnique** de Montréal a réalisé la prouesse de faire construire une structure pyramidale au moyen de nanobriques d'époxy transportées par des bactéries. L'opération a duré 15 minutes. Les chercheurs sont également parvenus à piloter un groupe de bactéries dans le flux sanguin d'un rat à l'aide du même dispositif.

BURLINGTON, ON. Apr. 7, 2010. **Siemens Energy** announced that it has received an order for 43 of its 2.3 MW, SWT-2.3-101 wind turbines for the Greenwich Wind Energy Project near Thunder Bay. In November 2009, Siemens was also contracted to supply 43 wind turbines of the same model for the Talbot Wind Energy Project near Chatham, Ontario. The purchaser of the 86 wind turbines with a combined rated capacity of nearly 200 megawatts is Renewable Energy Systems (RES) Canada Inc., an affiliate of RES Americas which has developed and/or constructed approximately 10 percent of the wind capacity in the United States. Once completed, the two projects are expected to provide power for over 60,000 homes.

TORONTO, ON. Apr. 12, 2010. **Medworxx Inc.** announced that the Hospital for Sick Children (SickKids) has adopted the Medworxx Learning Management System. The system will be the e-learning platform for the employees of the hospital. Medworxx provides healthcare solutions for patient flow, compliance and education. Over 500,000 people in 300 hospitals use its products.

MONTRÉAL, PQ. 18 mar. 2010. Une des deux équipes de **l'École de Technologie Supérieure** s'est classée première sur vingt-sept équipes aux Computer Science Games. Cette compétition annuelle regroupait 260 participants provenant d'universités nord-américaines.

# *A View from the West*

On: BC Mining, Garbage Energy, UC President, Alberta Workplaces, Free Wireless, Skills Competition, Adventure Tourism, Sask Growth, Jump Cell, and Forestry Machines

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

- With gold and other mineral prices high, optimism is returning to the mining industry. Jim Sutherland describes in "Return of the Gilded Age." [*BCBusiness*. 38(3):46-51. March, 2010. www.bcbusinessonline.ca] how boom times are back for BC's precious metals sectors. The government is reviewing 30 projects that are believed to possess some of the world's richest copper and gold reserves. Mining has always played an important role in British Columbia and the province has a strong infrastructure support in place to take advantage of its complex geology that offers lots of promise.

- The process and issues associated with incinerating solid waste to produce electricity are discussed by Colleen Kimmett in "Garbage to Burn." [*BCBusiness*. 38(1):39-43. January, 2010]. The Burnaby BC facility incinerates 280,000 tons of waste a year—which is just over 20% of Metro Vancouver's total, 24/7, and produces 16.7 megawatts of electricity, enough to power 16,700 homes. Advantages and disadvantages of this method of waste disposal and energy generation are discussed. As stated in the article not everyone is convinced that this technology is an environmentally and economically sound investment.

- The University of Calgary has selected its eighth President and Vice-Chancellor. Dr. Elizabeth Cannon, a U of C triple alumna, begins her term on July 1, 2010, succeeding Dr. Harvey Weingarten. The chair of the Search Committee, Jack Perraton, stated "We conducted an international search, so I am especially proud to say that, Elizabeth, one of our own, was the best candidate from among a group of very talented candidates." Dr. Cannon is a professor in the Department of Geomatics Engineering and has served as Dean of the University of Calgary's Schulich School of Engineering since 2006. She has a long history of leadership at the University and in the broader community. Her innovative work focuses on geomatics engineering and the commercial application of geomatics technology. She has been involved as an expert at the frontiers of global positioning systems since 1984 and her work has resulted in advancements in satellite-based navigation systems worldwide. For information see: www.ucalgary.ca/presidentelect

- Results from the 2010 survey of Alberta's Best Workplaces are provided in the March issue of *Alberta Venture* [pp. 29-57. March, 2010. www.albertaventure.com ]. Rankings are provided for eleven categories including best workplace for working parents, health and safety, training and development, diversity, workplace for millennial's, volunteerism and community involvement, environmental consciousness, perks and incentives, benefits; and small, medium, and large worksites. Awardees represent a diverse range of private and public employers.

- The story of a telecommunications start-up who is providing a Calgary community of 3,450 households with free broadband wireless Internet is provided by Heidi Staseson in "The Web Over Hawkwood" [*Alberta Venture*. pp. 60-64. March, 2010]. The concept of providing free or a blended model of free and paid-for service has been implemented in other centers globally with mixed results. In some cases this type of business model is regarded as a supplement to traditional providers and not necessarily as a replacement.

- The 40th World Skills Competition was held in September, 2009 in Calgary, Alberta. [www.worldskills2009.com ]. Over 848 competitors from around the world competed for recognition in the skills, trades, and technology sectors. Almost 20,000 delegates attended from around the world, and over 150,000 visitors attended the event, many of these being primary and high school students. An important objective of the organizers was the encouragement of young people to pursue lucrative careers in these sectors. The event generated at $3.2M surplus much of which will be used for scholarships and career focused initiatives. Additionally the Alberta Government sponsored a $14M program in which brand new equipment from the competition was distributed amongst high school and post secondary educational institutions around the province. The next competition will be held in London, England in 2011.

- Adventure tourism is a growth industry, worldwide. Bob Covey reports in the article "Leap of Faith" in the January 2010 issue of *Alberta Venture* on opportunities, challenges, and developments in this business sector. [www.albertaventure.com/2010/01/leap-of-faith] In particular the article focuses on the extreme adventure sport of the Rocky Mountain Zip line of Darrell Bossert where the courageous can zip 15 meters above the ground at 50 km/hr down a 1,200 foot slope.

- The Conference Board of Canada has forecasted that Saskatchewan will lead the country in GDP growth for 2010 for the second time in a row. Investors are seeing unprecedented opportunities in its diverse economy. Penny Eaton reports on how this success has occurred through business owners and employee's vision, determination, and sheer hard work in *Saskatchewan Business Magazine*. ["Leading the Country by Investing on the Home Front". 31(1): 33-37. January/February, 2010]. Labour-sponsored venture capital funds and other types of opportunities funding that have experienced solid growth each year are also described.

- The cellular telephone and other wireless devices business are highly competitive and one key to success is standing out from the competition. Penny Eaton in her article "Staying a Jump Ahead" [*Saskatchewan Business Magazine* 31(2):29-33. March 2010] describes how one company, Jump.ca, headquartered in Regina creates unique experiences for their customers in their 14 retail stores. This focus on customer experience is credited with the company's success and providing opportunities for expansion in other markets.

- Improving productivity is important to success in the logging industry. Bill Tice reports in *Canadian Forest Industries* ["Technology Update". pp. 8-12. January/February, 2010. www.canadianforestindustries.ca] how machine utilization is on the rise thanks to the use of new data logger technology from FPInnovations - FERIC Division in Newfoundland. The technology and its benefits are described. Results suggest improved machine utilization of 10-15%. Importantly, the machine operators have embraced the data logger technology as they have seen what it can do.

## *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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# *Novel Issues in DSRC Vehicular Communication Radios*

*By Yasser L. Morgan, University of Regina*

***Abstract***

The evolving Dedicated Short Range Communications (DSRC) standards have captured the attention of industry and researchers alike. DSRC is poised to resolve much of the vehicular safety issues [1] and to provide low-cost high-bandwidth services for roaming vehicles throughout North America [2]. Future vehicles will utilize DSRC communications along with modern safety applications to implement advanced traffic safety like crash prevention and intersection collision avoidance. The DSRC stringent operational environment resulted in fairly complex standards design and architecture. The DSRC is presented by a suite of standards namely IEEE 802.11p, IEEE P1609.0, .1, .2, .3, .4, and .5. In 2006, the DSRC standards work groups decided to re-define the design objective to be for 'trial-use'. This decision reflects the view that current technologies require re-evaluation and improvement before becoming viable for commercial use. The decision is also fuelled by the need to resolve different aspects of the vehicular short-range communications at various layers.

***Sommaire***

Les standards évolutifs des communications spécialisées à courte portée (CSCP) ont capté l'attention aussi bien de l'industrie que des chercheurs. Les CSCP pourraient résoudre une bonne part des problèmes de sécurité véhiculaire [1] et procurer des services à large bande économiques pour les véhicules en Amérique du Nord. Les véhicules de l'avenir utiliseront les communications CSCP conjointement avec des mécanismes modernes de sécurité pour mettre en place des mécanismes de sécurité routière avancée tels la prévention des collisions aux intersections ou ailleurs. Les CSCP sont illustrées par une suite de standards tels IEEE 802.11p, IEEE P1609.0, .1, .2, .3, .4, et .5. En 2006, les groupes de travail sur les standards CSCP ont décidé de redéfinir leurs objectifs de conception pour viser la mise en oeuvre expérimentale. Cette décision reflète l'opinion que les technologies actuelles exigent une réévaluation et des améliorations avant de devenir viables pour un usage commercial. La décision a aussi été motivée par le besoin de résoudre divers aspects des communications véhiculaires à courte portée dans diverses couches.

## *I.0 Introduction*

The DSRC networks are designed to provide certain wireless services for roaming vehicles throughout North America. The DSRC network [3] and its applications are built over two basic units; the Road-Side Unit (RSU) and On-Board Unit (OBU). The RSU is, generally, a stationary unit that connects roaming vehicles to the access network, which could be connected to a much larger infrastructure or a core network. The OBU is typically a network device installed in a roaming vehicle and is connected to both the DSRC wireless network and to in-vehicle network. This simple architecture is illustrated in Figure 1. The wireless connection between RSU and OBU is based on 802.11p [3] and a suite of 1609.x standards. The 1609.x suite of standards is called Wireless Access in Vehicular Environment (WAVE), and the terms WAVE and DSRC are typically used indistinguishably, but the latter one usually implies the inclusion of 802.11p. The term WAVE tends to imply a focus on the MAC and network services. The cones shown in smaller dots in Figure 1 represent the RSU communication zones while the ellipse represents the radio range of the OBU. As OBUs move between communication zones, vehicles exchange information with the roadside; in addition, vehicles use the same WAVE media to communicate with each other.

The communication zone covered by each IEEE 802.11p RSU is limited to less than 1 Km at most and uses 5.9 GHz radio transmission [3]. OBUs are expected to join the WAVE Base Station Set (WAVE BSS or WBSS) of the closest† RSU, exchange information, and may leave within very limited time (3.6 sec.)‡. The limited lifetime of an OBU within specific RSU-WBSS communication zone imposes hard requirements on the design of the DSRC standards and on the nature of future DSRC applications as described later. DSRC networks use WAVE Short Messages Protocol (WSMP) to exchange safety information between vehicles and roadside or just between vehicles.

The use of DSRC networks is best described by application examples. The examples included hereafter are illustrated mainly to familiarize the reader with the DSRC environment, its requirements, and the use of DSRC networks.

### 1.1 Intersection Collision Avoidance

In this example, a vehicle *W* is approaching the intersection with a high speed and is likely to run the red lights as displayed in Figure 2 (see following page). RSU-W discovers that vehicle *W* is likely to cause intersection collision, and therefore, it sends a WSMP message to vehicle *W* alerting its driver by displaying an alert box as shown in Figure 2. In addition, RSU-W sends a message to the Vehicle Tracking System and Central Intersection Communication (VTS/CIC).

The VTS/CIC informs the Intersection Collision Avoidance System (ICAS) which is an application that runs over the same VTS/CIC hardware. The ICAS identifies the geographical locations that need to be alerted. In this example, ICAS informs RSU-N and RSU-S. Both RSUs broadcast an alert to vehicles within their communication zone (vehicle *N* and *S*) of the imminent collision. Vehicle *S* decides to inform its driver by displaying an alert box as displayed in Figure 2. In this infrastructure assisted example, a direct communication between vehicles *W* and *S* is not possible since there is no line of sight. Yet a safety message is deliverable via DSRC infrastructure support.

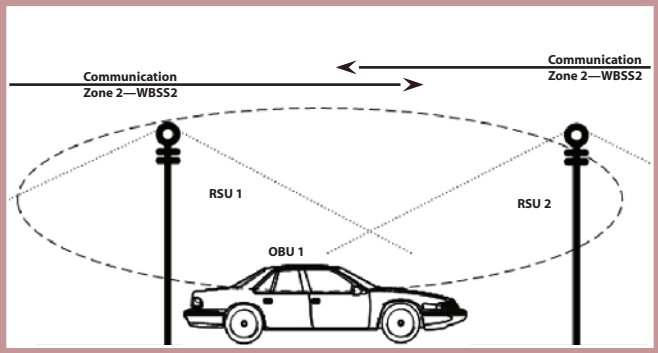


**Figure 1: An OBU roaming between two RSUs.**

### 1.2 Intersection Maps, Rules and Policies

Another DSRC application is to download intersection rules, policies and maps. In Figure 2, vehicle *E* downloads the intersection map in order

† In fact OBUs use a complex decision mechanism to identify which WBSS to join. The use of the term closest here is a reasonable approximation to serve the purpose of this article.

‡ The IEEE 802.11p and IEEE 1609.x standards do not impose specific limitations on the range of communication zones. A vehicle may stop in a communication zone infinitely. Numerical figures in this article are provided to give the reader a numeric sense of the DSRC ranges.

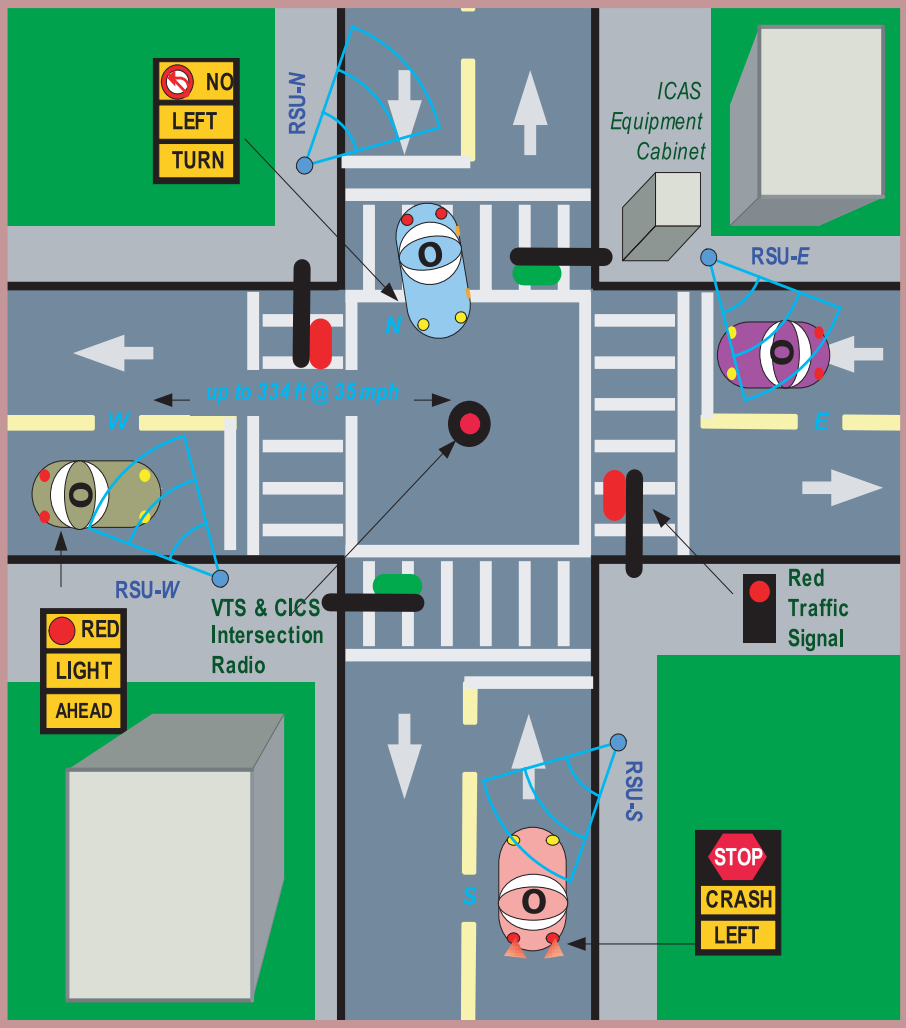


**Figure 2: Intersection collision avoidance**

to calculate driving parameters such as the stopping distance which is identified by the stop line, or lane change rules. If vehicle *N* plans to turn left; it must download the intersection rules and policies in order to learn if it is allowed to turn left. Vehicle *N* may also need to learn if the "No-Left-Turn" rule applies at certain hours of the day, and compares that to its local time. When the driver of vehicle *N* starts the vehicles' left-turn signal, a traffic application running on OBU-N detects a violation to the "No-Left-Turn" rule, and alerts the driver by displaying alert box as shown on vehicle *N* Figure 2.

In the previous examples, vehicles may alert their drivers via alert box, audio message or process the exchanged message by taking specific action. For instance, in the intersection collision avoidance example, if vehicle *W* has a smart engine, the vehicle may slow gradually to stop at the stop-line overriding the driver actions. In case of immanent collision, the vehicle may deploy the airbags immediately before the collision. The reader is encouraged to read about more applications in [16].

Also the idea of downloading local intersection map here is different from the commercially available navigation systems. The intersection map here identifies exact lane boundaries, lane rules, time varying traffic policies, location of stop line, maximum allowed height under a bridge, etc.

There are many DSRC applications in development and standardization phase. As an example, there are needs to download rerouting maps if an accident or construction is blocking certain routes. There are commercial applications for drive-through or toll payment. In all applications, wireless DSRC devices use the WAVE stacks to exchange packets. Various standards and protocols are defined on the top of the WAVE stack to allow inter-operability. For instance, a rule like "No-Left-Turn" is encoded to a predefined WSMP message that can be processed by vehicles of any make.

This article covers some of the major design approaches in DSRC standards and identifies miscellaneous research topics within the DSRC peculiar radio environment. The article illustrates major short-range vehicular communication hurdles, introduces novel research topics, and contemplates aspirant approaches. The article also directs interested readers to comprehensive references which research related meticulous solutions. In this article, Section 2 illustrates the generic WAVE architecture along with practical example. Section 3 investigates some of the most pressing radio challenges like synchronization, the use of multi-channel and the use of Software Defined Radio (SDR) towards multi-vertical radio layers. Finally, the article ends with Section 4 which concludes and comments on the challenges facing the DSRC research.

## 2.0 Generic WAVE Architecture

The generic WAVE architecture extends the legacy DSRC architecture [5] as illustrated in Figure 3. RSU is a WAVE device that is, typically, stationary. An RSU communicates with OBUs using WAVE interface and on a different interface connects to a supporting network.

Due to operational and deployment reasons, the RSU interface to the supporting network may implement a variety of solutions, like fixed wireless or data-over-power-line solution. The DSRC Supporting Network, in turn, may connect to the global network or to a local host processing local traffic rules.

Similarly, OBUs are WAVE devices that are, typically, mobile. The OBU connects to the RSU using WAVE interface, and on a different interface connects to the Vehicle Data Distribution System. That system houses other in-vehicle devices and some of those devices may connect to the global network using long range wireless like cellular or WiMAX.

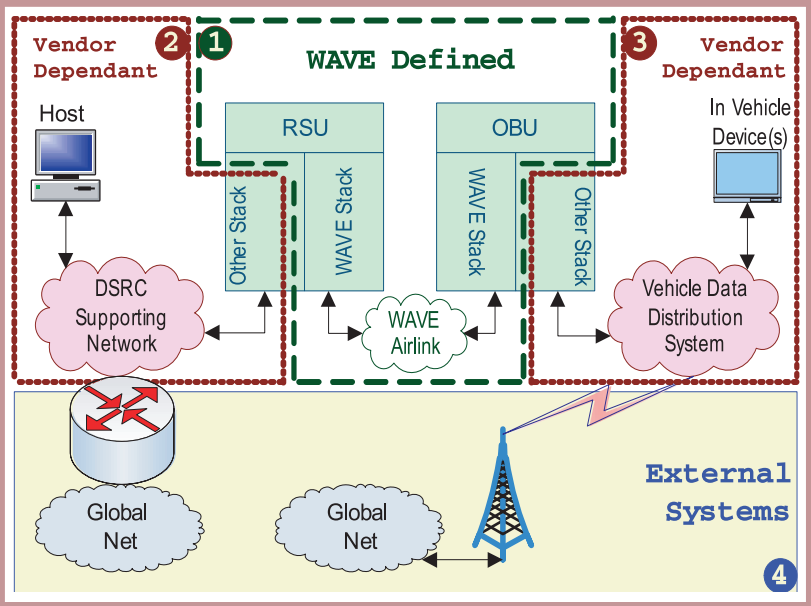


**Figure 3: Generic WAVE architecture**

## 3.0 Related Radio Challenges

The design of the DSRC radio faces several technical challenges that have substantial impact on DSRC operations and performance in critical situations.

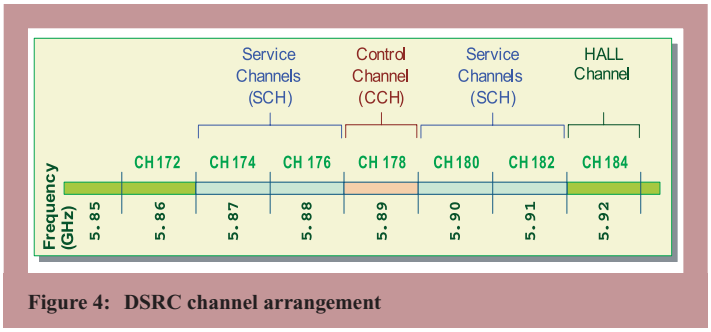


**Figure 4: DSRC channel arrangement**

Figure 4 shows WAVE channel arrangement within the 5.9 GHz spectrum. A typical WAVE device uses the Control Channel CCH and at least one Service Channel SCH within the same WBSS. The High Availability Low Latency (HALL) channel is left for future use. In most current prototypes, channel 172 is unused. As a general rule, CCH (178) is exclusively used to communicate safety and control information while SCH is typically used to communicate IP-based services.

WAVE relies on the IEEE 802.11a Orthogonal Frequency Division Multiplexing (OFDM) mechanism to provide data transmission rates of 9, 12, 18, 24, and 27 Mbps for 0-60 Km/hr vehicle speed and 3, 4.5, 6, 9, and 12 Mbps for 60-120 Km/hr vehicle speed. The system comprises 52 sub-carriers, modulated using BPSK, QPSK, 16-QAM, or 64-QAM. Convolution coding is used with a coding rate of 1/2, 2/3, or 3/4. The data rates are determined by coding rate and modulation type [6],[7].

The following sub-sections focus on the major radio challenges and MAC design issues, and then, briefly illustrates possible alternative approaches.

### 3.1 Synchronization of WAVE Devices

The IEEE 802.11 [3] follows the classical CSMA/CA and IEEE 802.11p requires channel time synchronization between communicating WAVE devices [8]. The synchronization also has significant impact on performance and resources utilization. Researchers have proposed several synchronization approaches like in [9].

As soon as a group of WAVE devices are synchronized, they alternate the utilization of the CCH and SCH as illustrated in Figure 5. A typical WAVE device may visit the CCH for a period called CCH Interval (CCHI) and is shown by the hashed area at the top-left row of Figure 5. Then the WAVE device may switch to the SCH for a period called SCH Interval (SCHI), which is shown by the hashed area at the second row of Figure 5. Both CCHI and SCHI actual resource utilization are delayed after switching by a period called Guard Interval (GI) in order to accommodate for device differences. From Figure 5, it is clearly essential to minimize the GI by adopting an accurate and efficient synchronization mechanism.

Among proposed synchronization mechanisms, two major approaches seem to gain popularity within the DSRC community. First approach

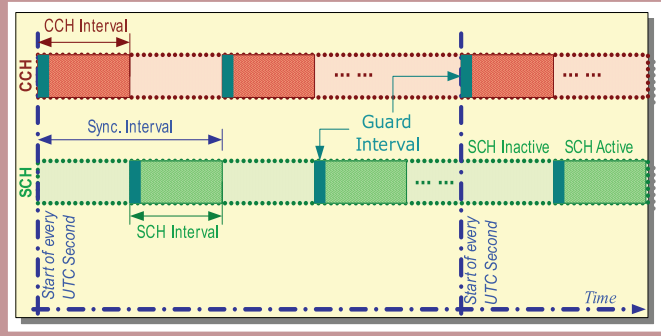


**Figure 5: WAVE Channel synchronization**

allows WAVE devices to align their radio clock to the earliest clock signal the device receives. This distributed system has built-in robustness since roaming devices can adopt different clock reference as they move to newer communication zones. There are no concerns about nation-wide failure or fears of nation-wide attacks because any synchronization failure would be local to a single communication zone. However, there is little guarantee that WAVE devices cannot be led to follow invalid or malicious clock. Furthermore the process of continuously drifting the clock results in lesser efficiency in terms of radio resource utilization.

The second approach assumes the availability of global clock signal with sufficient accuracy (like UTC). WAVE devices align their radio resources to a globally accurate clock every second. A simple mechanism is employed to allow WAVE devices to align to the best available clock signal in the absence of a global signal like the situation when vehicles drive inside a tunnel for instance. This approach suffers from being too centralized. An attack or failure in the global clock source, while unlikely, leads to wide-spread irrecoverable failure of the DSRC network. In addition, the impact of having clock signal that propagates through a large geographical area at the start of each second remains unexplored. More research is needed to evaluate the impact of this clock signal on other forms of communications like satellite, cellular and other WiFi and WiMAX communications.

Current WAVE standards follow the global signal approach. However, it is likely that the WAVE adopts, eventually, a combination of the global signal and some other distributed approaches. In addition, it is important to decentralize the global clock reference and to initiate its signal differently based on geographic locations. Furthermore, preliminary results have shown that massive deployment of 5.9 GHz can have some impact on other forms of radio communications. This issue, despite its vitality, remains largely unexplored and presents fertile research topics.

### 3.2 Adopting Multi-Channel

Most current radio devices are based on single-channel concept; each radio may either receive or send data at any point in time by following the CSMA/CA mechanism. There is a subtle difference between WAVE and other wireless environments. The cost of installing a WAVE device has to be sufficiently low since WAVE devices are viewed as essential safety devices. Hence, users seeking cheaper devices can install a simple radio device that utilizes single-channel only and be assured to capture all safety messages. A single-channel WAVE device operates only on one channel at a time. Referring to Figure 5, a single-channel device is expected to switch between CCH and SCH frequently. Now assume the Control Channel Interval is CCHI, Service Channel Interval is SCHI, the Guard Interval is GI, the Synchronization Interval is SI, and the Radio Utilization is RU. Then assuming the simple cheap single-channel WAVE device is used, it follows that:

$$RU_S = ( SI - 2GI) / 2 \; SI < 1/2 \quad (1)$$

Alternatively, developing a multi-channel WAVE device enhances the radio utilization since the radio device would, simultaneously, receive data on one channel and send on another with no degradation in signal quality and even when using sufficiently different power or data-rate on each channel. Multi-channel devices apply CSMA/CA to each channel independently [10]. The use of multi-channel WAVE device improves RU as follows:

$$GI=0, \; RU_M = SI = 1 \quad (2)$$

$$\text{Therefore: } RU_M > RU_S \quad (3)$$

The use of multi-channel radio is fundamental to improving the utilization of WAVE resources by dedicating CCH to safety and emergency information only without limiting the simultaneous communications of IP-services on SCH.

Despite the simple persuasive math supporting the use of multi-channel radios, interoperability changes the math a bit. In a single WBSS that has single-channel and multi-channel WAVE devices, the radio utilization of multi-channel devices is lowered to guarantee interoperability. Multi-channel devices cannot utilize the SCH during the CCHI because the single-channel devices are not listening on the SCH during CCHI, and therefore, cannot issue RTS or CTS messages. Knowing this, one QoS research may develop an algorithm to utilize the unused bandwidth for intercommunication between multi-channel WAVE devices during CCHI. Obviously, this approach involves further optimization to the classical 802.11e priority mechanism.

The WSMP is used to carry routine, safety and emergency information on CCH and SCH which is critical to the DSRC public safety applications. The WSMP packets must reach their destination within very lim-

ited time, but they are not frequent enough to justify the time consumed in revisiting CCH. While there has been no solid research to support the assumption of relatively low WSMP bandwidth demands, this assumption is shared by most researchers in this field and the technical reports generated by projects like PATH are consistent with this assumption. Another QoS research may develop a scheduling algorithm to use the idle time in propagating control messages on CCH. Comprehensive QoS solutions must consider end-to-end solutions like in [11] to complement the per-hop MAC QoS.

It is worth hinting that during the early work on WAVE standards we investigated a design that uses SCH all the time and employs a follow-me message to communicate safety messages. The continuous study led to exponential system design complexity to guarantee message authentication and to synchronize the switching of all devices to CCH. Yet, the frequent visits to CCH in order to process safety and routine messages remain controversial. In [12] researchers proposed alternative techniques that are worth further studying.

### 3.3 WAVE Over Long-Range Communications

It may seem a little peculiar at first to propose a new approach for WAVE over long-range communications. After all, the basic concept of DSRC is to provide high bandwidth communication configured for localized services and traffic safety use. The concept of short-range communications supports the public safety applications perfectly in most of the situations but not quite for all situations.

Long highway stretches that span multiple miles with little difference in traffic information and limited traffic volume present a good example for situations when DSRC is uneconomical. In those situations, using WAVE devices leads to the unnecessary deployment of massive infrastructure. Instead, lesser number of WiMAX or cellular services can be deployed to carry the DSRC communications using WAVE standards over a WiMAX media for example.

In order for this proposal to work, OBUs must be equipped with multi-radios that utilize WiMAX signals. A better approach is to abstract the DSRC WAVE layer using SDR like the one proposed in [13] and [14]. This approach, while complex, realizes the inevitable use of SDR and cognitive radio to provide support for applications running over multiple vertical radio layers.

## *4.0 Conclusion*

This article provides brief discussion of the DSRC standards and their peculiar short-range vehicular communication environment from distinctive perspectives. Major radio issues like synchronization and the use of SDR remain controversial. However, we tried to provide the necessary understanding of the DSRC capabilities and limitations. Issues like synchronization, multi-channel and use of WAVE over long-range communications media are fundamental to the DSRC design and are inherited from its environment. Other issues like in [15] customize the radio design to realize the uniqueness of the vehicular environment.

The reader is encouraged to use the ideas in this article and the landmark references provided for extended reading. There will be a following article on routing, network, mobility, service discovery, security, and middleware issues.

The current DSRC standards are going for voting by mid 2010, and, if passed, will be published for trial use by late 2010. The term trial use leaves room for researchers to comment on critical and non-optimal design issues like those listed in this article. Improved algorithms can be adopted in the next phase of DSRC standards. We contemplate aspirant approaches to the major hurdles facing the evolving short-range vehicular communications.

### References


[1] "Statement by Prime Minister Junichiro Koizumi (Central Traffic Safety Policy Council chairman) on Achieving a Reduction to Half the Number of Annual Traffic Accident Fatalities," Japanese government, January 2003.

[2] National Center for Statistics and Analysis, "Traffic Safety Facts 2003," Report DoT HS 809 767, National. Highway Traffic Safety Admin., U.S.-DoT, Washington, DC, 2004.

[3] IEEE 802.11p SWG et al, "Draft Amendment to Standard for Information Technology - Telecommunications and information exchange between systems - Local and Metropolitan networks - specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Amendment: Wireless Access in Vehicular Environments (WAVE)," IEEE 802.11p D1.2, September 2006.

[4] IEEE P1609.3 SWG et al, "Wireless Access in Vehicular Environments (WAVE) Networking Services," IEEE P1609.3 D1.4, September 2009.

[5] C. Cseh; "Architecture of the dedicated short-range communications (DSRC) protocol," in the proceedings of the IEEE 48th Vehicular Technology Conference VTC-98, vol. 3, pp. 2095-2099, May 1998.

[6] J. Mar, C. H. Chou, C.C. Kuo and Y.R. Lin; "A Pilot Sub-Carrier-Aided Frequency Equalizer for the Dedicated Short-Range Communications System over Time-Varying Fading Channels," in the Proceedings of Management and Technology Forum, China Communications, pp. 33-41, December 2006.

[7] J. Liu and J. Li; "Packet Design and Signal Processing for OFDM-Based Mobile Broadband Wireless Communication Systems," in the IEEE Transactions on Mobile Computing, vol. 5, issue 9, pp. 1133-1142, Sep. 2006.

[8] IEEE P1609.4 SWG et al, "IEEE P1609.4 Trial-use Standard for Wireless Access in Vehicular Environments (WAVE) - Multi-Channel Operation," IEEE P1609.4 D09, September 2009.

[9] H. Anh, J. Kim, W. Cho, J. Choi, K. Lim and J. Kwak; "A robust and low-complexity timing synchronization algorithm for ADSRC system," in the Proc. of International Conference on Wireless and Optical Communications Networks IFIP-2006, pp. 6, April 2006.

[10] B. J. Ko, V. Misra, J. Padhye and D. Rubenstein; "Distributed Channel Assignment in Multi-channel 802.11 Mesh Networks," IEEE Wireless Communications and Networking Conference WCNC-2007, Hong Kong, March, 2007.

[11] D. Jiang, V. Taliwal, R Meier, W. Holfelder and R. Herrtwich; "Design of 5.9 GHZ DSRC-Based Vehicular Safety Communication," in the IEEE Wireless Communications Magazine special issue on Intervehicular Communications, vol. 13, issue 5, pp. 36-43, October 2006.

[12] Y. Morgan "Notes on DSRC and WAVE Standards Suite, Its Architecture, Design, and Characteristics," in the IEEE-JCST, vol. 11, no. 4, September 2010.

[13] M. Umemoto; "An Experimental DSRC Multimode Terminal Using Software Defined Radio Technology," in the Proc. of the IEEE Radio and Wireless Conference RAWCON-2001, pp.165-168, August 2001.

[14] A. Yokoyamai and H. Harada; "Implementation of Multi-Channel Modem for DSRC System on Signal Processing Platform for Software Defined Radio," in the Special Section on Software Defined Radio Technology and Its Applications, IEICE Transactions on Communications, vol: E89-B, no. 12, pp. 3225-3232, November 2006.

[15] Y. H. Cheng, Y. H. Lu and C. L. Liu; "Adaptive Channel Equalizer for Wireless Access in Vehicular Environments," in the proceedings of the 6th International Conference on ITS Telecommunications, pp. 1102-1105, Chegdu China, June 2006.

[16] IntelliDrive initiative http://www.intellidriveusa.org/


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**Dr. Morgan** is an Associate Professor with University of Regina. He received his B.Sc. and M.Sc. from Cairo University and his Ph.D. from Carleton University, Ottawa, Canada. Dr. Morgan's main research is in the area of vehicular communications at various layers and especially at the MAC layer. Dr. Morgan is focused on mobile QoS and service delivery. Since 2004 he has published many journal papers on vehicular communications and he has manifest contribution to the IEEE DSRC 802.11p and WAVE IEEE P 1609.3 and P 1609.4 standards.

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*For outstanding contributions to Canadian and global network research and education*

**Alberto Leon-Garcia (FIEEE)** is Director of the Information and Communications Forum at the University of Toronto, holding a Canada Research Chair in Autonomic Service Architecture. From 1999 to 2002 he was founder and CTO of AcceLight Networks in Ottawa, which developed an all-optical fabric multi-terabit/second, multiservice core switch. In 2006, Dr. Leon-Garcia received the Thomas Eadie Medal from the Royal Society of Canada for his research of the design, operation, and management of application-oriented multiservice packet networks. He was elevated to IEEE Fellow in 1999 for "contributions to multiplexing and switching of integrated services traffic."

Dr. Leon-Garcia is recognized as an innovator in networking education. In 1986, he led the development of the University of Toronto-Northern Telecom Network Engineering Program. In 1997 he oversaw the creation of the Master of Engineering in Telecommunications program, and the communications and networking options in the undergraduate computer engineering program. He is author of the leading textbooks: *Probability and Random Processes for Electrical Engineering* and *Communication Networks: Fundamental Concepts and Key Architecture*. The holder of several patents, he has published research extensively in the areas of switch architecture and traffic management.

Current research interests include application-oriented networking and autonomic resources management, with a focus on enabling pervasive smart and green infrastructure. His research team is now developing a network and applications testbed that uses virtualized resources to enable at-scale experimentation in new network protocols and distributed applications. Dr. Leon-Garcia is a highly sought-after keynote speaker with recent addresses including IEEE LCN 2009 and SYTACom Research Workshop 2009.

## Médaille d'or A.G.L. McNaughton de l'IEEE Canada 2010

*Pour contributions exceptionnelles à la recherche et l'enseignement canadien et mondial sur les réseaux*

**Alberto Leon-Garcia (FIEEE)** est directeur du Forum sur l'information et les communications à l'Université de Toronto, et occupe une chaire de recherche du Canada en architecture de services autonomes. De 1999 à 2002 il fut fondateur et CTO de AcceLight Networks à Ottawa, qui a développé un commutateur de noyau multi-terabit/seconde entièrement optique. En 2006, Dr. Leon-Garcia a reçu la médaille Thomas Eadie de la Société royale du Canada pour sa recherche sur la conception, l'opération et la gestion des réseaux applicatifs multiservices à commutation de paquets. Il a été nommé Fellow de l'IEEE en 1999 pour « contributions au multiplexage et à la commutation de trafic à services intégrés ».

Dr. Leon-Garcia est reconnu en tant qu'innovateur dans le réseau de l'éducation. En 1986, il a dirigé le développement du programme d'ingénierie de réseau Northern Telecom de l'Université de Toronto. En 1997 il a supervisé la création du programme de maîtrise en génie des télécommunications, et l'ajout des options communications et gestion de réseau du programme de génie informatique au premier cycle. Il est l'auteur de manuels de premier plan, dont *Probability and Random Processes for Electrical Engineering* and *Communication Networks: Fundamental Concepts and Key Architecture*. Il est détenteur de plusieurs brevets et a publié intensivement dans les domaines de l'architecture de commutation et de la gestion de trafic.

Ses intérêts de recherches incluent la gestion de réseau orientée application et la gestion des ressources autonomes, avec un accent sur l'infrastructure intelligente et verte. Son équipe de recherche développe présentement un réseau et un banc d'essai d'applications qui utilise des ressources virtuelles pour permettre l'expérimentation à l'échelle de nouveaux protocoles de réseaux et d'applications réparties. Dr. Leon-Garcia est un conférencier très recherché ayant participé à des événements récents tels IEEE LCN 2009 et l'Atelier 2009 de SYTACom Research.


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## 2010 IEEE Canada R.A. Fessenden Medal

*For outstanding contributions in wireless communication theory*

**Norman Beaulieu (FIEEE)** received the B.A.Sc. (honors), M.A.Sc., and Ph.D. degrees in electrical engineering from the University of British Columbia in 1980, 1983, and 1986, respectively. He was awarded the University of British Columbia Special University Prize in Applied Science in 1980 as the highest standing graduate in the Faculty of Applied Science.

Dr. Beaulieu was a Queen's National Scholar Assistant Professor with the Department of Electrical Engineering, Queen's University from September 1986 to June 1988, an Associate Professor from July 1988 to June 1993, and a Professor from July 1993 to August 2000. In September 2000, he became the iCORE Research Chair in Broadband Wireless Communications at the University of Alberta and in January 2001, the Canada Research Chair in Broadband Wireless Communications. His current research interests include broadband digital communications systems, ultra-wide bandwidth wireless systems, ad hoc wireless networks and cooperative wireless networks, fading channel modeling and simulation, diversity systems, multiple input multiple output (MIMO) systems, space-time coding, synchronization in interference channels, and cognitive radio.

Dr. Beaulieu received the NSERC E.W.R. Steacie Memorial Fellowship in 1999. Professor Beaulieu was elected Fellow of the Engineering Institute of Canada in 2001 and was awarded the K.Y. Lo Medal in 2004. He was elected Fellow of the Royal Society of Canada in 2002 and was awarded the Thomas W. Eadie Medal in 2005. Professor Beaulieu is listed on ISIHighlyCited.com and was a Communications Society Distinguished Lecturer. He is the recipient of the Communications Society 2007 Edwin Howard Armstrong Achievement Award.

## 2010 IEEE Canada Power Medal

*For contributions to the understanding and diagnosis of power cable problems*

**John Densley (FIEEE)** graduated from the University of London (U.K.) with a B. Sc. (Eng.) and Ph.D. in 1964 and 1967, respectively. He joined the National Research Council of Canada in 1968 where he set up a research program that focused on the aging mechanisms of extruded medium voltage power cables that were failing prematurely in service. The work determined the important parameters in the electrical degradation and helped establish conditions for standard accelerated aging tests. Dr. Densley was made a Fellow of the IEEE in 1987 for this work.

In 1991 Dr. Densley moved to Ontario Hydro Research Labs, which later became Kinectrics, where he worked on diagnostic techniques to assess the condition of high voltage equipment. This involved carrying out fundamental studies of insulation degradation such as measuring partial discharge, space charge and electroluminescence phenomena. The results were used in the development of instrumentation and to improve data interpretation. Dr. Densley retired in September 2000 and now does consulting and volunteer committee work. He is active in the IEEE DEIS and in the Insulated Conductors Committee (ICC) of the PES, where he is Chair of the Subcommittee on Field testing and Diagnostics and Chair of two Working groups preparing cable standards. He was awarded in 2008 the ICC George H. Bahder Memorial Award for "significant contributions to the understanding of failure mechanisms and specifically on the topic of electrical treeing in polymeric insulation materials such as XLPE and EPR". He is also active in CIGRE SC D1 and IEC.

## Médaille R.A. Fessenden de l'IEEE Canada 2010

*Pour contributions exceptionnelles à la théorie de la communication sans fil*

**Normand C. Beaulieu (FIEEE)** a obtenu un B.A.Sc. (avec distinction), une M.A.Sc., et un Ph.D en génie électrique de l'Université de la Colombie-Britannique en 1980, 1983, et 1986, respectivement. Il a reçu le Prix universitaire spécial en sciences appliquées de l'Université de la Colombie-Britannique en 1980 en tant que diplômé de plus haut rang de la Faculté de sciences appliquées.

Dr. Beaulieu fut assistant professeur au département de génie électrique de l'Université Queen de septembre 1986 à juin 1988, professeur agrégé de juillet 1988 à juin 1993, et professeur de juillet 1993 à août 2000. En septembre 2000 il est devenu président de la chaire de recherche iCORE sur les communications sans fil à bande large de l'Université de l'Alberta, et en janvier 2001 président de la chaire de recherche du Canada sur les communications sans fil à bande large. Ses intérêts de recherche courants incluent les systèmes de communications numériques à bande large, les systèmes sans fil à bande ultra-large, les réseaux sans fil ad hoc et les réseaux sans fil coopératifs, la modélisation et la simulation de l'effacement de canal, les systèmes de diversité, les systèmes à sorties multiples à entrées multiples (MIMO), le codage espace-temps, la synchronisation dans les canaux d'interférence, et la radio cognitive.

Dr. Beaulieu a reçu la bourse commémorative E.W.R. Steacie du CRSNG en 1999. Il a été nommé Fellow de l'Institut canadien des ingénieurs en 2001 et s'est vu attribuer la médaille K.Y. Lo en 2004. Il a été reçu Fellow de la Société royale du Canada en 2002 et la médaille Thomas W. Eadie lui a été attribuée en 2005. Professeur Beaulieu est sur la liste du ISIHighlyCited.com et fut un conférencier distingué de la Communications Society. Il est le récipiendaire du Prix d'accomplissement Edwin Howard Armstrong 2007 de la Communications Society.

## Médaille d'électricité de l'IEEE Canada 2010

*Pour contributions à la compréhension et au diagnostic des problèmes de câbles électriques*

**John Densley (FIEEE)** a obtenu les diplômes B.Sc. (Ing) et Ph.D. de l'Université de Londres (R-U) en 1964 et 1967 respectivement. Il a rejoint le Conseil national de recherches du Canada en 1968 où il a mis en place un programme de recherche sur le vieillissement à long terme des systèmes d'isolants électriques d'équipements de puissance à hautes tensions. La recherche de son groupe s'est concentrée sur les mécanismes de vieillissement des câbles électriques extrudés de moyenne tension qui présentaient des défauts prématurés lorsqu'ils étaient en service. Le travail a permis de déterminer les paramètres importants dans la dégradation électrique et a aidé à établir des conditions pour les essais standards de vieillissement accéléré. John a été nommé Fellow de l'IEEE en 1987 pour ce travail.

En 1991 John quitta pour les laboratoires de recherches d'Ontario Hydro, qui plus tard sont devenus Kinectrics, où il a travaillé sur les techniques diagnostiques permettant d'évaluer la condition d'équipements à hautes tensions. Ceci impliquait d'effectuer des études fondamentales de dégradation de l'isolant telles que mesurer la décharge partielle, les charges spatiales et les phénomènes d'électroluminescence. Les résultats ont été utilisés dans le développement de l'instrumentation et pour améliorer l'interprétation des données. John a pris sa retraite en septembre 2000 et effectue maintenant de la consultation et du travail de comité volontaire. Il est actif au niveau du DEISS de l'IEEE, et au sein du « Insulated Conductors Committee » (ICC) de la PES, où il est président du sous-comité des essais sur place et diagnostics et président de deux groupes de travail préparant des normes sur les câbles. La récompense commémorative George H. Bahder de l'ICC pour « contributions significatives à la compréhension des mécanismes de défaillance et plus spécifiquement sur l'arborescence électrique dans les matériaux d'isolation à base de polymère tels le XLPE et l'EPR » lui a été attribuée en 2008. Il est également actif dans le CIGRE SC D1 et la CEI.

*sponsored by / commandité par Telus*

## 2010 IEEE Canada Computer Medal

*For outstanding contributions to pattern recognition and intelligent systems*

**Mohamed S. Kamel (FIEEE)** is Professor and Director of the Pattern Analysis and Machine Intelligence Laboratory at the Department of Electrical and Computer Engineering, University of Waterloo, where he holds a University Research Chair. Professor Kamel held a Canada Research Chair in Cooperative Intelligent Systems from 2001 to 2008. He received his M.A.Sc. from McMaster University and his Ph.D from the University of Toronto.

Dr. Kamel's research interests are in Computational Intelligence, Pattern Recognition, and Cooperative Intelligent Systems. He has authored and co-authored over 400 papers in journals and conference proceedings, 11 edited volumes, 16 chapters in books, 2 patents and industrial project reports. Under his supervision, 81 Ph.D and M.A.SC students have completed their degrees.

He is the Editor-in-Chief of the International Journal of Robotics and Automation, Associate Editor of the IEEE SMC, Part A, Pattern Recognition Letters, Cognitive Neurodynamics and Pattern Recognition, member of the editorial advisory board of the *International Journal of Image and Graphics* and the *Intelligent Automation and Soft Computing* journal.

Dr. Kamel is member of ACM, PEO, Fellow of IEEE, Fellow of the Engineering Institute of Canada (EIC), Fellow of the Canadian Academy of Engineering (CAE) and Fellow of the International Association of Pattern Recognition (IAPR). He served as consultant for General Motors, NCR, IBM, Northern Telecom and Spar Aerospace. He is co-founder of Virtek Vision Inc. of Waterloo (now part of Gerber Technology Co) and chair of its Technology Advisory Group. He served as member of the board from 1992-2008 and VP research and development from 1987 to 1992.

## 2010 IEEE Canada Outstanding Engineer Award

*For seminal contributions to control system theory and applications*

**Edward J. Davison (FIEEE)** received the B.A.Sc. degree in Engineering-Physics and the M.A. degree in Applied Mathematics from the University of Toronto in 1960, 1961 respectively, and the Ph.D. degree and Sc.D. degree from Cambridge University in 1964 and 1977, respectively. He was appointed as University Professor of Electrical and Computer Engineering at the University of Toronto in 2001.

Dr. Davison has made outstanding contributions to the theory and practice of Control Systems and Automation; in particular, he has introduced many fundamental results in this area such as the model simplification problem, the robust servomechanism problem, the notion of decentralized fixed modes, the topic of tuning regulator theory, and the notion of robustness. He also has been active as a consultant in this area in his role as Designated Consulting Engineer in the province of Ontario and as president of Electrical Consociates Ltd., and has consulted for the Canadian Space Agency, the Communications Research Center, Polysar, the Porter Commission on Electric Power Planning and others.

He was inducted into the University of Toronto's Engineering Alumni Hall of Distinction in 2003, and has received several awards including the E.W.R. Steacie Memorial Fellowship. He is a Fellow of the Canadian Academy of Engineering, the International Federation of Control (IFAC), the IEEE, and the Royal Society of Canada. He has served on numerous positions in the IEEE Control Systems Society including President in 1983. In 1993 he was awarded the triennial Quazza Medal from IFAC, in 1997 he received the IEEE Control System Society's Hendrick W. Bode Lecture Prize, and in 2003 he received the Killam Prize in Engineering of the Canada Council for the Arts.

## Médaille d'informatique de l'IEEE Canada 2010

*Pour contributions exceptionnelles à la reconnaissance de formes et aux systèmes intelligents*

**Mohamed S. Kamel (FIEEE)** est professeur et directeur du laboratoire d'intelligence artificielle et analyse de formes au département du génie électrique et informatique de l'Université de Waterloo, où il détient une chaire de recherche universitaire. Professeur Kamel a dirigé une chaire de recherche du Canada sur les systèmes intelligents coopératifs de 2001 à 2008.

Les intérêts de recherches du Dr. Kamel se situent au niveau de l'intelligence artificielle, la reconnaissance de formes, et les systèmes intelligents coopératifs. Il a été auteur et co-auteur de plus de 400 articles dans des journaux et actes de conférence, avec 11 volumes édités, 16 chapitres de livres, 2 brevets et des rapports de projets industriels. Sous sa supervision, 81 étudiants au doctorat et à la maîtrise ont complété leurs études.

Il est rédacteur en chef du journal international de robotique et d'automatisation, rédacteur associé de l'IEEE SMC, partie A, Lettres sur la reconnaissance des formes, Neurodynamique cognitive et Reconnaissance de formes. Il est membre du comité consultatif éditorial du *International Journal of Image and Graphics* et du *Intelligent Automation and Soft Computing*.

Dr. Kamel est membre de l'ACM, PEO, Fellow de l'IEEE, Fellow de l'Institut canadien des ingénieurs (ICI), Fellow de l'Académie canadienne de Génie (ACG) et Fellow de l'Association internationale de reconnaissance des formes (IAPR). Il a été consultant chez General Motors, NCR, IBM, Northern Telecom et Spar Aerospace. Il est co-fondateur de Virtek Vision Inc. de Waterloo (faisant maintenant partie de Gerber Technology Co) et président de son groupe conseil en technologie. Il y a servi comme membre du conseil de 1992 à 2008 et VP recherche et développement de 1987 à 1992.

## Prix d'excellence en génie de l'IEEE Canada 2010

*Pour contributions à la théorie et aux applications des systèmes de commandes*

**Edward J. Davison (FIEEE)** a obtenu son B.A.Sc en génie physique et une M.A. en mathématiques appliquées de l'Université de Toronto en 1960 et 1961 respectivement, et un Ph.D. et un Sc.D. de l'Université de Cambridge en 1964 et 1977 respectivement. Il a été nommé Professeur universitaire en génie électrique et informatique à l'Université de Toronto en 2001.

Dr. Davison est à l'origine de contributions exceptionnelles à la théorie et la pratique des systèmes de contrôle et d'automatisation; en particulier, il a introduit nombre de résultats fondamentaux dans ce domaine tels le problème de simplification de modèle, le problème de servomécanisme robuste, la notion de modes fixes décentralisés, la théorie des régulateurs synthonisables, et la notion de robustesse. Il a également été actif comme consultant dans ce secteur en tant qu'Ingénieur conseil désigné de la province de l'Ontario et comme président d'Electrical Consociates Ltd, et comme consultant pour l'Agence spatiale canadienne, le Centre de recherches sur les communications Canada, Polysar, la Commission Porter sur la planification de l'énergie électrique et bien d'autres.

Il a été intronisé au Engineering Alumni Hall of Distinction de l'Université de Toronto en 2003, et a reçu plusieurs récompenses incluantla bourse commémorative E.W.R. Steacie. Il est Fellow de l'Académie canadienne du génie, de l'International Federation of Automatic Control (IFAC), de l'IEEE, et de la Société royale du Canada. Il a occupé de nombreuses positions dans l'IEEE Control Systems Society incluant celle de président en 1983. En 1993 il a reçu la médaille triennale Quazza de l'IFAC, en 1997 le prix de conférence Hendrick W. Bode de l'IEEE Control Systems Society, et en 2003 le prix Killam en génie du Conseil des arts du Canada.

## 2010 IEEE Canada Outstanding Engineering Educator Award

*For exemplary teaching, curriculum development & lifelong dedication to students*

**Vijay Bhargava (FIEEE, FRSC, FCAE, FEIC)** was born in India in 1948. In 1966 he came to Canada and by 1974 had obtained the B.Sc., M.Sc., and Ph.D. degrees from Queen's University in Kingston. He has held regular positions with Indian Institute of Science, Concordia University, University of Victoria and is currently Professor at University of British Columbia (UBC). Dr. Bhargava has served as the IEEE Student Branch Counsellor and Undergraduate Advisor at Concordia University. He served as the founding Graduate Advisor at the University of Victoria and co-wrote the document *A Graduate Program in Electrical Engineering at the University of Victoria* for the new faculty of Engineering. He was voted professor of the year by the graduating class of 2000 at the University of Victoria. In 2003, Dr. Bhargava was appointed to a five year term as Head of the ECE Department at UBC to lead its expansion under a Provincial initiative known as "Double The Opportunity." He recruited 25 faculty members and facilitated the development of new options in strategic areas such as Energy Systems, Biomedical Engineering and Nanotechnology and Microsystems. He is co-author/co-editor of five books and 205 journal papers.

In 1988 Dr. Bhargava founded the *Canadian Conference on Electrical and Computer Engineering* and nurtured it for several years. He served as the Director of IEEE Region 7 (also known as IEEE Canada) in 1992 and 1993. His Major awards include IEEE Canada's McNaughton Gold Medal, IEEE Graduate Teaching Award, the UBC Killam research Award and Eadie Medal of the Royal Society of Canada.

## 2010 IEEE Canada Robert H. Tanner Industry Leadership Award

*For leadership in advancing academic & industry joint advancement of technology*

**Ibrahim Gedeon (SMIEEE)** as the CTO, is responsible for technology strategy, service and network architecture, service delivery and operational support systems for TELUS Communications Inc. and TELUS Mobility. He is responsible for the Wireless-Wireline service and network convergence, enterprise applications and network infrastructure strategies and evolution.

Mr. Gedeon began his career in telecommunications engineering and research in 1990 when he joined Bell Northern Research. He moved to Nortel Networks in 1994 as a network design engineer, in 1996 he was named vice president and director of Data Network Engineering at Nortel, and vice president of Internet Brand Management in 1999. He was appointed senior vice president of Wireless Engineering in 2000 and led the global engineering team responsible for operations, sales support, and systems engineering.

Mr. Gedeon has held numerous leadership roles with the IEEE and has received several professional awards and industry recognition. These honours include being named to *Global Telecoms Business* magazine's GTB Power 100, a list of the 100 most powerful and influential people in the telecoms industry, as well as receipt of IEEE Canada's Outstanding Engineer Award. Ibrahim is currently the General Chair for the IEEE ICC 2012 Conference in Ottawa and currently serves on the board or council of other industry associations such as ATIS, Industry Canada's Communications Research Centre, and CASA Foundation. Ibrahim has a bachelor's in electrical engineering from the American University of Beirut and a Masters in Electronics Engineering from Carleton University.

## Prix d'excellence en enseignement du génie de l'IEEE Canada 2010

*Pour un enseignant modèle, son développement de programmes d'études et son dévouement à vie envers les étudiants*

**Vijay Bhargava (FIEEE, FRSC, FCAE, FEIC)** est né en Inde en 1948. En 1966 il est venu s'établir au Canada et en 1974 il détenait un B.Sc., une M.Sc., et un Ph.D. de l'Université Queen's à Kingston. Il a occupé des positions régulières au sein de l'Institut Indien de la Science, l'Université Concordia, l'Université de Victoria et il est actuellement professeur à l'Université de la Colombie-Britannique (UBC). Dr. Bhargava a servi comme conseiller de la branche étudiante de l'IEEE et conseiller aux études de premier cycle à l'Université Concordia. Il a servi comme conseiller fondateur aux études de premier cycle à l'Université Victoria et co-écrit le document *A Graduate Program in Electrical Engineering at the University of Victoria* pour la nouvelle faculté de génie. Il fut élu professeur de l'année par la promotion 2000 à l'Université Victoria. En 2003, Dr. Bhargava a été nommé directeur du département GÉI de l'UBC pour un mandat de cinq ans pour mener une expansion issue de l'initiative provinciale « Double the Opportunity ». Il a recruté 25 membres de la faculté et a facilité le développement de nouvelles options dans des secteurs stratégiques tels que les systèmes électriques, le génie biomédical, la nanotechnologie et les microsystèmes. Il est co-auteur/co-éditeur de cinq livres et de 205 articles scientifiques.

En 1988, Dr. Bhargava a fondé la *Conférence canadienne de génie électrique et informatique* et l'a soutenue pendant plusieurs années. Il a servi comme directeur de la région 7 de l'IEEE (également connue sous le nom de IEEE Canada) en 1992 et 1993. Ses récompenses importantes incluent la médaille d'or McNaughton de l'IEEE Canada, le Prix en enseignement au premier cycle de l'IEEE, la Bourse de recherches Killam de UBC et la médaille Eadie de la Société royale du Canada.


*sponsored by Canadian Heads of ECE / commandité par les directeurs canadiens de GEI*

## Prix d'excellence en leadership industriel Robert H. Tanner de l'IEEE Canada 2010

*Pour leadership dans l'avancement conjoint de la technologie au niveau universitaire et industriel*

**Ibrahim Gedeon (SMIEEE)** en tant que directeur de la technologie, est responsable de la stratégie de technologie, du service et de l'architecture de réseau, de la prestation de service et des systèmes de support opérationnels chez TELUS Communications Inc. et TELUS Mobilité. Il est responsable de la convergence de service et de réseau sans fil-câble, des applications d'entreprise et des stratégies et de l'évolution d'infrastructure de réseau.

M. Gedeon a débuté sa carrière en génie des télécommunications et recherche en 1990 chez Recherches Bell Northern. Il a ensuite rejoint Nortel Networks en 1994 en tant qu'ingénieur de conception de réseau, où il fut nommé vice-président et directeur de l'ingénierie de réseau informatique en 1996, et vice-président de la gestion de marques Internet en 1999. Il fut nommé vice-président principal de l'ingénierie sans fil en 2000 et a dirigé l'équipe globale d'ingénierie responsable des opérations, du support aux ventes, et de l'ingénierie de systèmes.

M. Gedeon a assumé de nombreux rôles de leadership au sein de l'IEEE et a reçu plusieurs récompenses professionnelles et reconnaissances de l'industrie, y compris être nommé par le *Global Telecoms Business* magazine sur la GTB Power 100, une liste des 100 personnes les plus puissantes et influentes de l'industrie des télécommunications, et s'être vu accorder par l'IEEE Canada le prix d'Excellence en génie. Ibrahim est président de la conférence ICC IEEE 2012 qui se tiendra à Ottawa et sert sur le conseil d'organisations telles l'ATIS, le Centre de recherches sur les communications d'Industrie Canada, et la Fondation CASA. Ibrahim possède un Baccalauréat en génie électrique de l'Université américaine de Beyrouth et une Maîtrise en génie électronique de l'Université Carleton.


*sponsored by IEEE Foundation / commandité par Fondation de l'IEEE*

## 2010 IEEE Canada W.S. Read Outstanding Service Award

*In recognition of 40 years of dedicated, outstanding and sustained service to IEEE Canada*

**Mohamed El-Hawary (FIEEE, FCAE, FEIC, FEC)** is a Professor of Electrical and Computer Engineering at Dalhousie University and was Associate Dean of Engineering between 1995 and 2007. His contributions cover more than forty years of sustained work in research, education and service to the community. On the research side, Dr. El-Hawary pioneered in computational solutions for economic operation of power systems including hydro-thermal systems. His fundamental and pioneering work on economic operation of power systems, the application of computational intelligence techniques to power system operational problems is frequently referred to by the users community, and is documented in ten textbooks and research monographs and more than 300 research articles.

He served as IEEE Canada President (2002-2003), Secretary of IEEE (2004-2005), and the Awards Board and Fellows Committee (2008-2010). Moreover, he served as IEEE Canada Awards Chair (1994-1998). Dr. El-Hawary serves currently as a member of the 2010 Publications Services and Products Board, and is IEEE Press Power Engineering Series Editor. He served as Editor-in-Chief of IEEE Press in 2006-2007. He is Founding Editor, Power Letters, Power Engineering Society, is Associate Editor for the three major Electric Machines and Power Systems' Journals, and is Editor, Electrical Power Engineering, McGraw-Hill Encyclopedia of Science and Technology.

Dr. El-Hawary received numerous awards and recognitions including the McNaughton medal and is a Fellow of the Canadian Academy of Engineering, the Institute of Electrical and Electronics Engineers, Engineers Canada, and the Engineering Institute of Canada.

## 2010 IEEE Canada J.J. Archambault Eastern Canada Merit Award

*In recognition of dedicated and distinguished service to the profession*

**Dennis Peters (SMIEEE)** is an Associate Professor and Chair of Electrical and Computer Engineering at Memorial University in St. John's Newfoundland and Labrador. His research involves techniques for design and verification of software and computer systems, with particular focus on real-time applications and parallel or distributed processing. He earned the B.Eng. (Electrical) degree from Memorial in 1990, and the M.Eng. and Ph.D. degrees in Electrical and Computer Engineering from McMaster University in 1995 and 2000, respectively.

Dr. Peters has been a member of the IEEE for over 20 years and has been very active in section and regional activities. He has served on the Newfoundland and Labrador Section executive committee continuously since 1999, including a term as Chair (2002-03). He has also served on the organizational committees for local, national and international conferences, including co-chair of the Technical Program Committee for CCECE 2009. He also takes an active role in the Engineering Profession, serving on the Board of Examiners for the Professional Engineers and Geoscientists of Newfoundland and Labrador (PEGNL), and as a member of the Canadian Engineering Qualifications Board.

When he can get away from his work he enjoys spending time with his wife, Ruth, and children, Stuart (7) and Margaret (3). One day he hopes to find time to again go sailing around the beautiful coastline of Newfoundland.

## Prix d'excellence de service W.S. Read de l'IEEE Canada 2010

*En reconnaissance de 40 années de service dévoué, exceptionnel et soutenu à l'IEEE Canada*

**Mohamed El-Hawary (FIEEE, FCAE, FEIC, FEC)** est professeur de génie électrique et informatique à l'Université de Dalhousie et fut le doyen associé en génie entre 1995 et 2007. Ses contributions techniques couvrent plus de quarante années de travail soutenu dans la recherche, l'éducation et le service à la communauté. Au niveau de la recherche, Dr. El-Hawary fut un pionnier dans le domaine des solutions informatiques pour l'opération économique des systèmes énergétiques incluant les systèmes hydrothermiques. Son travail fondamental et pionnier sur l'opération économique des systèmes énergétiques et l'application des techniques d'intelligence artificielle aux problèmes opérationnels de système énergétique est fréquemment référé par la communauté d'utilisateurs, et est documenté en dix manuels et monographies de recherches et plus de 300 articles de recherche.

Il a servi comme Président de l'IEEE Canada (2002-2003,) Secrétaire de l'IEEE (2004-2005) et au Conseil des prix et Comité des Fellows (2008-2010). De plus, il a servi comme Président des récompenses de l'IEEE Canada (1994-1998). Dr. El-Hawary est actuellement membre du Conseil des services et produits de publications 2010, et est éditeur de IEEE Press Power Engineering Series. Il a été éditeur en chef de IEEE Press en 2006-2007. Il est éditeur fondateur de Power Letters, de la Power Engineering Society, est l'éditeur associé de trois journaux importants sur les machines électriques et systèmes énergétiques, et est éditeur, génie électrique, de l'Encyclopedia of Science and Technology (McGraw-Hill).

Dr. El-Hawary a reçu plusieurs prix et reconnaissances incluant la médaille McNaughton et est Fellow de l'Académie canadienne du génie, de l'Institute of Electrical and Electronics Engineers, et de l'Institut canadien des ingénieurs.

## Prix d'excellence J.J. Archambault de l'est du Canada de l'IEEE Canada 2010

*En reconnaissance d'un service dévoué et distingué à la profession*

**Dennis Peters (SMIEEE)** est professeur agrégé et directeur du département de génie électrique et informatique à l'Université Memorial de St-Jean, Terre-Neuve et Labrador. Son domaine de recherche est relié aux techniques de conception et vérification de logiciels et systèmes informatiques, avec un accent particulier sur les applications en temps réel et le traitement parallèle ou distribué. Il a obtenu son B.Eng. (Électrique) de Memorial en 1990, et sa M.Eng. et son Ph.D. en génie électrique et informatique de l'Université McMaster en 1995 et 2000, respectivement.

Dr. Peters est membre de l'IEEE depuis plus de 20 ans et a été très en actif au niveau de la section et des activités régionales. Il a servi sur le comité exécutif de la section de Terre-Neuve et Labrador sans interruption depuis 1999, incluant un mandat comme Président (2002-03). Il a également servi sur des comités d'organisation de conférences locales, nationales et internationales, incluant la co-présidence du Comité de programme technique pour la CCGÉI 2009. Il joue également un rôle actif dans la profession du génie, servant sur le Conseil des examinateurs pour les ingénieurs professionnels et les géoscientifiques de Terre-Neuve et du Labrador (PEGNL), et comme membre du Bureau canadien des conditions d'admission en génie.

Quand il peut se libérer de son travail il apprécie passer du temps avec son épouse, Ruth, et ses enfants, Stuart (7) et Margaret (3). Il espère trouver assez de temps un jour pour naviguer autour du beau littoral de Terre-Neuve.



*sponsored by IEEE Canadian Foundation / commandité par Fondation canadienne de l'IEEE*

## 2010 IEEE Canada M.B. Broughton Central Canada Merit Award

*For outstanding contribution to three CCECEs in central area ('01, '04, '08)*

**J.M. (Sean) Dunne (SMIEEE)** graduated from University College, Dublin, Ireland in 1965 with a Bachelor of Engineering degree.

For 37 years in project and business management he led the introduction of new technology to the manufacture and testing of large electric motors and generators at General Electric in Peterborough. Since retirement from GE in 2003 he has travelled extensively and has been Test Engineer or Commissioning Manager on 15 large hydroelectric power generation projects. In 2008-2009 he managed the commissioning of the first units of two large (4x300MW) pump storage power stations in China.

A member of IEEE since 1993, he received the Central Canada Council Merit Award in 1996, became a Senior Member of IEEE in 2004, and has been Chair, IEEE Peterborough Section, from 2001 to 2010. Sean has also been active as Publications chair, CCECE (2001, 2004 and 2008), Executive member of PEO Peterborough Chapter, Committee chair of Peterborough Engineering Symposium (2001, 2007 and 2009), and Webmaster, Peterborough PEO & IEEE websites.

Sean is a strong proponent of cooperation between the different branches of the engineering community. In Peterborough the local levels of the IEEE, Professional Engineers Ontario (PEO), and Ontario Association of Certified Engineering Technicians and Technologists (OACETT) all work together on the Annual Engineering Symposium, the Engineering Week Challenge and on social events, developing a spirit of kinship and encouraging mutual support. In all his work Sean promotes the model of a fault-tolerant organization, where mistakes are seen as part of the learning process, and innovation is encouraged.

## 2010 IEEE Canada E.F. Glass Western Canada Merit Award

*In recognition of dedicated and distinguished service to the profession*

**Meliha Selak (SMIEEE)** is a Specialist Engineer with BC Hydro where she works in the Power System Protection and Control Planning group. She holds a degree in Electrical Engineering from the University of Sarajevo and has more than 30 years experience in various aspects of power systems engineering, including utility protection, research and development, project management and international consulting. Among her technical achievements is the development of BC Hydro's power system protection guidelines. Prior to joining BC Hydro in 2000, she worked as a research engineer in the Power System Group at the University of British Columbia, in connection with the development of an EMTP-based real-time power system simulator.

Meliha is a member of the IEEE Power & Energy Society (PES) Governing Board, currently serving as Vice President for Chapters. Also, she is a member of the IEEE Power System Relay Committee (PSRC). She has written numerous technical reports and papers on power system subjects and is also a paper reviewer. Meliha is a distinguished lecturer of IEEE PES.

Meliha's involvement with IEEE started about 10 years ago with the IEEE Vancouver Section. Among other roles within the Section, she served as PES Chapter Chair for three years, during which time Vancouver PES Chapter achieved High Performance Chapter status in two consecutive years, and received the IEEE PES Outstanding Large Chapter Award for 2006. At the same time, the Chapter won membership contests in two consecutive years. Meliha also continues activities in Vancouver Section as Student Activities Chair and PES Chapter Past Chair.

## Prix d'excellence M.B. Broughton du centre du Canada de l'IEEE Canada 2010

*Pour contribution exceptionnelle à trois CCGÉIs ('01, '04, '08) de la zone centrale*

**J.M. (Sean) Dunne (SMIEEE)** a obtenu son Baccalauréat en génie électrique de University College de Dublin, Irlande en 1965.

Pendant 37 années en gestion de projets et d'entreprise il a mené l'introduction de nouvelles technologies de fabrication et d'essais de grands moteurs et alternateurs électriques chez General Electric à Peterborough. Jusqu'à sa retraite de GE en 2003, il a beaucoup voyagé à travers le monde et a été ingénieur de mise en service ou directeur de mise en service sur un total de 15 grands projets de génération d'énergie hydroélectrique. En 2008-2009 il a dirigé la mise en service des premières unités de deux grandes centrales de stockage (4x300MW) en Chine.

Membre de l'IEEE depuis 1993, il a reçu le Prix au mérite du Conseil du centre du Canada en 1996, est devenu membre senior de l'IEEE en 2004 et a été Président de la section de Peterborough de l'IEEE de 2001 à 2010. Sean a également été actif en tant que Président des publications des CCGÉI (2001, 2004 et 2008), membre de l'exécutif du chapitre PEO de Peterborough, Président du Comité de colloque en génie de Peterborough (2001, 2007 et 2009), et webmestre pour les sites web PEO & IEEE de Peterborough.

Sean est un partisan convaincu de la coopération entre les différentes branches de la communauté du génie. À Peterborough les sections locales de l'IEEE, du « Professionnal Engineers Ontario » (PEO), et de l' « Ontario Association of Certified Engineering Technicians and Technologists » (OACETT) travaillent maintenant ensemble sur le Colloque annuel de génie, sur le Défi de la semaine du génie et sur des événements sociaux, développant ainsi l'esprit de famille et encourageant l'appui mutuel. Dans le cadre de son travail, Sean fait la promotion du modèle d'une organisation tolérant l'erreur, où celles-ci sont vues en tant qu'élément du processus d'apprentissage, et où l'innovation est encouragée.

## Prix d'excellence E.F. Glass de l'ouest du Canada de l'IEEE Canada 2010

*En reconnaissance d'un service dévoué et distingué à la profession*

**Meliha Selak (SMIEEE)** est ingénieure spécialiste chez BC Hydro où elle travaille dans le groupe de planification de contrôle et de protection du réseau électrique. Elle détient un diplôme en génie électrique de l'Université de Sarajevo et possède plus de 30 années d'expérience dans divers aspects du génie électrique, dont la protection des services publics, la recherche et développement, la gestion de projet et la consultation internationale. Parmi ses accomplissements techniques on trouve le développement des directives de protection du réseau de BC Hydro. Avant de joindre cette firme en 2000, elle travaillait en tant qu'ingénieur de recherches dans le groupe de systèmes électriques de l'Université de la Colombie-Britannique, en liaison avec le développement d'un simulateur de système électrique en temps réel basé sur les PTEM.

Meliha est un membre du conseil d'administration de l' « IEEE Power & Energy Society (PES) », servant actuellement de vice-présidente aux chapitres. De plus, elle est membre du comité « Power System Relay » de l'IEEE (PSRC). Elle a écrit de nombreux rapports techniques et articles sur des sujets concernant les systèmes électriques et fait également de la revue d'article. Meliha est une conférencière distinguée de l'IEEE PES.

La participation de Meliha au niveau de l'IEEE a commencé il y a environ 10 ans avec la section IEEE Vancouver. Parmi ses rôles dans la section elle a servi comme présidente du chapitre PES pendant trois ans; durant cette période le chapitre PES de Vancouver a atteint un statut de performance élevée sur deux années consécutives et a reçu le prix de Grand chapitre PES exceptionnel de l'IEEE en 2006. En même temps, le chapitre a remporté des concours de recrutement pendant deux années consécutives. Meliha poursuit ses activités dans la section de Vancouver comme présidente des activités étudiantes et présidente sortante du chapitre PES.


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**Christophe Caloz** (FIEEE)—Montréal, Québec
*For contributions to the development and application of electromagnetic metamaterial structures.*

**Norman Ross Chapman** (FIEEE)—Victoria, British Columbia
*For contributions to geoacoustic characterization of ocean bottom environments.*

**Zhizhang David Chen** (FIEEE)—Halifax, Nova Scotia
*For contributions to time-domain electromagnetic modeling and simulation.*

**Aniruddha M. Gole** (FIEEE)—Winnipeg, Manitoba
*For contributions to the modeling of power electronics apparatus.*

**Maev Grigoryevich Roman** (FIEEE)—Windsor, Ontario
*For contributions to high-resolution imaging, acoustic microscopy, and advanced material characterization.*

**Leslie Ann Rusch** (FIEEE)—Québec, Québec
*For contributions in optical and wireless communications systems.*

**Christian Schlegel** (FIEEE)—Edmonton, Alberta
*For contributions to iterative demodulation and decoding in wireless communication.*

**Robert Schober** (FIEEE)—Vancouver, British Columbia
*For contributions to wireless communications.*

**Abdel A. Sebak** (FIEEE)—Montréal, Québec
*For contributions to electromagnetics scattering, and design and modeling of antennas.*

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*For his contributions to the field of Applied Electrostatics, and in particular to the understanding, optimization and application of using electrostatic forces to electrostatic precipitation, agricultural spraying, powder coating and painting, and electrophotography.*

**Frank Corbett** (LMIEEE)—Montréal, Québec
*For his exceptional contributions to the Canadian profession of Electrical Engineering.*

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*For his contributions to the field of systems and industrial engineering, particularly to multiple participant-multiple objective decision making, decision support systems, resources allocation, and enforcement of environmental regulations.*

**Andrew Goldenberg** (FIEEE)—Toronto, Ontario
*For his contributions to the area of robotics and mechatronics technology.*

**Wenyuan Li** (FIEEE)—Burnaby, British Columbia
*For his exceptional contributions to power engineering, particularly in power system reliability assessment and probabilistic planning.*

**Konstantinos Plataniotis** (SMIEEE)—Toronto, Ontario
*For his contributions to the field of image processing, biometrics and adaptive learning.*

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*For his contributions to the multimedia communications area, and in particular, to the field of haptic, audio, and video multimedia collaborative protocols and their applications.*

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*For his concept, planning and implementation of a strategy that culminated in creating IEEE Canada as a constituent society of the EIC while retaining its relationship within IEEE as Region 7, and continuing with the development of IEEE Canada by implementing major improvements to its website, major awards programme and integration with the IEEE Canadian Foundation.*

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**Christophe Caloz** (FIEEE)—Montréal, Québec
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*Pour contributions à la modélisation et la simulation électromagnétique temporelle.*

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*Pour contributions à la modélisation des appareils en électronique de puissance.*

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*Pour contributions à l'imagerie haute résolution, la microscopie acoustique, et la caractérisation des nouveaux matériaux.*

**Leslie Ann Rusch** (FIEEE)—Québec, Québec
*Pour contributions aux systèmes de communications sans fils et optiques.*

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*Pour contributions à la démodulation itérative et au décodage dans les communications sans fils.*

**Robert Schober** (FIEEE)—Vancouver, Colombie-Britannique
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**Abdel A. Sebak** (FIEEE)—Montréal, Québec
*Pour contributions à la diffusion électromagnétique et à la conception et modélisation d'antennes.*

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*Pour leadership soutenu aux niveaux régional et IEEE en effectuant des changements positifs pour l'IEEE et ses membres.*

## Membres de l'IEEE Canada élus Fellows de l'ICI 2010

**Peter Castle** (FIEEE)—London, Ontario
*Pour ses contributions au domaine de l'électrostatique appliquée, et en particulier à la compréhension, l'optimisation et l'application de l'utilisation des forces électrostatiques à la précipitation électrostatique, la pulvérisation agricole, les enduits et peintures en poudre, et l'électrophotographie.*

**Frank Corbett** (LMIEEE)— Montréal, Québec
*Pour ses contributions exceptionnelles à la profession canadienne du génie électrique.*

**Liping Fang** (SMIEEE)—Montréal, Québec
*Pour ses contributions au domaine des systèmes et du génie industriel, en particulier à la prise de décision multi-participants – multi-objectifs, aux systèmes d'aide à la décision, à l'attribution de ressources, et à l'application des règlements environnementaux.*

**Andrew Goldenberg** (FIEEE)—Toronto, Ontario
*Pour ses contributions au domaine de la technologie robotique et mécatronique.*

**Wenyuan Li** (FIEEE)—Burnaby, Colombie-Britannique
*Pour ses contributions exceptionnelles au génie électrique, en particulier dans l'évaluation de la fiabilité des systèmes électriques et la planification probabiliste.*

**Konstantinos Plataniotis** (SMIEEE)—Toronto, Ontario
*Pour ses contributions au domaine du traitement d'images, de la biométrie et de l'apprentissage adaptatif.*

**Abdulmotaleb El Saddik** (FIEEE)—Ottawa, Ontario
*Pour ses contributions au domaine des communications multimédia, et en particulier, au domaine des protocoles de collaboration de multimédia de type vidéo, audio, et haptique et de leurs applications.*

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### Médaille John B. Stirling

**Robert T. H. Alden** (LFIEEE)—Mississauga, Ontario
*Pour sa conception, planification et mise en place d'une stratégie qui a mené à la création de l'IEEE Canada comme société constitutive de l'ICI tout en maintenant sa relation au sein de l'IEEE en tant que Région 7, et à la continuation du développement de l'IEEE Canada en mettant en place des améliorations importantes à son site Web, son programme des prix majeurs et son intégration avec la Fondation canadienne de l'IEEE.*

**Translation volunteers / *Traducteurs bénévoles***
Christian Pépin, Eric Holdrinet

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# IEEE EPEC 2010

## Annual Electrical Power and Energy Conference

## *Sustainable Energy for an Intelligent Grid*

### *August 25-27, 2010, Halifax, NS, Canada*

The annual IEEE Electrical Power and Energy Conference (EPEC 2010) will take place August 25-27, 2010 in Halifax, Nova Scotia, Canada. Located on the coast of the Atlantic, Halifax has one of the best Living Histories in Canada with countless festivals and events. First-rate facilities combined with succulent seafood and a cosmopolitan flair make it a unique and unforgettable meeting and convention destination.

The objective of EPEC 2010 is to provide a forum for experts in Electrical Power and Energy to disseminate their recent research outcomes and exchange views on future research directions of these fields, and to seek direct cross-fertilization in these areas. Special sessions will be organized. We will also invite renowned experts to give keynote speeches. Bring your research findings along with your family to EPEC 2010, enjoy our programs and appreciate the natural wonders of Halifax.

### *Topics*:

**The topics of interest include, but are not limited to the following:**

- **Computational Intelligence Systems**
- **Electricity Markets**
- **Energy Storage**
- **Wind Power**
- **Smart Grid**
- **Computational Methods in Power System**
- **Transmission and Distribution**
- **Solar Power**
- **Microgrids**
- **Wave & Tidal Power**
- **Power System Communications**
- **Hydrogen Power**
- **Energy Systems for Buildings**
- **Bio-thermal Power**
- **Energy Conservation and efficiency**
- **Small Hydro Power**
- **Technology Trends**
- **Fuel Cells**
- **Clean & Renewable Energy Markets**
- **Novel Power Generation**

### *Important Dates*

| | |
|---|---|
| May 10, 2010 | Submission of tutorial and workshop proposals |
| May 15, 2010 | Notification of paper and tutorial/workshop acceptance |
| June 10, 2010 | Submission of final camera-ready papers |

Exhibitions: There will be an exhibition site at the conference. Companies and institutions who are interested are encouraged to contact the exhibition chair for further information.

For detailed up-to-date information, please visit the EPEC 2010 conference web site:
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# *Resonance as a Versatile Transduction Mechanism for Micro- and Nano-transducers*

*By Behraad Bahreyni, Simon Fraser University, BC*

***Abstract***

Resonant micro-transducers have been a subject of extensive research worldwide and are also at the centre of the research by our group at Simon Fraser University. This paper provides an introduction to the operating concepts of resonant micro-transducers. Common transduction mechanisms for micro- and nano-transducers are discussed. The quasi-digital output of resonators and their relative immunity to noise and interference has led to the development of numerous resonance-based transducers for various applications. The advantages of resonant transducers as well as their main application areas of sensing, actuation, and signal processing are discussed and numerous examples are provided.

***Sommaire***

Les micro-transducteurs résonants ont fait l'objet de recherches intensives à travers le monde et sont aussi au centre des recherches de notre groupe à l'Université Simon Fraser. Cet article présente une introduction aux concepts de fonctionnement des micro-transducteurs résonants. Les mécanismes de transduction usuels pour micro- et nano-transducteurs sont discutés. La sortie quasi-digitale des résonateurs et leur immunité relative au bruit et aux interférences a mené au développement de nombreux transducteurs à base résonante pour plusieurs applications. Les avantages des transducteurs résonants ainsi que leurs principales applications dans les domaines de la détection, actionnement, et traitement de signal sont discutés et de nombreux exemples sont fournis.

## *1.0 Introduction*

Many linear physical systems exhibit an amplified response to their input at particular frequencies. If the output amplification is due to presence of underdamped pairs of complex conjugate poles, the system response around that particular frequency can be approximated by the response of an underdamped second-order system. In most macro-scale mechanical and civil engineering problems, resonance is an undesired phenomenon which results in accelerated aging, noise, and even destruction of a device or a structure. For example, the additional strain caused by amplified displacements affects the structural imperfections more prominently, often leading to the development of cracks and eventual failure. Micromachined devices, however, can undergo sustained resonance for extended durations which often exceeds their designed lifetime. This fact can be attributed to the small structural volumes of these devices which are made from high quality materials with very small defect densities (e.g., crystalline silicon). In this paper, applications of micromachined resonators for sensing, actuation, and signal processing are described. Examples will include devices from our group or others in academia and industry.

A linear system of order two or higher has several natural frequencies which are the eigenvalues of the system characteristic equation. Consider the simple mass-damper-spring system in Figure 1. Although simplistic, it is often assumed that the damping force on an object is proportional to its velocity. Thereby, the equation of motion for the mass is:

$$F = M_{eff}\frac{d^2x}{dt^2} + \xi\frac{dx}{dt} + K_{eff}x \qquad (1)$$

where $M_{eff}$ is the *effective* mass of the object, $K_{eff}$ is the *effective* spring constant, and $\zeta$ represents the all of the damping mechanisms in the system. If we define $\omega_0^2 = K_{eff}/M_{eff}$ and $Q = M_{eff}\omega_0/\xi$, the eigenvalues of the system are given by:

$$s_{1,2} = -\frac{\omega_0}{2Q} \pm j\omega_0\sqrt{1-\frac{1}{4Q^2}} \qquad [1] \qquad (2)$$

As can be seen, $\boldsymbol{Q}$ is a measure of damping in the system and is referred to as the *quality factor* of the resonator. For large values of $\boldsymbol{Q}$, the eigenvalues of the system approach $\pm j\omega_0$ on imaginary axis, where $\omega_0$ is called the *undamped natural frequency* of the system. Parameters $\omega_0$ and $\boldsymbol{Q}$ are the primary factors when describing the operation of resonators. Figure 2 illustrates how these two parameters can be estimated using the frequency response of a high-$\boldsymbol{Q}$ resonator. It must be noted that most systems have several eigenvalues (infinite in case of continuous structures), and therefore, can have multiple resonant peaks in their frequency response. In that case, it is often possible to estimate the overall behaviour of the system as the superimposition of many second order resonators and use much of the results from the analysis of second-order systems [2].

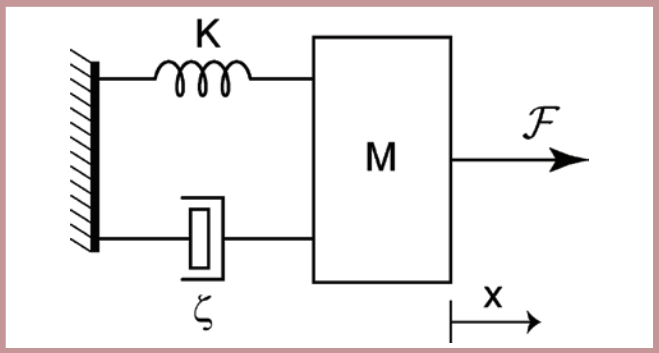



**Figure 1. A damped mass-spring system.**

Electrical resonance is frequently encountered during the design of electrical systems and circuits and is often modelled as a series or parallel RLC network. It is common practice to use an equivalent electrical network to represent the operation of a mechanical resonator [3]. The main reason for this conversion, besides its familiar presentation to electrical

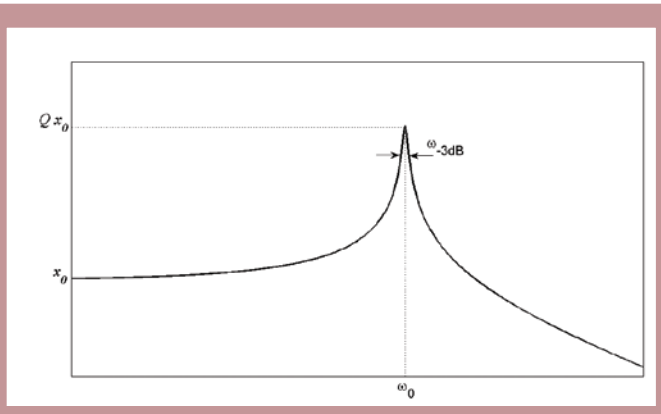



**Figure 2. Sample frequency response of a high-$Q$ resonator to a constant-amplitude input signal. The quality factor can be estimated from the ratio of the resonant frequency, $\omega_0$ to the -3dB bandwidth of the resonance peak. For a high-$Q$ resonator, the undamped natural frequency and the frequency of peak spectral response are essentially the same.** [1]

engineers, is that the resonator model can then be used in circuit simulators along with the interface electronics that is developed for the system, and hence, running a more comprehensive analysis of the system.

## 2.0 Transduction Mechanisms

Resonance can be used for sensing, actuation, or signal processing at micro- and nano-scales. The resonant frequency, $\omega_0$, of a resonant sensor changes in response to the measurand. Resonant actuators take advantage of the amplified response of the structure to the excitation signal at resonance in order to improve the displacements by a factor of $\sim Q$. For signal processing applications, the resonator is essentially used to filter out unwanted signals and provide high selectivity using one or a number of coupled resonators. In all these cases, it is needed to employ proper transduction mechanisms to convert signals from electrical domain to mechanical at the input port of the device or from mechanical domain to electrical at its output port. At micro- and nano-scales, transduction mechanisms for actuation include electrostatic [4], piezoelectric [5], thermal [6], magnetic [7], and optical [8]. Sensing of resonance is also achieved through a variety of techniques such as electrostatic [9], piezoelectric [10], piezoresistive [11], and optical [12]. Due to the ease of fabrication and low power consumption, most commercialised resonant devices use electrostatics for both sensing and actuation. Piezoelectricity is employed when the losses through the resonator need to be minimised and piezoresistors are usually used if they do not add to the fabrication complexity [13].

## 3.0 Resonance for Signal Processing

Resonators have long been used for signal processing applications due to their highly selective frequency response [14]. Two of the major application areas have been in realisation of high-frequency bandpass filters and low-phase noise oscillators [15]. For both applications, the resonators must have low losses and high $\boldsymbol{Q}$s and be able to handle large amounts of electrical/mechanical power (e.g., as high as 2 watts in filter applications for mobile handsets) [16]. Resonator-based filters use multiple resonators that are coupled electrically or mechanically and the primary design objectives are reduction of insertion losses and increasing $\boldsymbol{Q}$ for narrow band filters while avoiding resonator nonlinearities [1, 17]. For timing resonators, too, high-$\boldsymbol{Q}$ and low-loss resonators are needed in order to achieve low phase noise operation [18, 19]. Many of the developed timing resonators employ electrostatic interfaces at their input and output ports, primarily to due to the relative ease of fabrication and potential for integration with electronics [4, 15, 19, 20]. If an actuation voltage $v_a \cos \omega t$ is applied to the input port of the resonator, the exerted force on resonator body is:

$$F = -\frac{1}{2}\frac{\partial C}{\partial x}(V_B + v_a \cos \omega t)^2 = -\frac{\partial C}{\partial x}\left(\frac{2V_B^2 + v_a^2}{4} + v_a V_B \cos \omega t + \frac{v_a^2 \cos 2\omega t}{2}\right) \quad (3)$$

where $V_B$ is the DC bias voltage between the input/output electrodes and $\partial C/\partial x$ is the rate of changes in the input/output capacitance. Generally, the applied DC voltage is significantly larger than the AC signal, and therefore, the nonlinear term in the above equation may be omitted. Using equation (1) and the definitions of $\boldsymbol{Q}$ and $\omega_0$, the current at the output port of the resonator is given by:

$$i_{out} = \frac{dQ}{dt} = \frac{d(CV_{out})}{dt} = \frac{1}{K_{eff}}\left(\frac{\partial C}{\partial x}\right)^2 V_B^2 \frac{v_a \omega \sin(\omega t - \phi)}{\sqrt{\left(1 - \frac{\omega^2}{\omega_0^2}\right)^2 + \left(\frac{\omega}{Q\,\omega_0}\right)^2}} \quad (4)$$

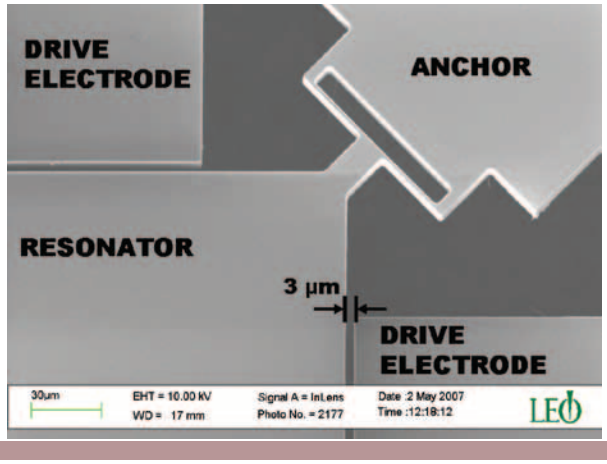
where we have assumed that the output electrode is biased with the same voltage at the input and the resonator is symmetric. At resonance, i.e., $\omega = \omega_0$, the effective impedance of the resonator is resistive and is often referred to as "motional resistance" or $R_m$. Fundamental resonant frequencies of mechanical structures increase as the dimensions of these structures shrink. For example, resonators that are designed for operation in 10s or 100s of MHz range typically have basic dimensions on the orders of 10s of μm. At such small scales, parallel plate electrodes offer a relatively large $\partial C/\partial x$ factor.

It follows that for electrostatic resonators with parallel plate electrodes, we have:

$$R_m = \frac{g^4\sqrt{K_{eff}M_{eff}}}{\epsilon^2 A^2 V_B^2 Q} \quad (5)$$

where $\epsilon$ is the dielectric constant of the medium between the electrodes, $\boldsymbol{A}$ is the effective electrode area and $\boldsymbol{g}$ is the gap between them. The need for reducing the gap between the electrodes and higher quality factors is evident from equation (5) and has been the subject of research for more than a decade [15, 19, 21].

In addition to phase noise requirements, the timing resonators are often needed to be extremely stable amid temperature variations. This poses a serious challenge in using micromachined silicon resonators, as the typical temperature coefficient of $\Delta f_0/f_0$ for these resonators is between -15 to -25ppm/ºC, or about two orders of magnitude larger than temperature-compensated quartz oscillators. Consequently, a variety of electronic, mechanical, and material engineering techniques are employed to compensate for temperature variations and improve the oscillator stability [22, 23, 20]. Another challenge for commercialisation of resonators for signal processing applications is the requirement for hermetic packaging to isolate the device from variations in ambient pressure, humidity, etc. In order to reduce air damping and have large quality factors, most micromachined resonators need to operate under vacuum, which further complicates packaging of these devices. A promising packaging solution was proposed by Candler et al where fabricated devices where coated with a capping layer and released afterwards through etch-holes [20]. The CMOS interface electronics can be built on top of the resonator if the capping layer is an epitaxial silicon layer.



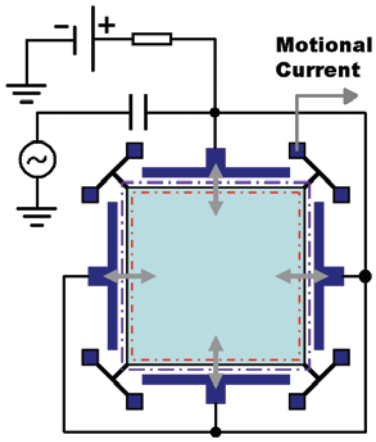




**Figure 3.** ***(Top)*** **A close-up of the anchor area, designed to minimize support loss [21].**

***(Bottom)*** **A bulk resonator for timing applications.**

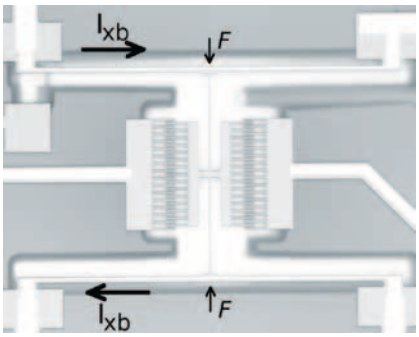



**Figure 4. A resonant magnetic field sensor. Inside a normal magnetic field, a distributed force is applied to the crossbars and is axially transferred to the beam-springs of the resonator, modifying its resonant frequency. [29]**

All of the basic resonant modes of structures have been employed for signal processing applications. At low frequencies (i.e., 1kHz to 10MHz), beam-based flexural resonators are typically used. At higher operating frequencies of 1MHz to 1GHz, bulk resonators based on simple plate geometries offer lower losses and higher quality factors compared to flexural resonators. Surface resonant modes have had widespread applications in design of bandpass filters for the 100MHz to 1GHz frequency range. Figure 3 illustrates the schematic of a square plate bulk resonator which was used in an oscillator circuit for timing applications [21].

## 4.0 Resonant Sensors

The output signal from a resonant sensor is a change in frequency, which is more robust against noise and interferences compared to the typical voltage or current signal†. On the other hand, time and frequency are quantities that can be measured with a very high level of accuracy and precision. For example, it is routine to have a 1ppb, or more than 30 bits, of resolution in frequency measurements (or control) with a simple setup in laboratories, but achieving a similar level of measurement precision for a voltage or current signal is extremely challenging, if not impossible. Therefore, resonant sensors typically have a superior resolution and noise performance within a given family of sensors. Another favourable property of resonant sensors is their quasi-digital output as frequency can be measured directly with a digital system without analog-to-digital converters.

Recalling that $\omega_0 = \sqrt{K_{eff}/M_{eff}}$, it can be seen that a shift in the resonant frequency of a structure is a consequence of a change in the effective mass or the effective spring constant of the structure:

$$\Delta\omega_0 = \frac{\omega_0}{2}\left(\frac{\Delta K_{eff}}{K_{eff}} - \frac{\Delta M_{eff}}{M_{eff}}\right) \tag{6}$$

Therefore, besides fabrication and signal processing issues, realisation of micromachined resonant sensors requires design of proper mechanical elements for coupling of the desired measurand to the resonator while avoiding interference from unwanted sources such as packaging stresses. These technical challenges have led to a significant amount of research on the design, modeling, and fabrication of resonant sensors. Some of the developed devices include mass [24], strain [25], pressure [26], charge [27, 28], magnetic field [29], acceleration [6], and chemical sensors [9].

A resonant magnetic field sensor is shown in Figure 4 [29]. The operation of the sensor is based on using a resonator to measure the Lorenz force on two current carrying beams (crossbars) when the sensor is put inside a magnetic field normal to its plane of operation. At the heart of the sensor is an electrostatic resonator whose body is kept under continuous oscillations with the aid of a nonlinear oscillator circuit. Inside a magnetic field $\vec{B}$, the magnitude of the opposing distributed forces on each of the current carrying beams is given by $|\vec{F}| = |I_{XB}\,\overrightarrow{L_{XB}} \times \vec{B}|$ . On the other hand, under an axial force of $P$, the spring constant of the beams that connect the resonator body to the crossbars is given by:

$$k_b = \frac{P}{L - 2\sqrt{\frac{EI}{P}}\tanh\left(\frac{L}{2}\sqrt{\frac{EI}{P}}\right)} \tag{7}$$

where $E$ is the Young's modulus of the material and $L$ and $I$ are the length and the second moment of inertia of the beam springs, respectively. Changes in the spring constant of the beams in turn modify the resonant frequency of the device, which is proportional to the input magnetic field:

$$S_B^{\omega} = \frac{d\omega}{dB} = \frac{3\,I_{XB}L_{XB}\omega_0}{10\,L\,k_b} \tag{8}$$

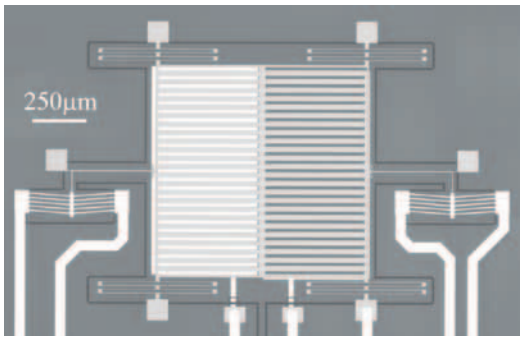



**Figure 5. An electric field sensor using thermal resonant actuators [32].**

## 5.0 Resonant Actuators

Resonant actuators have an amplified response to their excitation around the resonant frequency of the structure by a factor that can be as high as $Q$ times their DC response. For a low loss resonator, this allows using input signals that are orders of magnitude smaller than the off-resonance excitations for the same amount of displacement. Resonant actuators are often used as part of a sensor structure in order to either reduce the interference from input signals or to amplify the influence of the measurand on the sensor performance.

Micromachined vibratory gyroscopes are the most widely available transducers in this category [30]. In vibratory gyroscopes, the resonator body is kept under continuous oscillations in one direction. The Coriolis effect leads to the coupling of energy into orthogonal modes whose displacements are then sensed. Proper mechanical design and electrical tuning of the structure ensures that the resonant frequencies of the excitation and sense modes are close to each other in order to take advantage of the displacement amplification around the resonant frequency of the orthogonal modes.

Figure 5 illustrates an electric field sensor that was developed by Bahreyni et al [31]. In an electric field mill, a current is produced through repeated exposure and shielding of a set of electrodes using a moving shutter:

$$i_{out} = \epsilon E_n \frac{dA}{dt} \tag{9}$$

where $E_n$ is the normal component of the incident electric field and $A$ is the effective area of the electrodes underneath the shutter. Thermal actuators were used to produce the required shuttle oscillations over fixed electrodes on the substrate. In order to minimize the interference from the drive signals, the nonlinear response of thermal actuators was employed to drive the sensor body at its resonance with the aid of mechanical amplifiers. These precautions led to the superior resolution of this sensor compared to other micromachined electric field sensors.

## 6.0 Research Within the IMuTS Laboratory

Resonance is a promising candidate as the transduction mechanism for the realisation of single-chip, multi-transducer systems. Often, these systems need to communicate the collected data to some external inquiring device. Therefore, filters and reference oscillators are often needed and can be realised using the on-chip resonators. Moreover, resonance allows simple combination of signals from multiple transducers as long as the dynamic ranges of transducers do not overlap. It is often possible to also use resonant transducers for many of the remaining transducers.

† *It should be noted that the operation of some resonant sensors is based on a change in the quality factor of the resonant device. However, it is difficult to accurately measure or control the absolute value of the quality factor of resonators and such sensors have limited applications.*

Therefore, the emphasis is placed on the mechanical design of the transducers and their interface circuits rather than developing fabrication processes for individual devices.

At the Integrated Multi-Transducer Systems (IMuTS) laboratory at Simon Fraser University, our group investigates the design and operation of various micro- and nano-transducers. Our areas of research cover chemical, physical, and biological sensors, mechanical signal processing, and interface circuit design for such devices. A good proportion of our research, as the name of the group implies, is concentrated on design and fabrication of multiple transducers on one chip, where resonant transducers play the central role. Interface circuit design is also an integral component of our research on resonant sensors. In most cases, the resonant sensor is placed inside the feedback loop of an amplifier to realise an oscillator circuit whose output frequency varies according to the changes in the measurand. In addition to the oscillator circuit, signal processing electronics is also needed to extract the frequency shift information and relate it to the variations in measurand [1, 32]. For multi-transducer systems, mixing and multiplexing circuits will also be needed and should be included in the design.

## *7.0 Conclusions*

An overview of resonance and its applications in the design of sensors, actuators, and signal processors at micro-scales were briefly discussed. The challenges of designing resonant transducers and their potential for a superior performance make the field a rather interesting area of research. It is believed that we will witness numerous commercialised resonant transducers in future as we understand their short- and long-term behaviour more deeply.

## References


[1] B. Bahreyni, Fabrication and Design of Resonant Microdevices. New York, USA: William Andrew Publishing, 2008.

[2] D. Ewins, Modal Testing. Great Britain: John Wiley & Sons, 2000.

[3] H. A. Tilmans, "Equivalent circuit representation of electromechanical transducers: I. lumped-parameter systems," Journal of Micromechanics and Microengineering, vol. 6, no. 1, pp. 157-176, March 1996.

[4] W. C. Tang, "Electrostatic comb drive for resonant sensor and actuator applications," Ph.D. dissertation, Department of Electrical Engineering and Computer Sciences, University of California, Berkeley, USA, 1992.

[5] D. DeVoe and A. Pisano, "Surface micromachined piezoelectric accelerometers (PiXLs)," IEEE Journal of Microelectromechanical Systems, vol. 10, no. 2, pp. 180-186, June 2001.

[6] M. Aikele, K. Bauer, W. Ficker, F. Neubauer, U. Prechtel, J. Schalk, and H. Seidel, "Resonant accelerometer with self-test," Sensors and Actuators A: Physical, vol. 92, no. 1-3, pp. 161-167, August 2001.

[7] X. Huang, X. Feng, C. Zorman, M. Mehregany, and M. Roukes, "VHF, UHF and microwave frequency nanomechanical resonators," New Journal of Physics, vol. 7, p. 247, 2005.

[8] L. Hao, J. C. Gallop, and D. Cox, "Excitation, detection, and passive cooling of a micromechanical cantilever using near-field of a microwave resonator," Applied Physics Letters, vol. 95, no. 11, p. 113501, September 2009.

[9] R. Howe and R. Muller, "Resonant-microbridge vapor sensor," IEEE Transactions on Electron Devices, vol. 33, no. 4, pp. 499-506, April 1986.

[10] G. Piazza and A. P. Pisano, "Two-port stacked piezoelectric aluminum nitride contour-mode resonant MEMS," Sensors and Actuators A: Physical, vol. 136, no. 2, pp. 638-645, May 2007.

[11] K. Phan, J. van Beek, and G. Koops, "Piezoresistive ring-shaped MEMS resonator," in Digest of Technical Papers of the International Conference on Solid State Sensors and Actuators, Transducers '09, Denver, USA, June 2009, pp. 1413-1416.

[12] O. Holmgren, K. Kokkonen, V. Kaajakari, A. Oja, and J. V. Knuuttila, "Direct optical measurement of the Q values of RF-MEMS resonators," in Proceedings of the IEEE Ultrasonics Symposium, vol. 4, Rotterdam, Netherlands, September 2005, pp. 2112-2115.

[13] B. Bahreyni, F. Najafi, and C. Shafai, "Piezoresistive sensing with twin-beam structures in standard MEMS foundry processes," Sensors and Actuators A: Physical, vol. 127, no. 2, pp. 325-331, March 2006.

[14] C. W. Hansell, "Filter," USA Patent 2005083, 1927.

[15] C. T.-C. Nguyen, "Frequency-selective MEMS for miniaturized low-power communication devices," IEEE Transactions on Microwave Theory and Techniques, vol. 47, no. 8, pp. 1486-1503, August 1999.

[16] E. Rubiola, Phase Noise and Frequency Stability in Oscillators. UK: Cambridge University Press, 2009.

[17] G. Piazza, P. J. Stephanou, and A. P. Pisano, "Single-chip multiple-frequency AlN MEMS filters based on contour-mode piezoelectric resonators," IEEE Journal of Microelectromechanical Systems, vol. 16, no. 2, pp. 319-328, April 2007.

[18] C. T.-C. Nguyen and R. T. Howe, "An integrated CMOS micromechanical resonator high-Q oscillator," IEEE Journal of Solid-State Circuits, vol. 34, no. 4, pp. 440-455, April 1999.

[19] Y.-W. Lin, S. Lee, S.-S. Li, Y. Xie, Z. Ren, and C. T.-C. Nguyen, "Series-resonant VHF micromechanical resonator reference oscillators," IEEE Journal of Solid-State Circuits, vol. 39, no. 12, pp. 2477-2491, December 2004.

[20] B. Kim, R. Melamud, M. A. Hopcroft, S. A. Chandorkar, G. Bahl, M. Messana, R. N. Candler, G. Yama, and T. Kenny, "Si-SiO2 composite MEMS resonators in CMOS compatible wafer-scale thin-film encapsulation," in Proceedings of the International IEEE Frequency Control Symposium, Geneva, Switzerland, May 2007, pp. 1214-1219.

[21] J.-Y. Lee, B. Bahreyni, Y. Zhu, and A. Seshia, "A single-crystal-silicon bulk-acoustic-mode microresonator oscillator," IEEE Electron Device Letters, vol. 29, no. 7, pp. 701-703, July 2008.

[22] G. Ho, K. Sundaresan, S. Pourkamali, and F. Ayazi, "Low-motional-impedance highly-tunable I2 resonators for temperature-compensated reference oscillators," in Proceedings of the 18th IEEE Micro Electro Mechanical Systems Conference, MEMS '05, Miami, USA, January 2005, pp. 116-120.

[23] H. Jianqiang, Z. Changchun, L. Junhua, and L. Peng, "A novel temperature-compensating structure for micromechanical bridge resonator," Journal of Micromechanics and Microengineering, vol. 15, no. 4, pp. 702-705, April 2005.

[24] J.-Y. Lee, B. Bahreyni, Y. Zhu, and A. Seshia, "Ultrasensitive mass balance based on a bulk acoustic mode single-crystal silicon resonator," Applied Physics Letters, vol. 91, no. 23, pp. 234103:1-3, December 2007.

[25] K. Wojciechowski, B. Boser, and A. Pisano, "A MEMS resonant strain sensor operated in air," in Proceedings of the 17th IEEE Micro Electro Mechanical Systems Conference, MEMS '04, Maastricht, The Netherlands, January 2004, pp. 841-845.

[26] J. C. Greenwood, "Etched silicon vibrating sensor," Journal of Physics E: Scientific Instruments, vol. 17, no. 8, pp. 650-652, August 1984.

[27] P. Riehl, K. Scott, R. Muller, R. Howe, and J. Yasaitis, "Electrostatic charge and field sensors based on micromechanical resonators," IEEE Journal of Microelectromechanical Systems, vol. 12, no. 5, pp. 577-589, October 2003.

[28] J. E.-Y. Lee, B. Bahreyni, and A. A. Seshia, "An axial strain modulated double-ended tuning fork electrometer," Sensors and Actuators A: Physical, vol. 148, no. 2, pp. 395-400, December 2008.

[29] B. Bahreyni and C. Shafai, "A resonant micromachined magnetic field sensor," IEEE Sensors Journal, vol. 7, no. 9, pp. 1326 - 1334, September 2007.

[30] C. Acar and A. Shkel, MEMS Vibratory Gyroscopes: Structural Approaches to Improve Robustness, ser. MEMS Reference Shelf. USA: Springer, 2009.

[31] B. Bahreyni, G. Wijeweera, C. Shafai, and A. Rajapakse, "Analysis and design of a micromachined electric field sensor," IEEE Journal of Microelectromechanical Systems, vol. 17, no. 1, pp. 31-36, February 2008.

[32] B. Bahreyni and C. Shafai, "Oscillator and frequency-shift measurement circuit topologies for micromachined resonant devices," Sensors and Actuators A: Physical, vol. 137, no. 1, pp. 74-80, June 2007.


## *About the Author*

**Dr. Bahreyni** received his BSc in electronics engineering from Sharif University of Technology, Iran, and M.Sc. and Ph.D. degrees in electrical engineering from the University of Manitoba, Canada, in 1999, 2001, and 2006, respectively. He was with the NanoSicence Centre at Cambridge University, UK, to research on interface circuit design for microresonators. His research interests include the design of micromachined transducers, microfabrication technology, modeling of microfabrication processes, and mixed-signal and RF circuit design. In September 2008, Dr. Bahreyni joined the School of Engineering Science at Simon Fraser University, BC, Canada, as an assistant professor and is currently leading a team of researchers at the Integrated Multi-Transducer Systems laboratory.

# *Futurology and Career Success*

*By Terrance Malkinson, SAIT Polytechnic, Calgary*

***Abstract***

What are futurists thinking about…where might we be going? How can we develop our own talents for predicting trends—or select amongst those proposed by futurologists, and then use this information to facilitate personal and career success?

***Sommaire***

Que pensent les futurologues à propos…d'où nous allons? Comment développer nos propres talents pour prédire les tendances—ou sélectionner parmi celles proposées par les futurologistes, et utiliser cette information pour atteindre des succès personels et en carrière?

## *Introduction*

We all think of the future. Even though predictions may and often do prove to be erroneous, this does not stop us. The past gives us knowledge and experience; the present an opportunity to change things. Together, the past and present allow us to envision the future. The future exists only in the ideas and vision that we have about it. These are phenomena of our mentality and the tools of thought that enable us to develop goals, plan strategies, and create tactics. Ideas are powerful and this has been demonstrated time and time again throughout history. The future is the time when real things will happen and emerges continuously and gradually from the present. We may have in mind a certain period of predictable time and we may think of our own future or that of some group or community. Our task is to evaluate futuristic ideas in concert with our personal values, desires and expectations using these to guide our actions to a desirable future and leaving a legacy of importance resulting in a better world.

Historically, complexity is increasing as the rate of change increases and as the number of things around us that are changing increases (Modis, 2003). The twentieth century has yielded more changes that the previous five centuries combined. Technological developments may well exceed the capabilities of our current social systems resulting in a transformation of business, society, the global order and perhaps even what it means to be human (Halal, 2009). Complicating our predictions are unexpected "wild cards" which have the power to completely and radically change the future (Cornish, 2003). Their occurrence needs to be acknowledged.

Let's illustrate this dicussion with a few predictions made by various futurologists. Then I propose some paths you may wish to follow in order to accellerate your journey towards career success and personal fulfillment.

## *Some Predictions*

Power and influence will migrate away from current world super-powers as less developed countries transform. Growth of global business entities and communication technologies reaching the most remote areas of the planet permitting access to information, education, and commerce will blur national boundaries. War, terrorism, and religious disagreements will decline with subsequent generations of humans; each of which will be better educated, experienced, and tolerant of those who have ideas different from their own. Diverse cultures will become increasingly integrated from contentious strangers into a tolerant and synergistic global population. No single racial or ethnic group will make up the majority of a nation's population. The presence of dominant nation states will diminish in favour of an equalized global population ensuring and securing peace and prosperity for all.

Lifetime employment with a single company with the expectations of an indexed lifetime company pension will disappear. Most employees will work outside the corporate umbrella and be responsible for their own retirement income. Employee/employer loyalty is disappearing. Employees will market their unique hyperspecialized skills on a contracted project-by-project basis to a variety of employers globally, much of this being accomplished through telecommuting. Multiple-simultaneous jobs which meet specific identified consumer needs will create multiple streams of compensation. The concept of retirement will change with many individuals working to advanced age taking competitive advantage of their years of experience. Business models will change with the declining public trust of business and its leaders.

Social and intellectual capital will become the primary economic value. Education providers will move away from the factory model. Education and skills development will become increasingly technology delivered and tailored to individualism identifying and bringing out the unique gifts that each person intrinsically has. Because of the dramatically escalating cost of post-secondary education students will critically evaluate providers and some may even consider self-education as a desirable option.

Improved urban design will create healthier environments and consequently healthier inhabitants for growing populations around the world. Each of us will be taking on responsibility for our personal impact on the environment both for what we do ourselves and for the products and services we provide. Personal automobile transportation will be reduced and likely eliminated within urban centers in favour of public transportation. Artificial islands will extend existing nations and create new micro-nations.

Difficult but necessary choices will need to be made regarding utilization of the planet's natural resources. These will not be limited to the petroleum industry but also include the macro- and micro-environments including climate, biodiversity, overconsumption, disposal of waste, destruction of fertile farmland, water supply, and micro-pollutants.

Multi-disciplinary developments will enhance the human body not only to repair worn out or diseased tissues but also improve quality of life for the elderly. Implanted devices will be created that continuously monitor human and animal state of health and reporting on deviations that can then be treated. Nanotechnology will permit repair of diseased cells from inside our body. Surgical robots will operate and intelligence based technology will perform diagnosis. Complementary and alternative medicine will be increasingly integrated with conventional medical practice.

Micro- and nano-technologies will revolutionize industry. More and more positions will be abolished as any activity that can be automated will be automated. Astro-biology will grow as an area of research confirming or denying the existence of extraterrestrial life. This will result in a re-examination of the meaning of individual existence and spirituality.

## *Strategies for Achieving Success*

The meaning of success is different for each of us. Take the time to discover your gifts that are timeless and unique. Embrace values that are important to you and pursue them will passion. Those who will be most successful are those who develop their skills to identify a problem to be solved or a need and then use their creativity to solve the problem or fulfill the need, sometimes creating their own job in the process. They seize the moment and very seldom procrastinate. Continuous personal improvement will be the norm. Successful people will demand uncompromising high ethics and civic virtue from themselves.

Develop skills to work effectively with a multigenerational, multicultural, interdisciplinary and diverse community. Chose education providers who think futuristically, understand globalization and whose curricula provide you with global perspectives and skills. Learn how to learn willingly, effectively and continuously throughout your career. Develop skills to anticipate and quickly adapt to changing economic, and market conditions. Be flexible in skills and employer requirements.

Take the time to develop your skills of observation, creativity, and innovation, administration and communication (written and oral). There is a wealth of proven information available to learn from, much of it published by the IEEE. Networking with your peers at IEEE Conferences and section events is another rich opportunity for personal growth. Find an influential mentor and perhaps even consider a qualified career coach and spiritual advisor to assist you in reaching your goals. Create living curriculum vitae that documents your career and other related activities in detail. Set a goal of adding a line item of growth each week.

Despite advances in technology humans will always be biological beings composed of flesh and blood needing compassion, and respectful social interaction with others and the natural world. By taking a holistic, balanced and self-fulfilling approach to mental and physical fitness, health, wellness and success will follow naturally. Take responsibility for your own future. There will be those who will challenge your enthusiasm; disregard what they say. It is to be expected that sometimes you will fail. Keep striving and always believe in yourself.

## *Conclusion*

We have made incredible advances in the last few decades. It was not that long ago when television was black and white, electronic devices consisted of vacuum tubes, documents were created on a typewriter, information was accessed physically in a library through time-consuming manual searching of card catalogues, you had to travel to your local bank to get your money, communicated with wired dial telephones, sent physical documents through mail, and we breathed the emissions of leaded gasoline. The future will bring more and more beneficial advances. Change is not to be feared but to be embraced with enthusiasm.

The savvy person will take time to gather information about projections for the future, analyze them, and then set up a strategy to achieve personal and career success. The following provide a wealth of information to supplement this brief overview and will enhance your quest to success.

### References and Further Reading:


Beinhocker, E., I. Davis and L. Mendonca. The 10 Trends You Have to Watch. Harvard Business Review. 87(7):55-60. July-August, 2009.

Berns, M., et al. The Business of Sustainability: What It Means to Managers Now. MIT Sloan Management Review. 51(1):20-26, Fall, 2009.

Challenger, J.A. Finding a Job in the 21st Century. The Futurist. 43(5):29-33. September-October, 2009.

Cornish, E. Wild Cards in Our Future. The Futurist. 37(4):18-22, July-August 2003.

Cornish, E., C.G. Wagner, D. Johnson, and Jeff Minerd. The Opportunity Century: 50 Paths to Success in the 21st Century. The Futurist. 34(1):1-15. 2000.

Halal, W.E. Emerging Technologies and the Global Crisis of Maturity. The Futurist. 43(2):39-46, March-April, 2009.

Marx, G. Educating Children for Tomorrow's World. The Futurist. 35(1):43-48, March-April, 2001.

Modis, T. The Limits of Complexity and Change. The Futurist. 37(3):26-32, May-June 2003.

Richarme, M. Ten Forces Driving Business Futures. The Futurist. 43(4):40-43, July-August, 2009.

Learning in 2020: Today's Leaders Take a Look at What's Ahead. Training & Development. 62(12): 30-43. December, 2008.

Outlook 2010. The Futurist. 43(6): 9 page inset. November-December, 2009.

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

On Solutions for the World, Changing Jobs, Top Entrepreneurs, Global Debt, Bouncing Out, Temp Jobs, Foresight, Star Hires.

*by Terrance Malkinson*
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◆ Ten new solutions that are believed would make a better world are provided in *Harvard Business Review*. ["Break-through Ideas for 2010" *Harvard Business Review*, 88(1):41-57, January-February 2010, www.hbr.org]. Compiled in cooperation with the World Economic Forum, each of the ten ideas is presented as a short essay written by internationally recognized authorities in the subject. Topics include:

- What really motivates workers: understanding the power of progress.
- The technology that can revolutionize health care: it's now high cost or high tech.
- What the financial sector should borrow: a military approach to keeping the economy safe.
- Getting the drugs we need: simple standards would spur innovation.
- A market solution for achieving "Green" financing that encourages building retrofits.
- A faster path from lab to market: removing the technology licensing obstacle.
- Hacking work: learn to love the rule breakers.
- Spotting bubbles on the rise: we have the tools to sound the alarm early.
- Creating more Hong Kong's: how charter cities can change the rules for struggling economies.
- Independent diplomacy: why pretend that only nation-states shape international affairs?

Each topic is discussed under the headings of "the Problem," "The Breakthrough Idea" and "The Promise."

◆ US Bureau of Labor statistics suggest that the average worker will change jobs ten times during their career. Even experienced people make mistakes when changing jobs. Boris Groysberg and Robin Abrahams discuss five common mistakes that people, make when changing jobs in "Five Ways to Bungle a Job Change" [*Harvard Business Review*, 88(1):137-140, January-February 2010]. Although focusing on executive careers, the five mistakes discussed are applicable to all levels of job change. An excellent experienced-based report based on an international survey of over 400 search consultants from more than 50 industries.

◆ A listing of top entrepreneurs of 2009 and discussion of their secrets for success are provided in "Entrepreneur of 2009 Award Winners" [*Entrepreneur*, 38(1):23-26, January 2010, www.entrepreneur.com ]. Leading as entrepreneur of the year is Rick Alden the designer of the Skullcandy series of headphones and earbuds and who as an entrepreneur is continuing on with developing new models of high-end headphones and starting new business enterprises. The emerging entrepreneur awardee was Kelly Giard who created the first sustainable lawn-care franchise. The college entrepreneur winner was Brady Ericson a sophomore at Drexel University who among other pursuits created a method of digitizing receipts for campus transactions.

◆ Spending our way out of worldwide recession will take years to pay back and create a lot of pain" is the header statement in Daniel Fisher's article "The Global Debt" (*Forbes*. 185(2):62-68, February 8, 2010. www.forbes.com/forbes/2010/0208/debt-recession-world-wide-finances-global-debt-bomb.html ). This in-depth article describes how governments throughout the world are deficit budgeting at levels never before experienced. The author suggests that repayment must occur eventually in what might be a difficult and painful process for all. The magnitude of the problem globally is discussed factually and is supplemented by exceptional graphics.

◆ We all experience crises in our lives. We cannot avoid these situations but we can control our response when it occurs. Joshua Margolis and Paul Stoltz provide a resilience regimen to help you respond quickly and constructively to a crisis in "How to Bounce Back from Adversity" [*Harvard Business Review*, 88(1):86-92, January-February 2010]. The resilience regimen described consists of a series of questions designed to help you replace negative responses with creative and resourceful ones that will move everyone forward despite real or perceived obstacles. Resilient managers look forward determining the best course of action in a traumatic situation.

◆ Employers in their attempt to reduce business costs are transitioning to a business model of the "as needed" labor force. They are unwilling to make a commitment of reasonable continuous employment resulting in a labor force consisting of "temporaries." The trend extends throughout all levels, even to the executive office. "The Disposable Worker" is the title of a recent in-depth article by Peter Coy, Michelle Conlin and Moira Herbst in *BusinessWeek,* [#4163. pp. 33-39. January 18, 2010. www.businessweek.com ] that discusses how "companies are making the era of the temp more than temporary." Implications of this business policy both for employees and for employers are discussed. Continuing on with the topic of temporary workers; issues associated with the practice of employing temporaries in blended workplaces where long-time employees work side-by-side with temporary employees are discussed by Rita Zeidner in the February 2010 issue of *HR Magazine* [55(2):28-33 "Heady Debate: Rely on Temps or Hire Staff?" www.shrm.org/Publications/hrmagazine ]. An interesting inset provides projections of the top 10 jobs for temporaries 2008-2010. A number of legal concerns that organizations should be aware of are also discussed.

◆ The cover story of February's issue of *IEEE Spectrum* is a report of ten technologists who achieved the job of their dreams ("Dream Jobs" *IEEE Spectrum*. 47(2): 26-41. February, 2010). The common theme for all of these individuals was a willingness to pursue a career path that was seen as different from the norm; courage to move into the unknown; and pursuing what they believed to be an intriguing idea. Each career journey provides interesting insights into creativity and innovation and the importance of believing in yourself and being passionate about your job in order to achieve career success.

◆ Faulty managerial practices often results in the organizations inability to reap the full benefits from hiring outstanding employees. Boris Groysberg, Linda-Eling Lee and Robin Abrahams discuss the value and the essential role of high quality colleagues as well as five common managerial mistakes in "What it Takes to Make 'Star' Hires Pay Off." [*MIT Sloan Management Review*. 51(2):57-61, Winter, 2010. www.sloanreview.mit.edu ].

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# Conferences: IEEE & Collaboration • Canada • 2010

## WEST…

IEEE Int'l Communications Quality and Reliability Workshop (CQR)
2010-05-08...10, Vancouver, BC
http://www.ieee-cqr.org

IEEE Int'l Conference on Intelligence and Security Informatics (ISI)
2010-05-23...26, Vancouver, BC
http://conferences.irmacs.sfu.ca/isi2010

## CENTRE…

IEEE Int'l Symposium on Network Coding (NetCod)
2010-06-09...11, Toronto, ON
http://www.networkcoding.org

5th Int'l Conference on Digital Information Management (ICDIM)
2010-07-05...08, Thunder Bay, ON
http://www.icdim.org

Annual Meeting of the North American Fuzzy Information Processing Society (NAFIPS)
2010-07-08...10, Toronto, ON
http://nafips2010.org

IEEE Int'l Symposium Antennas and Propagation and CNC/USNC/URSI Radio Science Meeting
2010-07-11...17, Toronto, ON
http://www.apsursi2010.org

Int'l Waveform Diversity and Design Conference (WDD)
2010-08-08...13, Niagara Falls, ON
http://www.waveformdiversity.org/

6th IEEE Int'l Conference on Automation Science and Engineering (CASE)
2010-08-21...24, Toronto, ON
http://www.case2010.org

IEEE/WIC/ACM Int'l Conferences on Web Intelligence and Intelligent Agent Technology (WI-IAT)
2010-08-31...09-03, Toronto, ON
http://www.yorku.ca/wiiat10

**24th Canadian Conference on Electrical and Computer Engineering (CCECE)**

2011-05-TBA, Niagara Falls, ON
http://www.ieee.ca/ccece11

## EAST…

8th ACIS Int'l Conference on Software Engineering Research, Management and Applications (SERA)
2010-05-24...26, Montreal, QC
http://acis.cps.cmich.edu/SERA2010/

IEEE Int'l Symposium on "A World of Wireless, Mobile and Multimedia Networks" (WoWMoM)
2010-06-14...17, Montreal, QC
http://wowmom2010.netgroup.uniroma2.it

8th IEEE Int'l NEWCAS Conference
2010-06-20...23, Montreal, QC
http://newcas.grm.polymtl.ca

14th Int'l 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

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

Int'l Symposium on Performance Evaluation of Computer & Telecommunication Systems (SPECTS)
2010-07-11...14, Ottawa, ON
http://atc.udg.edu/SPECTS2010/

**4th Annual Electrical Power and Energy Conference (EPEC 2010)**

2010-08-23...25, Halifax, NS
http://www.ieee.ca/epec10/

8th Annual Int'l Conference on Privacy, Security and Trust (PST)
2010-08-17...19, Ottawa, ON
http://pstnet.unb.ca/pst2010

3rd Int'l Conference on Wireless Communications in Underground and Confined Areas (ICWCUCA)
2010-08-23...25, Val-d'Or, QC
http://www.icwcuca.ca

IEEE Vehicular Technology Conference (VTC-Fall)
2010-09-12...15, Ottawa, ON *(see Ad on page 25)*
http://www.ieeevtc.org

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

IEEE Topical Meeting on Microwave Photonics (MWP)
2010-10-05...09, Montreal, QC
http://www.mwpconference.org

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