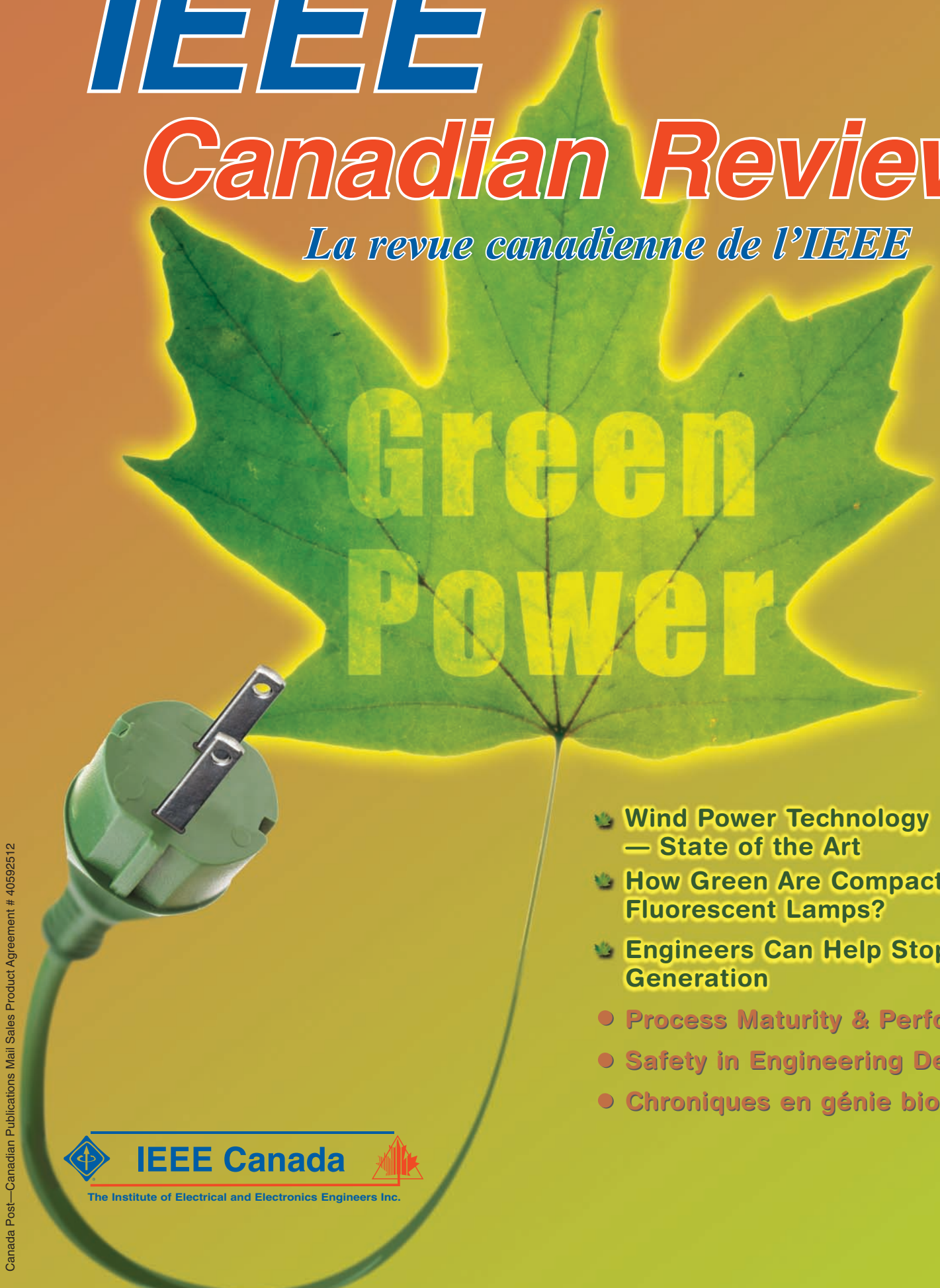
December / Décembre 2007, No. 56

IEEE Canadian Review

La revue canadienne de l'IEEE



- Wind Power Technology — State of the Art
- How Green Are Compact Fluorescent Lamps?
- Engineers Can Help Stop E-Waste Generation
- Process Maturity & Performance
- Safety in Engineering Design
- Chroniques en génie biomédical

IEEE Canada

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Editorial / *Éditorial*

Eric Holdrinet SMIEEE, Rédacteur en chef / Managing Editor

Ce numéro a été posté en retard. Désolé. Pour changer cet état de choses, il nous faut un volontaire pour gérer la revue diligente des articles, et un autre pour superviser la production. Ce pourrait être vous; devenez actif(-ve) dans votre association professionnelle! En attendant nous ferons de notre mieux, nous continuerons d'insister sur la qualité du contenu et de la présentation, et façonnerons trois numéro par an avec des sujets d'intérêt pour les membres du IEEE au Canada.

Le monde et la société ont été modifiés par la technologie, le plus visiblement au cours du dernier siècle, apportant de nombreux bénéfices – et certains inconvénients dont nous sommes de plus en plus conscients. Plusieurs formes de pollution et autres coûts sociétaux de l'utilisation ou l'abus des technologies font maintenant l'objet d'articles médiatiques, d'avis gouvernementaux, et de discussions de salons.

Nos concitoyens se fient sur les ingénieurs pour leur fournir le prochain mécanisme qui améliorera leur vie ou atténuera les inconvénients de la dernière génération de produits. L'électricité éolienne est souvent citée en exemple pour le remplacement de vieilles sources d'énergie polluantes et non-renouvelables. Les ingénieurs canadiens font leur part ainsi que les gouvernements et autres parties prenantes; nous vous offrons un court survol du domaine, avec éléments canadiens, dans "Wind Power Technology – State of the Art".

Un autre moyen pour les ingénieurs d'apporter des changements positifs est dans la façon dont ils font leur travail. "Safety in Engineering Design: Innovation through Competition" présente la Compétition de design sécuritaire James Ham de Minerva Canada, qui récompense de nouvelles façons de créer des produits plus sécuritaires*. Aussi, "Achieving The Right Balance Between Process Maturity And Performance" discute d'amélioration de qualité dans les processus de développement, et "Engineers Can Help Stop E-Waste Generation" plaide pour la minimisation des impacts écologiques futurs dans le design de produits électroniques.

Mais les ingénieurs ne peuvent tout faire et ne peuvent décider pour toute la société. Les décideurs corporatifs devraient voir un avantage dans l'apport au marché de produits plus verts, et les gouvernements peuvent fournir des incitatifs – via une réglementation judicieuse – pour les y contraindre. Voir notre article sur les ampoules compactes fluorescentes.

Finalement, il incombe à chacun de nous de prendre nos responsabilités et ajuster notre comportement, en tant que consommateurs et concepteurs, pour améliorer le lot de notre communauté ainsi que celui du village global. Nos achats ont un impact, mais aussi ce que nous disons à nos leaders, nos collègues, nous amis et notre famille, et spécialement comment nous montrons l'exemple.

* Vous pouvez aussi devenir membre de la toute nouvelle Société IEEE Product Safety Engineering!

This issue was mailed late. Sorry. To change this state of affairs, we need a volunteer to manage the peer-review of articles, and another to oversee production. It could be you; become active in your professional association! Until then we will do as best as we can, we will keep focusing on quality of content and presentation, and craft three issues per year with subjects of interest for IEEE members in Canada.

How Green was my Engineering… The world and human society have been changed by technology, most visibly in the last century, with enormous benefits – and some drawbacks of which we are increasingly aware. Many forms of pollution and other societal costs of technology's use or misuse now form the subject of media pieces, government briefs, and kitchen discussions.

Our neighbours rely on engineers to bring about the next construction that will improve their life, as well as mitigate the downsides of the last generation of products. Wind power generation, for example, is presented as a prime example of how to replace some older, polluting and non-renewable energy sources. Canadian engineers do their bit along with governments and other stakeholders in bringing this about; we present a short overview of the field, with Canadian tidbits, in "Wind Power Technology – State of the Art".

Another way for engineers to bring about positive change is in the very way they do their job. "Safety in Engineering Design: Innovation through Competition" presents the Minerva Canada James Ham Safe Design Competition, which celebrates new ways to create safer products*. As well, "Achieving The Right Balance Between Process Maturity And Performance" tells a story about improving quality in your organisation's development process, and "Engineers Can Help Stop E-Waste Generation" argues that electronic design can be performed in a way that minimizes future ecological impacts.

But engineers can't do it alone, and cannot decide for the whole of society. Corporate deciders should see an advantage in bringing greener products to market, and governments can provide the right incentives – through judicious regulation – to spur them on. Read our article on "Compact Fluorescent Lamps" for a case in point.

Finally, it behooves each of us to take responsibility and adjust our behaviour, as consumers and as designers, to improve the lot of your local community as well as that of the human village. What we buy has an impact, what we tell our leaders, our colleagues, friends and family, and especially how we lead by example.

* You could also become a member of the all new IEEE Product Safety Engineering Society!

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Bob Hanna, FIEEE, FEIC, FIEE, President of IEEE Canada: 2006-2007 / Président de l'IEEE Canada: 2006-2007

This year IEEE Canada held its first annual Electrical Power conference. The conference took place in Montreal on October 25-26, 2007, (http://www.ieee.ca/epc07) and was a great success. The conference was organized by the Montreal Section, Ottawa Section and IEEE Canada. We are grateful to all of the authors, invited guest speakers and the sponsors. Our sincere gratitude goes to Dr. Vijay Sood, conference chair, and the organizing committee for their dedication and hard work. Next years conference will take place during October in Vancouver. Arrangements are well underway, led by Dr. Ebrahim Vaahedi, conference chair.

Congratulations to the student team from the University of Alberta for winning the 3rd annual IEEE Canada/Telus innovation competition and $10,000 in prize money. This event took place in Edmonton from September 13-14, 2007, where student teams from nine universities competed. We are very grateful to TELUS for their generous financial support in funding this competition.

In 2007, IEEE Canada began holding a series of webinars (internet based seminars), aimed at providing our members with alternate access to IEEE seminars. We held three webinars, in which over 300 members participated and have received positive feedback. The material for the last two PowerPoint presentations is posted on our website. We are very grateful to Dr. Saman Adham, chair of Education Activities, for organizing these events. The Educational Activities Committee is planning to hold several webinars in 2008.

The IEEE Canada monthly electronic newsletter has undergone considerable improvement. We are very pleased to report that since October 2007, it is published in both English and French. This requires both time and dedication from our newsletter editors to ensure timely publication. We are grateful to Dr. Alex Bota, newsletter Editor, and his team for their excellent volunteer work.

The IEEE Canada Fall Board of Directors meeting took place from October 19-21, 2007 in St. John's, Newfoundland. The Board discussed the planned activities, reviewed the strategic plans to enhance services to our members and approved the 2008 budget. The budget has been adjusted to reflect the impact of our strong Dollar. The allocated rebate that IEEE Canada receives from IEEE is all in US currency and this amount has been steadily declining when transferred to our Canadian account.

I am pleased to report that IEEE Canada finances are in a good shape in spite of the negative impact that our strong Canadian Dollar has on our rebate. This is mainly due increased revenues, cost cutting measurers, surpluses from our conferences, rebate from advertising and career site. Above all, this result is made possible due to excellent volunteer work. IEEE Canada investment committee is reviewing options to reduce the exposure to the volatility of our Dollar fluctuation. On the positive side, our membership dues have reduced by about 25% when compared to last year and as a result we have seen noticeable membership growth. Please continue to renew your membership and encourage others to join IEEE.

This is my last communication with you as President of IEEE Canada. I am honored to have served you in 2006-2007 and I am thankful to our members to have giving me this unique opportunity to build on the success of my predecessors. This has been a very rewarding but challenging experience and I have immensely benefited from it. I am very grateful to members of the steering committee, members of the executive committee, IEEE Canada Board of Directors, Editors of our magazines and Journals and chairs of various committees for their support, guidance, friendship and outstanding efforts. Thanks, too, to many members who came forward during my visits to the sections and technical meetings and shared their ideas with me. I have immensely enjoyed meeting our students at the annual workshop and TELUS competition as they made me feel young again. We see these students as our future leaders and IEEE Canada is committed in providing the financial support to facilitate these gathering. Our IEEE Canadian Foundation has done an excellent service in providing over a dozen scholarships per year to our students and a similar number of special and McNaughton centre grants.

Cette année le IEEE Canada a tenu sa première conférence annuelle sur l'Énergie électrique. Elle a eu lieu à Montréal les 25-26 octobre 2007 (http://www.ieee.ca/epc07) et a été un grand succès. La conférence était organisée par les sections de Montréal et d'Ottawa et le IEEE Canada. Nous sommes reconnaissants envers les auteurs, conférenciers invités et leur commanditaires. Nos remerciements sincères à Dr. Vijay Sood, Président de la conférence, et au comité organisateur pour leur dévouement et leurs efforts. La conférence de l'an prochain se tiendra en octobre à Vancouver. Les préparations sont en bonne voie, sous la gouverne de Dr. Ebrahim Vaahedi.

Nos félicitations à l'équipe étudiante de l'Université d'Alberta pour avoir remporté la 3e compétition annuelle d'innovation IEEE Canada/TELUS et le prix de 10 000 $ qui l'accompagne. Des équipes étudiantes de neuf universités on participé à cet événement à Edmonton les 13-14 septembre 2007. Nous sommes très reconnaissants envers TELUS pour leur généreux soutien financier envers ce concours.

En 2007 le IEEE Canada a commencé à présenter une série de webinaires (séminaires diffusés via internet), visant à fournir à nos membres une accès alternatif aux séminaires du IEEE. Nous avons tenu trois webinaires, auxquels 300 membres ont participés, et avons reçu des commentaires positifs. Les deux dernières présentations PowerPoint ont été publiées sur notre site web. Nous remercions Dr. Saman Adham, président du Comité des activités éducationnelles, pour avoir organisé ces événements. Ce comité prévoit organiser plusieurs webinaires en 2008.

La Lettre d'information électronique mensuelle du IEEE Canada a complété une amélioration importante. Nous sommes heureux d'annoncer que depuis octobre 2007 elle est publiée en français aussi bien qu'en anglais. Ceci exige temps et dévouement de la part de nos éditeurs pour garantir une publication dans les délais. Nous sommes reconnaissants envers Dr. Alex Bota, Éditeur de la Lettre d'information et son équipe pour leur excellent travail bénévole.

Le Conseil d'administration d'automne du IEEE Canada s'est tenu les 19-21 octobre 2007 à St-Jean, Terre-Neuve. Le Conseil s'est penché sur les activités prévues, a passé en revue les plans stratégiques pour améliorer le service aux membres, et approuvé le budget 2008. Ce dernier a été ajusté pour refléter l'impact de notre dollar fort. L'allocation que le IEEE Canada reçoit du IEEE est en argent US, et ce montant a décliné régulièrement un fois transféré dans note compte canadien.

Il me fait plaisir de vous informer que les finances du IEEE Canada sont en bonne santé malgré l'impact négatif d'un dollar canadien fort sur nos revenus. Ceci est dû principalement à une augmentation des revenus de base, à des coupures de coûts, au surplus financier de nos conférences, et à des recettes de publicité et du Site de carrières. Par-dessus tout, ce résultat a été rendu possible par de l'excellent travail bénévole. Le Comité d'investissement du IEEE Canada passe en revue diverses options pour réduire notre vulnérabilité envers les fluctuations du dollar. D'un autre côté, les cotisations des membres ont diminué d'environ 25% comparé à l'an dernier, résultant en une croissance notable des adhésions. S'il vous plaît, n'oubliez pas de renouveler votre adhésion et encouragez vos voisons à joindre l'IEEE.

Ceci est mon dernier message pour vous en tant que Président de l'IEEE Canada. Je suis honoré d'avoir pu vous servir en 2006-2007 et suis reconnaissant envers nos membres pour m'avoir offert cette opportunité de bâtir sur le succès de mes prédécesseurs. Cela a été une expérience très enrichissante mais aussi exigeante et j'en ai énormément profité. Je suis très reconnaissant envers les membres du Comité de direction, du Comité exécutif, du Conseil d'administration du IEEE Canada, les Éditeurs de nos revues et journaux et les présidents des différents comités pour leur support, conseils, amitié et formidables efforts. Merci, aussi, aux nombreux membres qui se sont avancé lors de mes visites aux sections et réunions techniques et ont partagé leurs idées. J'ai énormément apprécié rencontrer nos étudiants et étudiantes à leur atelier annuel et la compétition TELUS car ils m'ont fait me sentir jeune à nouveau. Nous considérons ces étudiants comme nos futurs leaders et le IEEE Canada s'est engagé à leur fournir le support financier pour faciliter ces rassemblements. Notre Fondation canadienne de l'IEEE a livré un excellent service en décernant une douzaine de bourses par an à nos étudiants et un nombre similaire de prix spéciaux et allocations de Centres NcNaughton.

Dr. Ferial El-Hawary is our next IEEE Canada President and she possesses considerable experience and skills to continue moving this organization forward. Congratulations to Dr. Om Malik for becoming IEEE Canada President-Elect.

I am very grateful to all our volunteers in IEEE Canada, who work hard to serve our members across this beautiful country. I wish you and your families good health and prosperity for the New Year. ■

Dr. Ferial El-Hawary est notre prochaine Présidente de l'IEEE Canada et possède une expérience et des aptitudes remarquables pour faire progresser cette organisation. Nos félicitations à Dr. Om Malik pour être devenu Président-élu du IEEE Canada.

Je suis reconnaissant envers nos volontaires du IEEE, qui travaillent for pour servir nos membres dans ce beau pays. Je vous souhaite ainsi qu'à votre famille santé et prospérité pour la nouvelle année.■

Bob Hanna, P.Eng., FIEEE, FEIC, FIEE

University of Saskatchewan Space Team's "Space Climber" Shoots to First Place

by Clayton Ruszkowski

SASKATOON — For the third consecutive time, the University of Saskatchewan Space Design Team (USST) won first place at the Space Foundation's "Elevator 2010 competition" for space elevator and power beaming technologies. Twenty-nine teams from seven countries participated in the 2007 contest held October 13 to 22 in Salt Lake City. The Team had received a Special Grant of $3,000 from the IEEE Canadian Foundation to attend the competition.

The USST winning team with Climber, top side.

Below: *Team and Climber, bottom side.*

The Space Elevator concept is that of a super-strong ribbon going from the surface of the Earth to a point beyond geosynchronous orbit. The tether is held in place by a counterweight in orbit — as the Earth rotates the tether is held taut. Vehicles would then climb the ribbon powered by a beam of energy projected from Earth's surface.

For the 2007 competition's challenge the beam-powered robotic climber had to ascend a 120-metre-long vertical ribbon at a minimum speed of 2 m/s. This was a serious upgrade from the previous two years competitions, which mandated climbing a 60 m vertical ribbon at 1 m/s. This time USST narrowly missed seizing the $500,000 prize money, being only 0.2 m/s short of the target. However, they set competition records (and thus world records!) with the first ever laser powered climb - hence also the highest and fastest ever.

The USST entry also set the world record for the largest amount of wireless energy ever transferred into mechanical energy using a laser. The record until now was about 2 watts of mechanical energy; they transferred and maintained for almost a minute an astonishing 400 watts into mechanical energy to push up a 25 kg climber unit. Cold sweat broke out when the ribbon snapped during one of the runs, but the sturdy USST climber survived and was not damaged.

The team members were invited to speak and have just returned from three back-to-back prestigious Aerospace Conferences: Luxembourg City (Luxembourg), Kona (Hawaii) and Calgary (Alberta), sponsored by Euro Spaceward, the U.S. Air force and the Canadian Space Society.

For more information, please go to the USST website: http://www.usst.ca/

The space climber begins its 120-metre ascent, zipping up to the top in only 67 seconds —a world record for the highest and fastest climb.

Clayton Ruszkowski
President,
University of Saskatchewan
- Space Design Team
usst@usask.ca

H.S.LUNAN - *IN MEMORIAM*

Havelock Stanley "Flip" Lunan, 1924–2007, IEEE Life Senior Member and active volunteer for 55 years, passed away peacefully in Montreal on September 2nd after a lengthy illness. He is survived by his wife of 53 years, Zetta, four children, six grandchildren and two great granddaughters.

Soon after graduating from high school, Flip joined the RCAF where he was trained as a Radio Technician and subsequently served four years overseas during WWII. He must have liked what he was doing because after the War he attended McGill University graduating with a degree in Electrical Engineering after which he embarked upon a 34-year career with General Electric of Canada. He represented GE on many of the big power developments in Eastern Canada including, early in his career, being in charge of a consortium of various equipment manufacturers for the Churchill Falls project.

Although a shy man, Flip provided leadership throughout his life in many different areas such as being elected to the Board of Quebec's professional engineers association now known as the Order of Engineers, the Engineers' Club and to balance things out he also served as President of a Montreal curling club and a ski club in the Laurentian Mountains.

Flip Lunan was active in the Montreal Section for half a century, including being Chairman of the Section as well as of IEEE Montréal Conferences Inc.

Flip had been active in the Montréal Section of the IEEE for a half century holding various positions including being Chairman of the Montréal Section, and of IEEE Montréal Conferences Inc., which managed a recurrent International Power Conference with about 2500 attendees. He was also the recipient in 2000 of the IEEE's Third Millennium Medal awarded for "Outstanding Achievements and Contributions".

A man of great wisdom who always remained unflappable in the face of adverse events, Flip was a source of invaluable counsel to many within the Engineering Profession and to the IEEE. He also had great foresight and in the 1980s, before the introduction of the Loonie, he started to hand out to all of his friends brand new crisp dollar bills bearing a "happy face" stamp on each dollar bill with instructions that everyone was to keep those dollar bills and buy themselves a drink after his funeral. Hundreds of these dollar bills were spent at the Ye Olde Orchard Pub the evening after Flip was put to rest in the Field of Honour military cemetery in Montreal. Those of us who have known and worked with Flip consider ourselves to be truly fortunate. His life cannot be summarized in these few short sentences – it deserves a book!

by Len Ruggins

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

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

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

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

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The circulation of the ***IEEE Canadian Review*** is the entire membership of IEEE Canada, plus external subscribers.

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Authors are invited to contribute submissions in electronic form to the ***IEEE Canadian Review***. Please contact one of the editors. Responsibility for the content rests upon the authors and not the IEEE, or its members.

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Free of charge to all IEEE members in Canada. For IEEE members outside Canada: $20.00/year. Non-members: $35.00/year. Corporations and libraries: $37.50/year. Additional copies may be ordered at a cost of $7.50 each from the Managing Editor.

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The IEEE Fellow Committee has named 295 Senior Members to Fellow Grade, effective January 1st, 2008. The number of new Canadian Fellows is quite impressive at 12, in proportion to our total membership in the organization, and the Review is proud to number one of its Associate Editors amongst them. Sincere congratulations to our eminent new Fellows.

Kenneth Cadien Edmonton, Alberta *For contributions to chemical mechanical polishing.*	**Timothy Driscoll** Calgary, Alberta *For leadership in the development of codes and standards for electrical safety in industry.*	**Ling Guan** Toronto, Ontario *For contributions to image and multimedia signal processing.*
Vincent Hayward Montréal, Québec *For contributions to robot manipulator programming and the development of haptics interface technology.*	**Shesha Jayaram** Waterloo, Ontario *For contributions to the use of high voltage in process technology.*	**Bogdan Kasztenny** Markham, Ontario *For contributions to protective relaying methods, designs, and applications.*
Jorg Liebeherr Toronto, Ontario *For contributions to the design and analysis of computer networks and their protocols.*	**Yvon Savaria** Montréal, Québec *For contributions to the development of long interconnect VLSI signal processing architectures.*	**Ivan Stojmenovic** Ottawa, Ontario *For contributions to data communication algorithms and protocols for wireless sensor and ad hoc networks.*
Bin Wu Toronto, Ontario *For contributions to high-power converter technology and adjustable speed drives.*	**En-hui Yang** Waterloo, Ontario *For contributions to source coding.*	**Weihua Zhuang** Waterloo, Ontario *For contributions to mobile communications and networks.*

Complete list of new IEEE Fellows at http://www.ieee.org/fellows

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

BURLINGTON, ON. Sep. 6, 2007. Gennum Corporation has announced the availability of the industry's first 3Gb/s optical modules. Those dual transmitter and dual receiver optical modules meet the new Society of Motion Picture and Television Engineers (SMPTE) 3Gb/s SDI standard. This enables broadcast equipment manufacturers to achieve a data rate of 3Gb/s over a single optical serial link.

ALEXANDRIA, VA. Jul. 25, 2007. TranTech, a provider of video interview solutions, has announced that it has been selected by the Toronto Police Service to expand their use of the next generation of technology to capture video evidence. The system will be used to inter alia connect seven geographically dispersed police divisions, using a solution that comprises software, hardware and support services to deliver an integrated digital evidence management system.

CALGARY, AB. Nov. 29, 2007. The Canadian government has awarded a contract to Raytheon Canada for the repair, overhaul, engineering and upgrade services for eight AN/SPS-49 (V) radar systems for the Canadian Navy. The new contract extends Raytheon's support services to the Navy until 2013, with options to 2015. The contract is valued at $22.2 million.

MONTREAL, QC. Oct. 31, 2007. The signing of a Quebec-Japan nanotechnology development agreement has been announced. The signing took place at the Pointe-à-Callière Museum in Montreal. With representatives of the provincial and federal governments, universities and the private sector in attendance, the NBCI (Nano Business Creation Initiative) and NanoQuébec made official a three-year partnership agreement. NBCI is one of the largest private nanotechnology organization in the world with over 300 members active in the field.

TORONTO, ON. Oct. 25, 2007. Bioscrypt, a provider of enterprise access control technology, has announced that The Venetian Macao-Resort-Hotel is using Bioscrypt's VisionAccess 3D Face Readers to authenticate 12,000 employees and Bioscrypt's V-Smart fingerprint readers to control access to restricted areas. The Venetian Macao is the largest casino in the world.

MONTREAL, QC. Oct. 22, 2007. The Faculty of Engineering and Computer Science of Concordia will hold its first annual Awards of Distinction. The first honorees are James Gosling, known for designing the Java computer programming language and implementing its original compiler and virtual machine and John Holding, an aeronautics designer who has designed programs for both Canadair and Bombardier Aerospace.

MONTREAL, QC. Oct. 10, 2007. Noveko has announced the signature of an agreement between its agent in Asia and China National Service who is one of China 's most prominent state-owned companies. Under that agreement, CNSC has been mandated to promote Noveko's antimicrobial filtration technology to all levels of Chinese governments and its related food and health organizations. The goal is to obtain government authorizations required for the commercialization of the technology of Noveko.

CALGARY, AB. Sep. 28, 2007. Hemisphere GPS, a designer and manufacturer of GPS products has announced that it has reached a settlement with Trimble Navigation, relating to outstanding patent infringement lawsuits in the Northern District of California and the District of Kansas. In accordance with the terms of the settlement, the actions will be discontinued immediately.

BEIJING, Sep. 7, 2007. The Optical Memory National Engineering Research Center (OMNERC), a laboratory dedicated to optical disc research in Tsinghua University, has announced CH-DVD (China High Definition DVD), a new generation high definition DVD format developed in collaboration with research institutes and manufacturing enterprises at home and abroad. The physical format of CH-DVD includes Chinese-owned intellectual property, and is based on HD DVD, the next generation high definition DVD approved by the DVD Forum. The realization of CH-DVD was supported by the Chinese government, and will pave the way for the localization of blue-laser, high-definition DVD in China. ■

RIM wins '08 IEEE Corporate Recognition

The 2008 crop of IEEE Medal, Recognition and Prize Paper Recipients includes one Canadian awardee: Research in Motion (Waterloo, ON) won the IEEE Corporate Innovation Recognition "For developing and promoting the Personal Data Assistant, BlackBerry, and thereby transforming the mobile work environment." See http://www.ieee.org/portal/pages/about/awards/pr/2008medalrecips.html

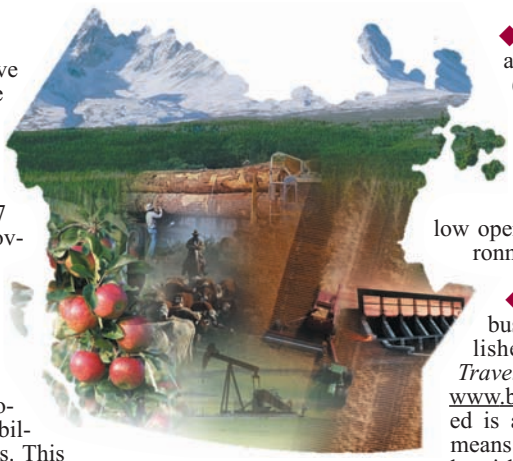
The IEEE Corporate Innovation Recognition was established in 1985. It is presented for outstanding and exemplary contributions by an industrial entity, governmental, academic organization, or other corporate body. The contribution may be achieved through the medium of innovative products, product lines, systems, or concepts which have resulted in major advancement of the arts and sciences of electrotechnology. The award consists of a certificate and crystal sculpture.

Congratulations from the IEEE Canadian Review's Editorial Board.

A View from the West

On: Oil Royalties, Leadership Skills, BC Inventors, The Cirque, Business Location, Business Travel, The Future of Food, Guest Workers, and Firefighters Training.

By Terrance Malkinson
Senator, University of Calgary



- Since the change in political leadership the Alberta Government has been engaged in strategic planning for the future. A number of new and in some cases controversial changes have emerged and some are summarized in the Premier's October report (www.alberta.ca/home/documents/ReporttoAlbertans(F).pdf). Of particular interest are discussions surrounding the release of the report of The Royalty Review Panel on September 18, 2007 (www.albertaroyaltyreview.ca). The Alberta Government's New Royalty Framework which is based on some of the Panels recommendations intends to give future generations of Albertans a fair share from the development of energy resources, provide stability and predictability to the oil and gas industry and assure internationally competitiveness and business stability. It is projected that changes proposed will bring in $1.4 billion in additional royalties in 2010 for Albertans. This represents an increase of 20% over revenues forecast for that year under the current policy. In Alberta resource royalties support sustainable economic development that contributes to quality of life for all Albertans now and for the future. One-third of any additional revenues generated by Alberta's New Royalty Framework will be put into savings and invested for future generations of Albertans, while two-thirds will be committed to capital-spending projects that meet the needs of a growing economy.

- The Banff Center for Leadership Development (www.banffcentre.ca/departments/leadership) has a long history as an educational provider for developing leadership skills that contribute to Canada and the larger global community. An interesting article "A Leading Question" (*Alberta Venture*; 11(6):87-95, June 2007; www.albertaventure.com) by Healther Zwicker provides one participant's perspective on the experience. I have also participated in a number of the Banff Centre programs and found the experience to be very valuable in my journey through life. The author's description of the "leap of faith" certainly brings back memories of my overcoming fears and building self-confidence. In a related on article on leadership education "Into the Wild" *Inc Magazine*; 29(10): 116-126; October 2007; www.inc.com) Alison Wellner describes the experience and benefits of wilderness experiential education for developing leadership and team building skills. The author discusses the experience of an executive team sent into the Wyoming wilderness for seven days of team building and how they got to really know each other.

- Six profiles of British Columbia inventors are provided in *BC Business* (35(11): 106-113, November 2007; www.bcbusinessonline.ca). Inventions profiled by Peter Severinson include: a 3-D side-scan sonar, waste nutrient extractor, air-powered tents, hydraulic table stabilizer, walking-assist implant, and biomechanical energy harvester. A link is provided to more information discovered while the author was researching his article.

- Cirque du Soleil (www.cirquedusoleil.com) is a Canadian success story. Its founder Guy Laliberté was named 2007 World Entrepreneur of the Year by Ernst & Young. The story of this incredible organization is provided in the *Globe and Mail: Report on Business* (24(2):56-64, September, 2007 www.globeandmail.com/robmagazine) by Konrad Yakabuski. Founded in 1984 and based in Montreal it is estimated that over 70 million spectators have viewed its unique entertainment offering. Its success has been the subject of many academic and industry articles on effective business management and visionary leadership. The Cirque has 3,800 employees and fourteen touring and permanently fixed shows with many more in the planning phase – including one starting in 2010 at the Oscar's venue: the Kodak Theatre in Hollowood. The company is a good global citizen with its involvement in communities, and its work with youth at risk. In cooperation with its partners, Cirque du Soleil is involved in nearly 80 communities worldwide.

- The best places to do business in Canada are reported in *Canadian Business* (80(18):26-32 September 10, 2007 www.canadianbusiness.com). In this sixth annual ranking Sherbrooke (QC) emerged at the top of 40 cities ranked, followed by Charlottetown and Saguenay. The leaders in general all achieved their status through low operating costs, a solid business growth environment, and a high quality of life.

- Many of us are required to travel on business. *Business Traveller* recently published its 2008 airline survey (*Business Traveller* Volume 31 2007; supplement 42 pages; www.businesstraveller.com). Information provided is aimed at providing you with an accurate means of comparing the various products offered by airlines. Interesting information on everything from seat configuration, entertainment, passenger power sources, plans of various aircraft, airlines, and emerging trends for the future of business travel.

- Canada with its vast agricultural regions has been known as a supplier of food. In a recent article in the Globe and Mail: Report on Business (24(4): 89-116, November 2007; www.globeandmail.com/robmagazine) a team of authors discuss "The Future of Food: 28 Ideas, Trends And Businesses That Are Changing How And What We Eat." Interesting insights on everything from test-tube meat, to the organic revolution and which industries at positioning themselves for the future of the food industry.

- With the labour shortage in Canada many businesses are turning to guest workers to keep their business working. In: "Welcome To Canada" *The Globe and Mail: Report on Business* (24(3):66-78 October, 2007; www.globeandmail.com/robmagazine) Susan Bourette discusses the issues and experiences of guest workers in Canada. A very detailed and complete report.

- As reported in *HazMat Management* (19(4): pg. 10 Fall 2007; www.hazmatmag.com) Canada now has the pre-eminent training facility for professional firefighters world-wide. The Greater Toronto Airports Authority's Fire and Emergency Services Training Institute located at Pearson International airport opened in April 2007 (www.gtaa.com/en/gtaa_corporate/unique_services/emergency_services/). Its mission is to lead in the education process of emergency services personnel industry and private corporations, enhance workplace safety and the ability to respond to emergencies within their organizations. A large number of courses are provided at their 2,804-square-meter facility that can accommodate 160 students and staff.

About the Author

Terrance Malkinson is a proposal manager/documentation specialist, an elected Senator of the University of Calgary, a Governor of the Engineering Management Society, international correspondent for IEEE-USA Today's Engineer Online, editor-in-chief of IEEE-USA Today's Engineer Digest, and editor of IEEE Engineering Management. The author is grateful to the Haskayne School of Business Library at the University of Calgary. He can be reached at malkinst@telus.net .

Wind Power Technology – State of the Art

By *Yongqiang Lang[1], Bin Wu[1] and Navid Zargari[2]*
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Abstract

Wind energy is one of the most promising and fastest growing energy resources in the world. Wind power generation does not produce any greenhouse gas, and has little negative environmental impact. Over the past two decades, a variety of wind energy technologies have been developed, including vertical- and horizontal-axis turbines, fixed- and variable-speed wind energy systems, pitch and stall controls, power converter technologies, and grid integration strategies. Many large wind power generation facilities have been developed worldwide in on-land and offshore wind farms. Accordingly, the size of wind turbines has increased from a few kilowatts to a few megawatts each. This paper provides a comprehensive summary of various technologies developed for wind energy systems as well as technical challenges and trends.

Sommaire

L'énergie éolienne est une des sources d'énergie les plus prometteuses en offrant le plus rapide taux de croissance au monde. La production d'énergie éolienne ne relâche pas de gaz a effet de serre et engendre peu d'effets négatifs sur l'environnement. Lors des vingt dernières années, un grand nombre de technologies éoliennes ont été développées, incluant des turbines à axe vertical et horizontal, des systèmes d'énergie éolienne a vitesse fixe et variable, des contrôles de tangage et décrochage, des technologies de conversion d'énergie, et des stratégies d'intégration au réseau électrique. Plusieurs grands aménagements de production d'énergie éolienne ont été installés à travers le monde sur des sites terrestres et au large des côtes. Ainsi, la taille des turbines éoliennes s'est accrue depuis quelques kilowatts jusqu'à quelques mégawatts chacune. Cet article présente un sommaire exhaustif de plusieurs technologies développées pour les systèmes d'énergie éolienne ainsi que des défis et tendances techniques.

1.0 Introduction

Wind energy has been used for thousands of years for milling grain, pumping water, and sailing at sea. The use of windmills to generate electricity can be traced back to the late nineteen century with the development of a 12 kW dc windmill generator [1, 2]. It is, however, only since the 1980s that the technology has become sufficiently mature to produce electricity efficiently and reliably from the wind. Over the last two decades, a variety of wind energy systems have been developed. This section provides an overview of the wind energy systems, including installation capacity, growth rate, costs of wind power, small versus large wind turbines, and onshore versus offshore applications.

1.1 Installed Capacity and Growth Rate

Wind energy is relatively clean and sustainable. It is one of the most promising and fastest growing energy resources in the world. Fig. 1 shows the total installed capacity of wind power worldwide [3]. The total cumulative capacity of global wind power has increased from 4.8 GW in 1995 to 74 GW by 2006. The 15 GW of new capacity in 2006 was the highest ever in a single year. The wind industry achieved an average growth of around 25% from 2001 to 2006. This impressive growth has been spurred by the continuous cost reduction in wind turbines, the government incentive programs for wind power production, and the public demand for cleaner energy sources.

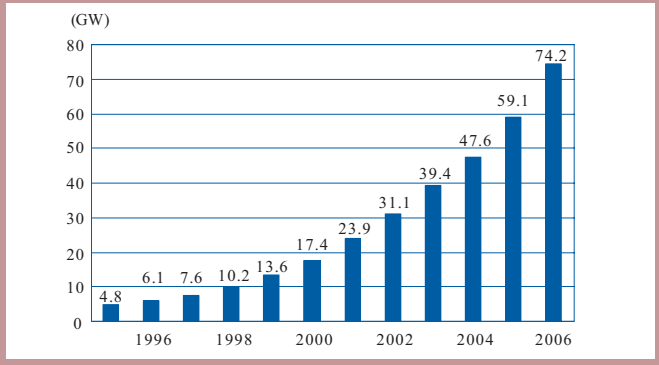

Fig.1 Global cumulative installed capacity of wind power generation.

Fig. 2 shows the cumulative wind power capacity of the top 12 countries as of December 2006 [3]. Europe maintained its role as the largest wind power region.

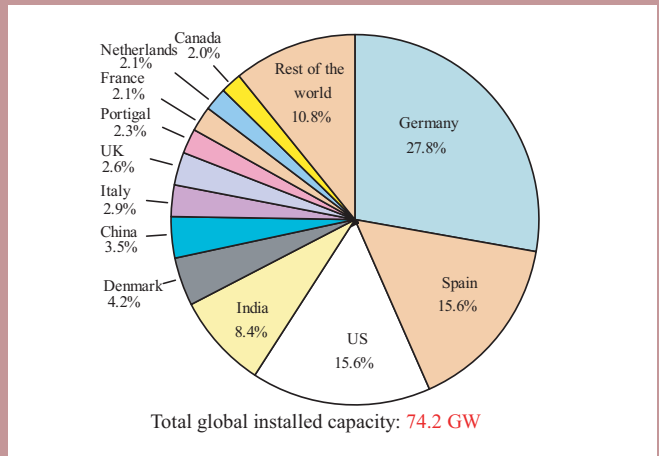

Fig. 2 Top 12 wind power countries as of December 2006.

North America, mainly USA and Canada, accounted for around 17.6% of global wind power capacity. Canada ranked the 12th with a cumulative capacity of 1.46 GW [4]. Asian countries were catching up, mainly driven by the markets in Indian and China.

Fig. 3 shows the top ten countries in new wind power installation in 2006 [3]. The United States made a significant step forward because of the advance of its market that was partially driven by the wind energy Production Tax Credit (PTC) program. Germany, India and Spain were also the leading wind power countries in 2006. China advanced to the 5th position, and Canada ranked the 7th with a newly installed capacity of 0.78 GW, a 113% increase from the previous year. The projects completed in 2006 include a 190 MW Prince Project in Sault Ste Marie, Ontario, a 150 MW Centennial Wind Power Project in Swift Current, Saskatchewan, and a 110 MW wind farm in Baie-des-Sables, Quebec. Fig. 4 shows a picture of Summerview wind farm in Alberta with a total capacity of 120 MW when the project is completed in 2009.

Canadian governments are currently seeking to put in place a minimum of 10 GW of installed wind power capacity by 2015 [4], which would result in a reduction of 12 million tons of greenhouse gas emissions. Canada has a broad geographical area, including windy coasts, plains and mountains with abundant wind resource. Compared to Denmark where 20% of electricity demand comes from wind power, Canada has more than enough wind resource to meet 20% of our electricity demand [5].

1.2 Cost of Wind Power Generation

The cost of electricity from wind power has reduced steadily over the past two decades. When the first utility-scale turbines were installed in the early 1980s, wind-generated electricity cost $0.3 per kWh [6]. Today, wind power plants can generate electricity for $0.07 to $0.12 per kWh [7]. Compared with other clean energy resources, such as photovoltaic (PV) arrays, solar thermal energy and small hydro, wind energy is one of the most economically viable energy resources as illustrated in Fig. 5 [8].

The most important factors in determining the cost of wind-generated electricity from a wind farm are the size of the wind farm, the wind speed at the site, and the cost of installing the turbines. To minimize the electricity cost, each of these factors should be carefully dealt with when a wind farm is built. In the case of offshore wind farms, the distance that power is transmitted to shore is a fourth potentially significant cost element [6].

1.3 Small Versus Large Wind Energy Systems

Wind turbines range from a few kilowatts for residential or commercial use to several megawatts for wind farms. Small wind turbines are normally below 300 kW each, and can be installed at homes, farms and small businesses to offset the consumption of utility power and to reduce their dependence on the utility grid. Small wind power is also suitable for remote areas, where access to the utility is difficult. Small wind power can be used in combination with other energy sources such as photovoltaic cells and diesel generators to form a distributed generation system. Large wind turbines range from 300 kW to a few megawatts each. They are usually installed in wind farms and can generate large amounts of electricity.

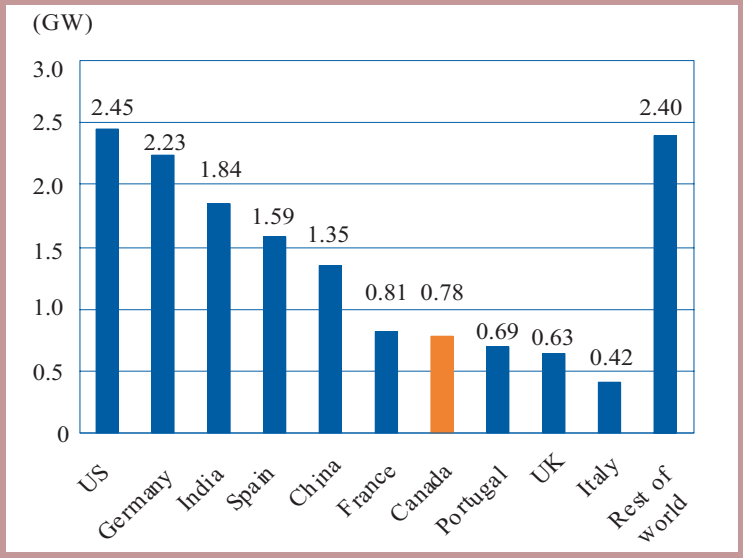

Fig.3 Top ten countries in new wind power installation in 2006.

Fig. 4 Summerview wind farm in Pincher Creek (Alberta)
Photo Courtesy of TransAlta Wind

Item	Small Wind Turbine		Large Wind Turbine
Rated Output Power	10 kW	50 kW	1.7 MW
Turbine Cost	$32,500	$110,000	$2,074,000
Installation	$25,100	$55,000	$782,000
Total Installed Cost	$57,600	$165,000	$2,856,000
Total Cost Per kW Installed	$5,760	$3,300	$1,680
Net Energy Output (MWh/yr)	17.2	85.5	N/A
Energy Production Cost ($/kWh)	$0.31*	$0.18*	$0.075-$0.12
* Calculated with a capacity factor of 20%			

Table 1 Costs of small and large wind turbines

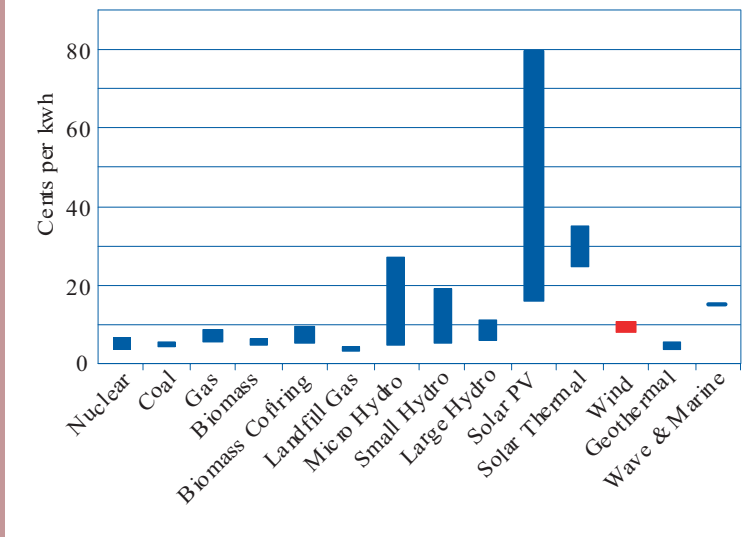

Fig. 5 Costs of different energy sources.

The costs of installation and energy production are determined by many factors. Generally speaking, the larger the wind turbines, the lower the costs. Table 1 gives an example of the costs of small and large wind turbines [9]. The results indicate that the cost of energy production of small wind turbines is higher than that of large turbines, which is one of the reasons for the rapid development of large (megawatts) turbine technology.

1.4 Offshore Versus Onshore Applications

Large wind turbines can find onshore and offshore applications. There are a few reasons for going offshore. One of the main reasons for moving wind farm development offshore is the lack of suitable wind turbine sites on land. This is particularly the case in densely populated countries such as some European countries. The other important reason lies in the fact that offshore wind speeds are often significantly higher and steadier than onshore. Considering the fact that the energy

obtained by wind turbines is proportional to the cube of the wind speed, the turbine generates more energy when operating offshore. In addition, offshore wind resources are enormous. For instance, the offshore wind resources in Europe are several times the total European electricity consumption [10].

The development of offshore wind farms has been slower than the onshore development. By the end of 2006, the total global offshore capacity stood at 878 MW, accounting for only 1.2% of total installed onshore capacity [11]. For offshore wind farms, the foundations and cables add significantly to the total project costs. For instance, in one of the Danish offshore wind farms, wind turbines were placed at 5 to 10-meter water depth. Foundation costs per turbine were 23% of project costs while grid connection costs per turbine were 14% of the project costs [10]. Furthermore, the maintenance costs of the offshore wind farms are generally higher than those of on-land wind farms. The balance between the wind power plant costs and maintenance costs is critical for the viability of offshore wind farm development.

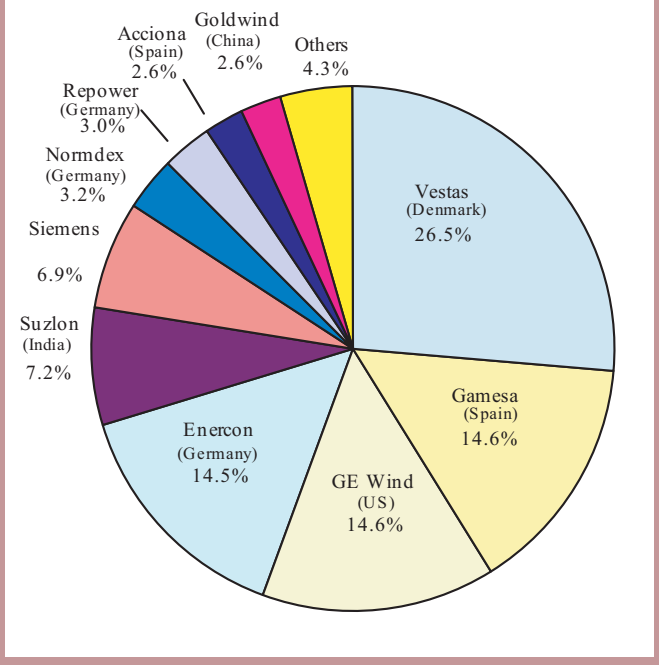

Fig.6 Main wind turbine manufacturers in the global market.

To reduce the installation and maintenance costs of offshore wind power plants, large wind turbines in the megawatt range are preferred. The potential offshore market is the primary drive for the development of large wind turbine technology. Canadian wind energy industry has been mainly focusing on onshore resources.

1.5 Wind Turbine Manufacturers and Market Shares

Fig. 6 illustrates the wind turbine manufacturers and their market shares in 2006 [11]. The top 10 wind turbine manufacturers in the world maintained their overall position. Vestas maintained its leading position. There was a close race for the second position among Enercon, GE Wind and Gamesa. Suzlon was ranked 5th followed by Siemens.

In Canada, Vestas dominated the market before 2006. However, Vestas is being challenged by GE Wind and other companies. With around 566 MW installed wind power in 2006, GE gained 73% market share of new installation, whereas Vestas only had around 25% market share [12]. Siemens is marking solid progress in securing future orders, and has signed contracts to install 199 turbines in Canada.

2.0 Wind Turbine Technology

Wind turbine is one of the most important elements in the wind power generation system. It comes with different designs and characteristics. This section provides an overview of the wind turbine technology.

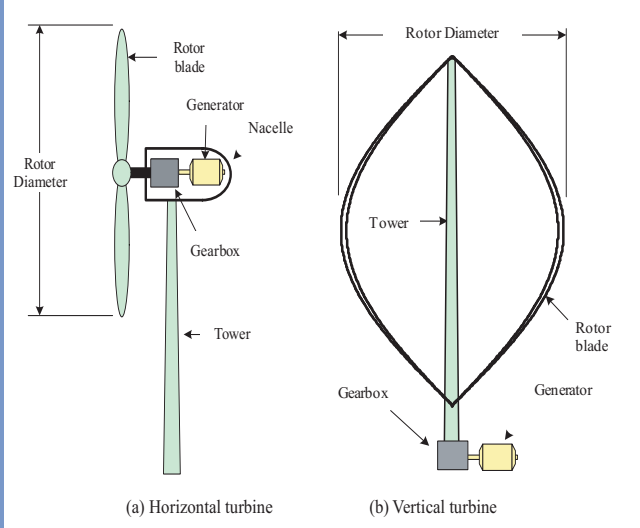

Fig. 7 Vertical- and horizontal-axis wind turbines.

2.1 Horizontal- and Vertical-Axis Wind Turbines

According to the orientation of the spin axis, wind turbines can be divided into horizontal-axis wind turbines (HAWT) and vertical-axis wind turbines (VAWT) as shown in Fig. 7 [13]. A horizontal-axis turbine is primarily composed of a tower and a nacelle mounted on top of the tower. The nacelle normally houses a generator and a gearbox.

For direct-driven wind turbines operating at low rotational speed, the gearbox can be eliminated. In vertical-axis wind turbines, the orientation of the spin axis is perpendicular to the ground. The turbines use vertically mounted, curved airfoils. The generator and gearbox are normally placed at ground level [14].

The two types of wind turbines have different characteristics and performances. A comparison between these two technologies is summarized in Table 2. One of the major disadvantages of the vertical wind turbine lies in its low wind energy conversion efficiency. It is the disadvantage that hinders the practical applications of the vertical-axis turbines. The horizontal-axis turbines dominate today's wind market. In what follows, we will focus our discussion on the horizontal-axis wind turbines.

	Advantages	Disadvantages
HAWT	• High wind energy conversion efficiency • Self-starting capability • Access to stronger wind speeds due to high tower	• High installation cost, strong tower to support heavy weight • Longer cable from the top of tower to ground
VAWT	• Reduced installation cost and easy maintenance due to the ground level gearbox and generator installation • Operation independent of wind direction, yaw device not needed	• Low wind energy conversion efficiency —around half of the efficiency of HAWTs • High torque fluctuations with each revolution • Lack of self-starting capability • Limited options for speed regulation in high winds

Table 2 Comparison between horizontal- and vertical-axis wind turbines

2.2 Fixed Speed versus Variable Speed Turbines

The wind turbines can be classified into fixed speed and variable speed wind turbines. The fixed speed wind turbine rotates at a fixed speed, which is independent of the wind speed. The maximum conversion efficiency can be achieved only at a given wind speed and will degrade at any other operating points. With the variation of wind speeds, the fixed speed turbine generates highly fluctuated output power to the grid, causing disturbances to the power systems. This type of turbines also requires a sturdy mechanical design to absorb high mechanical stresses [15].

Variable speed wind turbines can achieve maximum aerodynamic efficiency over a wide range of wind speeds. The turbine can continuously adapt its rotational speed to the wind speed. In doing so, the tip speed ratio, which is the ratio of the blade tip speed to the wind speed, can be kept at an optimal value for maximum power output.

To make the turbine speed adjustable, the wind turbine generator is normally connected to the utility grid through a power converter system. The converter system controls the speed of the generator that is mechanically coupled to the rotor of the wind turbine. As shown in Table 3, the main advantages of the variable speed turbine include increased wind energy capture, improved power quality and reduced mechanical stress [14]. The main drawbacks include increased manufacturing cost and power loss due to the use of power converters.

	Advantages	Disadvantages
Fixed Speed	• Simple, robust, reliable • Well-proven • Cheap and maintenance-free generator (SCIG)	• Poor energy conversion efficiency • Consumption of reactive power • High mechanical stress
Variable Speed	• High energy conversion efficiency • Improved power quality • Reduced mechanical stress	• Needs power converters, additional cost and losses • Complicated system control

Table 3 Advantages and drawbacks of fixed- and variable-speed wind turbines

2.3 Stall and Pitch Controls

To avoid damage to the wind turbine at very high wind speeds, power control for the turbine is required. There are a number of different ways to control aerodynamic forces on the turbine rotor, including pitch and stall controls [14]. The simplest control method is the passive stall control, where the blades of the turbine are designed such that when the wind speed exceeds a predefined level, the rotor will start to lose power to avoid damage to the turbine. The passive stall control is robust and cost-effective. The power control is smooth due to the slow aerodynamic power regulation. However, the main disadvantage of passive stall control is the reduction of the system efficiency at low wind speeds.

Pitch control is normally used for large wind turbines, where the blades can be turned out or into the wind when the power output becomes too high or too low. This method is effective in controlling the output power of the turbine. The blades can be pitched at low wind speeds to increase the system efficiency, and can be turned into a deeper stall at very high wind speeds to avoid damage to the turbine. The method can also keep the power output close to the rated output power of the generator when the wind speed is in a certain range. The major disadvantages of pitch control include the extra complexity due to the pitch mechanism and the higher power fluctuations at high wind speeds.

Another control method is referred to as active stall control, which is essentially the combination of the two methods mentioned above. This method features effective power control, low output power fluctuations, and ease of performing emergency stops. A comparison between stall and pitch controls is summarized in Table 4.

	Advantages	Disadvantages
Passive Stall Control	• Robust and cheap	• Complex design of blade • Low efficiency at low wind speeds • No startup torque
Active Stall Control	• Smoother power output at high wind speeds • High conversion efficiency • Assisted turbine startup • Easy emergency stop	• Complex control • Increased costs
Pitch Control	• Good power control • High conversion efficiency • Assisted turbine startup • Easy emergency stop	• Complex control • Increased costs • Instantaneous power fluctuation at high wind speeds

Table 4 Advantages and drawbacks of stall and pitch controls

2.4 Wind Turbine Size

Over the past two decades, the size of commercial wind turbines has steadily increased. As summarized in Table 5, a wind farm in the 1980s was typically equipped with 50 kW- 300 kW turbines with rotor diameters of 15m-30m, whereas the power rating of the turbines today has increased to a few megawatts with rotor diameters over 100m [14]. The increase in wind turbine size implies more power output since the energy captured is proportional to the square of its swept area. By increasing the rotor diameter, wind turbine can be deployed to low wind speed locations. In addition, larger wind turbine often results in reduced cost per kW [15].

Year	Capacity (kW)	Rotor Diameter (m)
1985	50	15
1989	300	30
1992	500	37
1994	600	46
1998	1,500	70
2003	3,000	90-104
2004	4,500-5,000	112-126
2007	6,000	127

Table 5 Growth in size in commercial wind turbines

3.0 Wind Energy Conversion

Wind energy systems (WES) have a variety of configurations. They can be classified into three groups from the power conversion perspective: 1) wind energy systems without using power converter technology, 2) wind energy systems using reduced-capacity converters, and 3) wind energy systems with full-capacity converters.

3.1 Wind Energy Systems without Using Power Converter Technology

A typical wind energy system without using power converter technology is illustrated in Fig. 8. A gearbox is used to match the speed difference between the turbine and generator such that the generator can deliver its rated power at a given wind speed. To reduce the cost, a squirrel cage induction generator (SCIG) is often a preferred choice. This configuration can be augmented with a soft starter for smooth grid connection and a three-phase capacitor bank for reactive power compensation.

The rotating speed of the generator is fixed due to the direct connection of the generator to the grid via a transformer. Strictly speaking, the generator speed varies with its output power, but the variation is less than 5% of the rated speed for small generators and within 1% for larger generators. This type of wind turbines is often known as fixed-speed turbines.

To increase the system efficiency, two-speed generators can be employed. By changing the number of pole pairs, the generator can operate at two different speeds depending on the wind velocity, which allows the generator to produce its rated power at two different wind speeds. The wind turbine can be designed with passive stall, active stall and pitch control for system protection and efficiency improvement.

The main advantages of the fixed speed wind energy system are low manufacturing and maintenance costs, while the main drawbacks include: 1) the system delivers the rated power to the grid only at one or two wind speeds, leading to low system energy efficiency; and 2) the power delivered to the grid is fluctuates vastly due to the fluctuation of the wind, causing disturbances to the utility grid. Despite its disadvantages, the fixed speed wind energy system is still widely used in industry with a power rating up to a few megawatts. For instance, a 2.3 MW wind turbine with a two-speed squirrel cage induction generator was installed in 2002 [16].

3.2 Wind Energy Systems Using Reduced-Capacity Converters

To overcome the problems with the fixed speed wind energy systems, wound rotor induction generators (WRIG) with slip power control can be employed to adjust the speed of the generator. There are two designs for the WRIG based wind energy systems: one with variable rotor resistance, and the other with a power converter in the rotor circuits.

A. Wound Rotor Induction Generator with Variable Rotor Resistance

Fig. 9 shows a typical block diagram of the WRIG based system with a variable resistance in the rotor circuit. The generator speed can be controlled by varying the rotor resistance. However, the speed adjustment range is limited with this technique, typically in the range of 0% to 10%

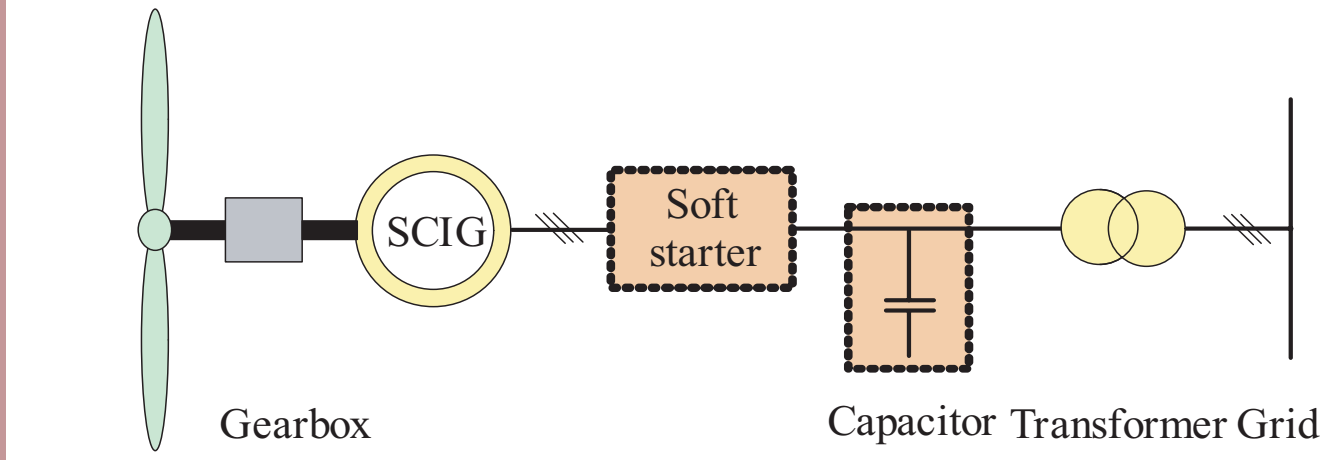

Fig. 8 Wind energy system without using power converter technology

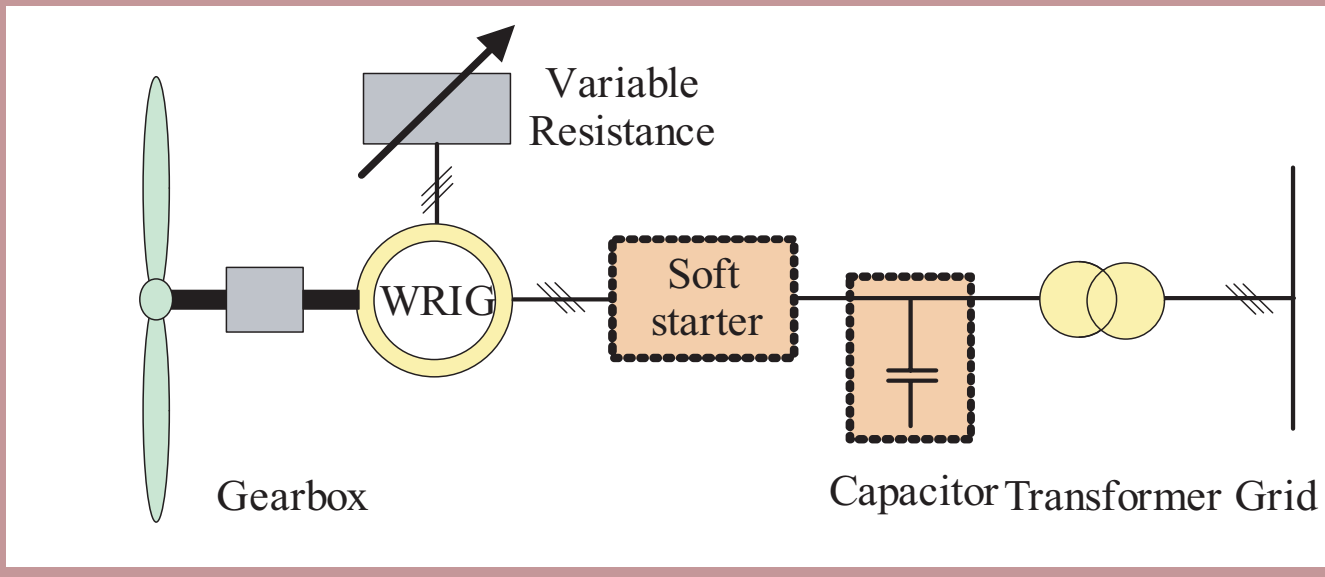

Fig. 9 Wind energy system without Variable Rotor Resistance

above the synchronous speed of the generator. The rotor resistance is normally made adjustable electronically by a power converter. With variable speed operation, the system can capture more power from the wind, but also has energy losses in the rotor resistance. The WRIG wind system has been in the market since the middle 1990's with a power rating up to a couple of megawatts [17].

B. Doubly Fed Induction Generator with Rotor Converter

A typical block diagram of the doubly fed induction generator (DFIG) based wind energy system is shown in Fig. 10. The configuration and operating principle of this system are the same as those of the WRIG system except that the variable resistance in the rotor circuit is replaced by power converters such that the losses on the external rotor resistance can be recovered and sent back to the grid. The power rating of the converters is approximately 30% of the rated power of the generator, resulting in reduced converter cost in comparison to the wind energy systems using full-capacity converters.

The use of the converter also allows bidirectional power flow in the rotor circuit, by which the speed range of the generator is increased. This system features improved overall system efficiency, extended generator speed range, enhanced dynamic performance, and low converter costs. It is these features that render the DFIG wind energy system widely accepted in today's wind market.

3.3 Wind Energy Systems with Full-Power Converters

The performance of the wind energy system can be greatly enhanced with the use of full-capacity power converter. Fig. 11 shows such a system where the generator is connected to the grid via a full-capacity converter. The power rating of the converter is normally the same as that of the generator. With the use of the power converter, the generator is fully decoupled from the grid, and can operate in a wide speed range. This also enables the system to perform reactive power compensation and smooth grid connection. The main drawback of the variable speed wind energy system with full-capacity power converter is a more complex system with increased costs.

Squirrel cage induction generators (SCIG), wound rotor synchronous generators (WRSG), and permanent magnet synchronous generators (PMSG) have all found applications in this type of wind energy systems with a power rating up to a few megawatts. For instance, a 3.6 MW SCIG wind unit was commissioned in Burbo Offshore Wind Farm in 2007 [18], and a 5 MW PMSG has been put into operation since 2004 [19].

Finally, it should be noted that the wind energy system can operate without using gearbox if a low speed permanent magnet synchronous generator with a large number of poles is used. The elimination of the gearbox helps to reduce the total system cost as well as maintenance cost.

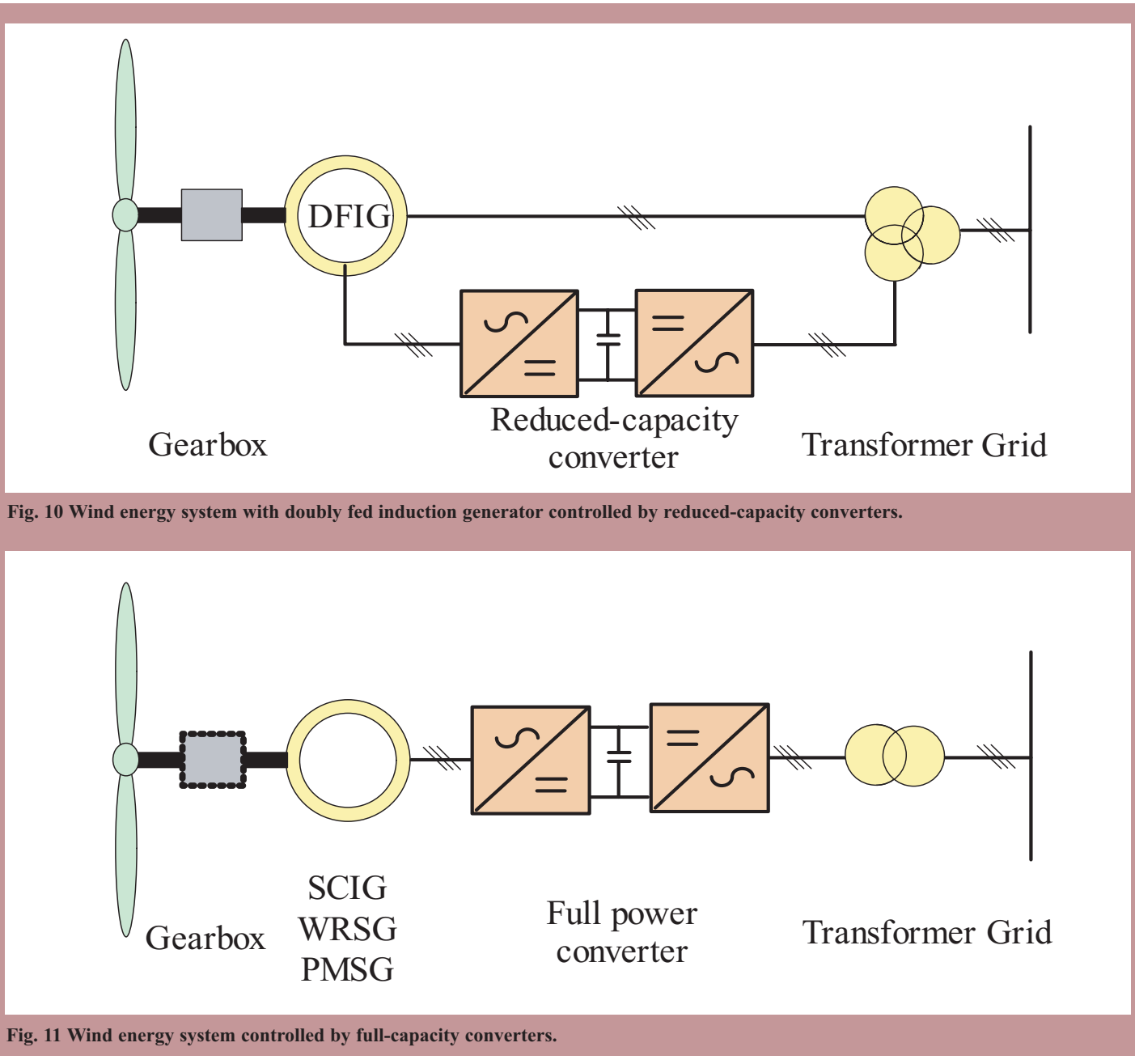

Fig. 10 Wind energy system with doubly fed induction generator controlled by reduced-capacity converters.

Fig. 11 Wind energy system controlled by full-capacity converters.

3.4 Installed Wind Energy Systems in Canada

All the above discussed wind energy system technologies are commercially available. Table 6 provides a summary of various types of wind energy systems installed in Canada.

4.0 Technology Challenges and Trends

There are many challenging issues in developing large wind power generation systems. This section briefly describes some of the challenges and trends in the area of grid code/compatibility, wind forecast, environmental issues, and large wind turbine technology.

Type	Generator	Power rating	Manufacturers	Note
WES without Power Converters (Fixed Speed)	SCIG	600 kW	Vestas	V44-600 single speed
		1.65 MW		NM 82 1.65MW
		1.3 MW	Nordex	N60 Two speed
		600 kW	Turbinewind	Two speed
		750 kW	NEG Micon	NM750/48 NM750/44
		150 kW	Siemens (Bonus)	
WES with Reduced-Capacity Converters (Variable Speed)	WRIG	660 kW	Vestas	V47-660kW
		1.8 MW		V80-1.8MW
	DFIG	1.5 MW	GE	
		3.0 MW	Vestas	V90-3.0MW
WES with Full-Capacity Converters (Variable Speed)	WRSG	600 kW	Enercon	E40 Direct-driven
		2.2 MW		E70 Direct-driven
		2 MW		E82 Direct-driven
		800 kW		E49 Direct-driven
		800 kW		E48 Direct-driven
		900 kW	Americas Wind Energy	AWE 52-900
	PMSG	750 kW	Lagerway	LW52 Direct-driven
		1.2 MW	Vensys	Vensys 62 Direct-driven

Table 6 Summary of installed wind turbines in Canada

4.1 Grid Code/Compatibility

Random change of wind speed in different time scales may cause the fluctuation in the output of wind farms and other power quality problems, all of which have adverse effect on the grid [20]. With high penetration of wind power, the effects caused by the interaction between the grid and wind farms become increasingly important [21]. To be integrated into the grid, wind farms have to meet certain grid code that governs the operation, maintenance and development of the utility grid, and the coordination of the actions of all users of the grid. Requirements in grid code mainly involve wind turbine fault ride through capability, active/reactive power control, frequency regulation, voltage control, power quality, and system protection. Meeting grid code may require technology innovation, which usually increases the complexity and cost of the wind energy system.

4.2 Wind Forecast

Integration of wind farms into the power systems poses a challenge to power system planners and operators [22]. With high level of wind power generation, maintaining the balance between load and generation becomes difficult. Predicting wind as accurately as possible is necessary to avoid balancing problems. Forecasting the output power of wind farms can also help to minimize the cost of power system operation[23]. Wind forecasting has been receiving considerable attention in recent years [15].

4.3 Environmental Issues and Public Acceptance

It is well known that wind energy produces little air pollution and does not contribute to climate change. It is, however, not free of impact of the environment. The impact of environment includes acoustic noises, visual distraction, land use, wildlife, and terrestrial ecosystems [15].

These issues are being addressed by the improved design of wind turbines and layout of wind farms. For instance, acoustics noises generated by wind turbine can be divided into high frequency noise by blade tips, low frequency noise by blade passing towers, and mechanical noise by machinery, especially gearboxes. Efforts are being made to reduce aerodynamical and mechanical noises for modern large wind turbines. Visual impact is a very important factor to the public acceptance of wind turbines. Although different styles of wind turbine have been designed, the horizontal-axis wind turbine with three blades remains popular.

Wind power has been gaining public acceptance. According to the online opinion poll, the public is very positive towards wind power with 96% of the poll in favor of wind power [24].

4.4 Large Wind Turbine Technology

The latest developments in wind technology are primarily driven by the emerging offshore market although the existing offshore market in terms of installed capacity is only around 1.2% of the total onshore installed capacity. The main technology trend is to develop large wind turbines that have low-mass nacelle, large rotor diameter to harness low speed wind resources, high system efficiency, and most importantly, low initial investment and low maintenance costs.

For offshore wind farms, the direct-driven variable speed wind turbine technology seems a dominant technology. It has the benefit of low maintenance cost due to the removal of the easy wear-tear gearbox. However, large-size multi-pole PMSG generators operating at very low rotational speeds should be employed. Total nacelle mass of direct-driven wind turbine increases compared to that of wind turbine with gearbox [15].

Large mass nacelle requires strong tower and foundation to support, resulting in high cost. Hybrid wind turbines with one-stage gearbox can use medium-speed generators. With the decrease in total nacelle mass, the hybrid wind turbines may also find offshore applications in the future.

5.0 Conclusions

This paper presents a comprehensive overview of wind energy systems developed over the last two decades. Various wind power technologies have been introduced, and comparisons have been made between vertical-axis and horizontal-axis turbines, fixed-speed and variable-speed turbine operations, pitch and stall controls, and wind energy systems with different configurations and power converters. The paper also provides a summary of technical challenges and trends.

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Engineers Can Help Stop E-Waste Generation

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Abstract

This article presents a call to consumers of electronic products and engineers who design them to adopt strategies that reduce the quantity of electronic waste generated by such consumption. The impact of this toxic waste on developing countries is particularly acute, and we have a responsibility as a definite portion comes from developed countries.

N.Ed. The opinions and the accuracy of facts presented are the responsibilities of the authors of the article.

Sommaire

Cet article lance un appel aux consommateurs de produits électroniques et aux ingénieurs qui les conçoivent d'adopter des stratégies qui réduiront la quantité de déchets électroniques générés par cette consommation. L'impact de ces déchets toxiques sur les pays en développement est particulièrement aigü, et nous avons une responsibilité car une portion substantielle en provient des pays développés.

N.Ed. Les opinions et la précision des faits présentés sont la responsabilité des auteurs de l'article.

1.0 Introduction

Have you recently replaced your cell phone with a newer model, and are now left with the old model sitting in your closet? Or have you recently upgraded your computer monitor to a flat-screen, and are now wondering what to do with your old bulky CRT monitor? Welcome to e-waste and what you can do about it!

2.0 What is E-Waste and How Much of It Is There?

Electronic waste, better known as e-waste, includes such items as computer equipment, televisions, stereos, home and cellular phones, ipods, and industrial electronics. As faster and smaller technology replaces the slower and bulkier models of electronics, increasing amounts of e-waste are being generated. Studies commissioned by Environment Canada reveal that e-waste accounts for more than 140 000 tonnes of waste each year in Canada [1]. Assuming an average weight of 5 kg per electronic device, that's roughly one electronic device thrown out by each man, woman and child every year in Canada. A recent study estimates about 20,000 tonnes of e-waste (not accounting for hand-held electronics) was generated in the GVRD [2]. In the US, the number is estimated at 5-7 million tonnes, and rising at 3-5% per year [3]!

3.0 Why is E-Waste a Problem?

Not only is the sheer volume of waste a concern, but the electronic equipment contains toxic metals, such as lead, cadmium, chromium, and mercury, and organic chemicals, such as brominated flame-retardants (BFRs). Effects to humans and wildlife from exposure to these materials include subtle neurobehavioural effects for lead, chronic kidney damage for cadmium, and sensory or neurological impairments for mercury. Lead also affects the central nervous system and kidneys, while mercury can lead to brain damage, birth defects, kidney failure, respiratory harm and liver damage. BFRs are highly toxic, persistent, and bioaccumulative, and are potential endocrine disruptors [4] (i.e., chemicals that interfere with the hormonal system that helps guide the development, growth, reproduction, and behaviour of animals and humans). If the waste is not handled properly, these toxins can end up in the landfills and leach out into our groundwaters, or be exported to developing countries, where the environmental regulations are less stringent and workers and the environment are readily exposed [5]. Some alarming conclusions have been drawn by the Basel Action Network (BAN) after conducting e-waste recycling investigations in countries such as China and Nigeria about the fate of e-waste and the receiving environment, as underlined by the accompanying photos [6].

Figure 1: A sea of television housings, cathode ray tubes, computers, monitors and other imported electronic waste not salable at the Alaba market in Lagos, Nigeria, is dumped here in a nearby swamp. ©*Basel Action Network 2006*

The Basel Action Network is a non-profit organization based in Seattle (WA) that looks at the human and economic cost of the dumping of toxic waste and pollution on the world's poorest regions, and promotes sustainable strategies to modify rich countries' consumption and waste patterns. The movie at http://www.ban.org/films/TheDigitalDumpTrailer.html makes their point quite graphically [6].

4.0 What is Being Done about E-Waste?

In Canada, international export of such products is regulated by the Federal Government, while the Provinces set rules for domestic disposition. In February 2006, the BC Government added computers, computer monitors, computer peripherals, and televisions to the Recycling Regulation making industry responsible for the lifecycle management of their products. British Columbia's regulation for e-waste recycling came into effect in August 2007.

On August 1, 2007, the industry organization, Electronics Stewardship BC, a member of Electronics Product Stewardship Canada (EPSC) – a not-for-profit organization working to design, promote and implement sustainable solutions for Canada's electronic waste problem – launched a province-wide used electronics recycling program, called "Return-It Electronics" (similar to existing Return-It depots for bottle recycling). BC customers now pay a surcharge on new TVs, computers, and printers to cover the cost of environmentally sound recycling of metals, glass, and plastics [7]. There is no charge to bring electronics in for recycling. Electronic equipment that is accepted at Return-It Electronics depots includes comput-

Figure 2: Children standing in front of smoldering electronic waste dump just outside of the Alaba market in Lagos, Nigeria. Burned electronic waste produced polycyclic aromatic hydrocarbons, dioxins and heavy metal emissions - carcinogenic and highly toxic chemicals. These children live next to the dump. ***© Basel Action Network 2006***

ers, computer monitors, printers, fax machines, and televisions. The program is similar to Alberta's recycling program, which was established in 2004.

In response to the growing concern over the mounting volumes of e-waste, EPSC has created environmental stewardship programs across Canada, which invest in design-for-environment improvements to their products and processes, and establish a vendor qualification program (for e-waste recycling companies) for the responsible recycling of end-of-life electronics.

In Europe, the Waste Electrical and Electronic Equipment (WEEE) Directive governs the handling of electronic goods at the end of their useful life. In contrast to the Canadian solution, which tends to transfer e-waste management responsibility onto e-waste recycling companies, the WEEE Directive is based on the principle of producer responsibility, compelling the manufacturers to take back their products for repair, reuse, refurbishment/upgrading, disassembly and recycling in an ecologically friendly manner [8].

Currently in BC, the non-profit organization Computers for Schools, accepts donations of used computer equipment in working condition [9]. There are also several recycling companies that collect end-of-use electronic equipment for disassembly and recycling of components, including Genesis Recycling of Aldergrove and TechnoTrash Recycling of Port Coquitlam. Some municipal recycling depots may accept electronics for recycling. For example, Burnaby is piloting an e-waste bin at their Recycling Depot.

Teck Cominco has also taken up the challenge, and is converting e-waste into a non-precious metals resource by shredding and thermally decomposing all plastics in a 1250oC furnace and recovering some of the metals at its Trail operations. Throughout the process, resulting gases are scrubbed and cleaned so that virtually no harmful pollution is emitted from the furnace stacks into the air [10].

5.0 What Can You Do About E-Waste?

5.1 As a User of Electronics:

- Reduce consumption: consider whether you really need to upgrade yet or whether you really need the item; decide not to upgrade the technology you own every time a new model appears on the market.
- When making a purchase, think about what you will do with the electronic item at the end of its useful life.
- Select electronics that are environmentally friendly (e.g., use less energy, produce less waste, are produced of recycled content, and are recyclable), even if you need to spend a bit more.
- When selecting electronics, use the Electronic Product Environmental Assessment Tool (EPEAT©) that certifies their environmental attributes (i.e., a performance rating system similar to LEED® for the built-environment). http://www.epeat.net/
- Upgrade a component instead of upgrading the entire item or system.
- Donate good quality recent equipment to schools through the Computers for Schools program. http://www.cfsbc.ca/
- Donate working or broken computer equipment for refurbishment or recycling to Free Geek Vancouver community organization. http://www.freegeekvancouver.org/
- Effective August 1, 2007, when the new Products Stewardship program by Electronics Stewardship BC came into effect, you may drop off any of the regulated products at Return-It Electronics identified collection locations without charge, and be assured they will be recycled responsibly. http://www.encorpinc.com/electronics/
- Return unwanted equipment to the brand manufacturer, sometimes at a fee, or a fee to cover shipping only. Manufacturers with a recycling program include Apple, Canon, Dell, Epson, HP, IBM, Lenovo, Lexmark, Sony, Toshiba. See http://www.epsc.ca/r_links.html for links to these manufacturers' recycling webpages.
- Take unwanted equipment to large electronics stores on 'take-back' days. Watch for information on local programs in your area.
- Ensure that e-waste recyclers are not trans-shippers in disguise, and that their e-waste has a trusted destination (i.e., not an open air dump in China or Africa with small children with hammers and blow torches salvaging valuable metals). The upcoming Product Stewardship program will assist with this.
- Plan for the biggest planned obsolescence, when analog TVs will be obsolete in 2009, e.g., postpone replacing your TV until closer to the date to give the analog model a longer life-span and wait to discard it until a recycling program for analog TVs is in place.

Figure 3: Women picking through wires torn out of computers. The wires are sorted by day and burned by night in this village. The families live right in the burnyards. Cancer causing polycyclic aromatic hydrocarbons and dioxins will result from burning wires made from PVC and brominated flame retardants. ***Guiyu, China. © Basel Action Network 2006***

Figure 4: Woman about to smash a cathode ray tube from a computer monitor in order to remove the copper laden yoke at the end of the funnel. The glass is laden with lead but the biggest hazard from this is the inhalation of the highly toxic phosphor dust coating inside. Monitor glass is later dumped in irrigation canals and along the river where it leaches lead into groundwater. The groundwater in Guiyu is completely contaminated to the point where fresh water is trucked in constantly for drinking purposes. ***Guiyu, China. © Basel Action Network 2006***

5.2 As a Designer of Electronics:

- Design products as if though you knew that the item will be returned to you and you will be tasked with either fixing it, upgrading it, or transforming it into the next generation of the product – and so that you would be proud to have the product returned to you at the end of its useful life.
- Use recycled or renewable raw materials and energy.
- Extend product life by designing products to be durable, upgradeable and repairable.
- Design for decomposition by designing for recycling / easy disassembly: To reduce the time required for disassembly, reduce the number of screws and screw types (ensuring that the minimum number of screws keeps the product together even when repeatedly dropped), minimize gluing and welding of different parts (especially lead-based solder), and instead, use more snap-fit and modular parts. Design products that self-dismantle when triggered (i.e., active disassembly) [11]. To facilitate recycling of the plastic, use international standards for marking parts that identify plastic resin types (i.e., label plastics like on beverage containers). Avoid painted and varnished plastic material to maintain the value of plastics for recycling. Choose highly recyclable materials such as aluminum. Design equipment casing to be stackable to minimize the warehouse space required at recycling plants.
- Reduce or eliminate the use of toxic materials, including materials that become toxic when they start to break down (e.g., lead in CRT monitor glass, lead in solder, brominated fire retardants).
- Select lightweight metals for exterior casings instead of plastic to eliminate the need for flame retardants without compromising fire safety. Currently under research are biobased (vegetable-based) plastics that may negate the need for brominated or phosphorus-based flame retardants, and would be biodegradable (e.g., corn-based bio-plastic and kenaf fibres for strength and heat resistance).
- Eliminate or reduce lead and lead soldering: tin/silver/copper alloy is one alternative that is replacing the tin/lead solder used to attach electronic components.
- Eliminate or reduce the use of polyvinyl chloride (PVC), which is often used in cabling and power supplies, and which produces dioxins and other toxic chemicals when burned uncontrolled during "recycling" in off-shore countries.
- Reduce the use of mercury in fluorescent lamps, such as those used in the backlighting system of most liquid crystal display (LCD) display panels, and instead use organic light-emitting diode (OLED) lights, such as those used in cellular phones and notebook computers.

Be part of the solution, not part of the problem! As an engineer, design electronics so they will be considered a resource at the end of their useful life instead of being treated as e-waste.

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How Green are Compact Fluorescent Lamps?
Taking a closer look into the subject uncovers potential shortcomings

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Abstract

Are compact fluorescent lamps bright green or greyish green? Although energy savings can be obtained by using them under certain conditions, those savings largely disappear in cold climates. Those lamps also present a number of shortcomings, including their containing mercury – raising the question of their safe disposal, and the undesirable harmonics they feed back to the power grid. Manufacturers and governments are called on to tackle those problems.

Sommaire

Est-ce que les ampoules compactes fluorescentes sont vert brillant ou verdâtres? Quoique des économies d'énergies puissent être atteintes sous certaines conditions, ces économies disparaissent essentiellement en climat froid. Ces lampes présentent aussi nombre de défauts, incluant le fait qu'elle contiennent du mercure – soulevant le problème de leur mise au rebut sécuritaire, et les harmoniques indésirables qu'elles introduisent dans le réseau électrique. Les manufacturiers et gouvernements sont interpellés pour qu'ils s'attaquent à ces problèmes.

1.0 The Case for Energy Savings

The Canadian Prime Minister, the Right Honourable Stephen Harper, has proposed to ban the incandescent bulbs from the Canadian market. This proposition replicates a similar plan announced by Australian government to ban incandescent light bulbs and replace them with more energy efficient fluorescent lamps. The switch from low efficiency incandescent bulbs to higher efficiency compact fluorescents aims to provide a substantial reduction of electric energy consumption and a corresponding reduction of greenhouse gas emissions.

Figure 1: Various designs of compact fluorescents are now available

Compact fluorescents are approximately four times more efficient than the 125 year old bulb. A 23 W compact lamp emits approximately the same amount of light than a 100 W bulb. The standard incandescent bulb has a luminous efficiency of more or less 25 lu/W while recent compact fluorescents reach 100 lu/W. The improvements in efficiency were obtained by reducing the tube diameter and by the use of high frequency (50 kHz +) electronic ballasts. The ballast is located in the base of the lamp and the component count is around 20. The published life expectancy of the fluorescent lamp is usually 5000 hours while the incandescent bulb last around a thousand hours. Table 1 shows a comparison of the light emitted by compact and incandescent bulb for various power ratings. (These figures slightly vary from one lamp manufacturer to another.)

Compact fluorescent	Incandescent bulb	Light
7 W	40 W	400 lu
9 W	60 W	550 lu
11 W	70W	600 lu
13 W	75 W	700 lu
15 W	80 W	850 lu
18 W	95 W	1000 lu
20 W	100 W	1250 lu
24 W	120 W	1400 lu

Table 1: comparison of compact and incandescent bulbs (from lamp manufacturers' commercial data)

There are several ways to estimate the energy economy obtained from replacing incandescent bulbs by compacts lamps. First, we can compare the energy saved by a single 25 W, 5000 hours compact lamp replacing five 100 W, 1000 hours incandescent bulbs. The energy saved is:

$$Q_{saved} = \frac{(100\text{W} - 25\text{W}) * 5000\text{h}}{1000\text{W/kW}} = 375\ \text{kWh}$$

At 8 cents a kilowatt-hour, for example, it represents an economy of $30; this is roughly the saving proposed on lamp packages. The higher lamp cost is rapidly offset by the potential savings.

A second approach will be to estimate the energy that can be saved in Canada each year if we totally ban the incandescent lamps in residential dwellings. Considering that the population of Canada is over 33 millions inhabitants, lets assume for our model the number of households to be around 10 millions. If there are twenty 60W bulbs per household and if these bulbs are "on" for an average of 1.5 hours per day, the energy consumed by these bulbs in Canada is:

$$Q_{year} = 10^6 \cdot 20 \cdot 60\text{W} \cdot 1.5\ \text{h} \cdot 365\ \text{days/year} = 6.6\ \text{TWh}$$

Comparing this last figure to the total annual Canadian electricity production which is 550 TWh (of which Quebec's portion is 225 TWh and Ontario's is 150 TWh), it corresponds to 1.2 % of the total electricity produced. Therefore, replacing all the bulbs could yield a reduction of 1% of our energy consumption and a substantial reduction of green house gas emissions! However…

2.0 A Question of Climate

Are such potential savings realistic? Well, it depends on where we live on planet Earth. The answer is yes for a country like Australia where the weather is mostly warm year-round and expenses for air conditioning far exceed heating expenses, and where the electrical energy is mainly produced from fossil sources. However, the situation is drastically different in Canada.

Canadians live in a much colder climate and use energy for heating quite a bit more than for air conditioning. Moreover, a large fraction of our electric energy is produced by hydraulic dams or nuclear reactors, both of them emitting only minute amounts of greenhouse gases. On top of that, in large areas of the country, we heat our houses with electrical heaters which are not far different from light bulbs – both of them being constructed from simple resistors.

In winter in Canada, turning off a bulb, either incandescent or fluorescent, does not result in any energy saving; the electrical heating system or the oil or gas furnace just increases its output to compensate the energy that was produced by the bulbs. In fact, in several large commercial buildings, the energy lost by lighting systems constitutes one of the main heating sources. In all-electric houses, during all the period when the heating system is "on", replacing the bulbs won't yield any energy saving!

Some savings are expected if only heat pumps, air conditioning equipment or bi-energy heating systems are used. In these cases, total energy savings would be considerably smaller than those previously estimated.

In some cases, replacing the bulbs can even increase the total amount of greenhouse gases emitted. Imagine a house heated by an oil furnace and located in an area where electricity is produced by a nuclear plant. If the incandescent bulbs are replaced by compact fluorescents and, assuming the same data previously used, a decrease in the electricity bill of approximately 250 kWh (20$) can be expected over a six month winter period. However, this energy must now be produced by the oil furnace and will increase the overall CO^2 emissions.

3.0 Electronic Waste and Other Shortcomings

Compact bulbs contain a drop of mercury (less than 5 mg) and should be considered dangerous waste at the end of their useful life. The bulbs sold in Europe bear a pictogram indicating that the lamp should not be through away in the usual garbage bin but must be returned to the store and recycled. This is not yet the case here.

Now, consider the following extracts from the package of a compact bulb sold in Canada and bearing a 2007 copyright mark:

'Do not use bulb where exposed to water or outdoors without an enclosed fixture. This device is not intended for use with emergency exit fixtures or lights and dimming devices. Reliable starting to -15ºC. A short-warm-up period is needed to reach full brightness.'

'Although this product complies with Part 18 of FCC Rules, interference to televisions, radios, wireless, telephones, and remote controls is possible. Avoid placement of this product near those devices. If you encounter interference, use product away from the device or plug either in a different outlet…'

The bulbs actually found in the market are plagued with several shortcomings.

- They are not suitable for use in the Canadian cold.
- They should not be used in a totally enclosed recessed fixture.
- The lamps cannot be connected to standard dimmers.
- There is a short delay between the turn on moment and full intensity operation.
- The intensity of the output light gradually decreases with aging.
- There are concerns about their real lifetime and about some catastrophic failure modes.
- The electronic ballast can cause electrical interferences.
- Those bulbs are a severe source of harmonics. In fact, per watt consumed, they inject in the distribution system more harmonics than the other usual electronic loads.

4.0 Harmonics

The last point is one of the less known drawbacks of this type of lamps, and some explanations are needed. Figure 2 shows the instantaneous current drawn from a 120 V outlet for a 23 W, 120 V, 60 Hz compact lamp. The rms value of this current is 360 mA. Note that a standard 23 W resistor will draw a current of only 192 mA at 120V.

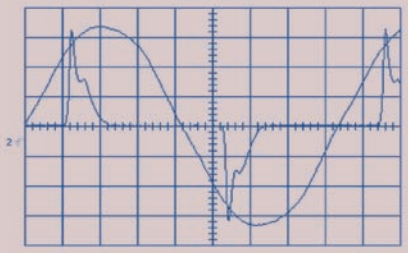

Figure 2: Compact fluorescent instantaneous voltage and current (50 V/div, 2 A/div, 2 ms/div)

The electrical characteristics of both bulb types are given in Table 2. The harmonics spectrum of the compact lamp current appears on Figure 3; it is worse than the current of non compensated switching power supplies.

Low cost solutions are available in order to transform these distorted current into almost pure sine waves. The lamp manufacturers do not incorporate them into their designs because the existing standards do not force them to do so.These compensation techniques have been applied to switching power supplies for computer and other electronic equipment and to electronic ballasts for standard fluorescent tubes. The effects of harmonics in distribution systems are well known: Poor power factor, additional losses, neutral currents, voltage distortion, life reduction of various apparatus such as power factor correction capacitors and electronic equipment, and interference; see IEEE Std 519. The potential proliferation of hundreds of millions of dispersed harmonics sources is definitely not good news.

	23W compact fluorescent	Standard 60 W bulb
Voltage	120 V	120 V
Current	360 mA (rms)	0.50 A
Harmonic current	300 mA (rms)	0
Fundamental current	213 mA (rms)	0.50 A
Apparent Power	41.5 VA	60 VA
Real Power	22.5 W	60 W
Reactive power	- 11.6 var	0
Power factor	0.48	1.0
Displacement power factor	0.88 (capacitive)	1.0
Distortion factor	0.54	1.0
Total harmonic distortion (Thd)	140%	0

Table 2: Electrical characteristics of compact and incandescent bulbs

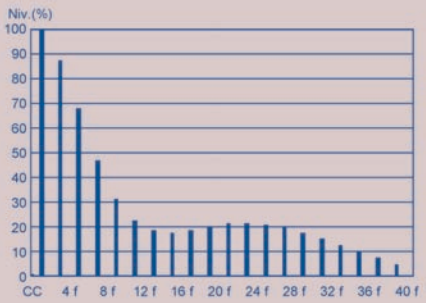

Figure 3: Harmonic spectrum of the current of a 23 W compact lamp

5.0 Conclusion and Recommendation

Manufacturers will certainly be able to address and correct some of the problems listed here. However, for the moment and considering these factors, we can hardly consider compact fluorescent bulbs green. Let us remember that the good old-fashioned, 125-year-old, incandescent bulb does not exhibit any of the problems mentioned in this article.

Before incandescent bulbs get banned, manufacturers should be made to significantly improve alternative products. Regulatory agencies should develop and enforce more stringent standards addressing safety and harmonics proliferation concerns and, finally, governments, both federal and provincial, should ensure that effective recycling networks are developed and that appropriate incentives are in place.

Unfortunately, even if all the preceding recommendations are applied, the benefits in terms of electricity production and greenhouse gas reduction in Canada will be far less than first expected.

About the Authors

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Achieving the Right Balance Between Process Maturity & Performance

By *Louis A. Poulin*
Chief Technology Officer, GRafP Technologies Inc.

Abstract

The Capability Maturity Model Integration (CMMI*) for Development Version 1.2, which integrates bodies of knowledge that are essential for development and maintenance, has become the de facto standard in the world for organizations developing products and providing services relying heavily on technology. Organizations in Canada have come to recognize that in order to survive and to grow, they need to demonstrate to their clients that they are among the best. If not, they run the chance of becoming the next outsourcing statistic. Likewise, organizations in developing countries in Asia, South America and Eastern Europe that provide outsourcing services also need to demonstrate to their clients in North America and Europe that they are among the best in the world, in order to benefit from outsourcing opportunities.

This paper summarizes observations made in the course of 58 assessments in Canadian organizations based on the CMMI* and on its predecessor, the CMM*. It stresses, among other things, the challenges faced by these organizations in optimizing ways to improve the quality of their products and services using the CMMI as a starting point.

Sommaire

Le Capability Maturity Model Integration (CMMI*) pour le Développement version 1.2, qui intègre des corpus de connaissances essentiels au développement et la maintenance, est devenu le standard mondial de facto pour les organisations développant des produits et fournissant des services basés fortement sur la technologie. Des organisations au Canada en sont venues à reconnaître que pour survivre et croître, elles doivent démontrer à leurs clients qu'elles sont parmi les meilleures. Sinon, elles courent le danger de devenir la prochaine statistique d'impartition. Également, des organisations dans des pays en développement en Asie, Amérique du sud, et Europe de l'est qui fournissent des services d'impartition doivent aussi démontrer à leurs clients en Amérique du nord et en Europe qu'elles sont parmi les meilleures au monde afin de bénéficier des opportunités d'impartition.

Cet article fait la synthèse d'observations faites dans le cadre de 58 évaluations dans des organisations canadiennes basées sur le CMMI* et son prédécesseur le CMM*. Il insiste, entre autres, sur les défis auxquelles ces organisations font face dans l'optimisation des façons d'améliorer la qualité de leurs produits et services en utilisant le CMMI comme point de départ.

1.0 Introduction

In July 2000, a research paper [1] that consolidated the results of 30 assessments we conducted in Canada in a period ranging from 1993 to 1999 showed that development initiatives in the Information Technology (IT) field had a 34.3% probability of experiencing serious schedule or budget problems, or problems related to products or services that did not adequately satisfy their requirements. This 34.3% value corroborated the finding made by the Standish Group International in 1995 [2] to the effect that 31% of IT projects were canceled before completion in the United States. From 2001 and on, we tried to gain a better understanding of the factors that contributed the most to the success, and sometimes failure, of organizations, particularly when they implemented development models, such as the CMMI*[3], Control Objectives for Information and related Technology (COBIT) [4], Six-Sigma [5], and Information Technology Infrastructure Library (ITIL) [6], or development standards such as ISO 9001, ISO 12207 and ISO 27001 (also known as ISO 17799 [7]). Implementation of such models and standards can be very taxing, particularly for small and medium enterprises. Even though they are sometimes required in order to demonstrate to potential clients the capability of an organization, the work we had performed with enterprises over several years suggested that there was a better way than traditional audits to demonstrate that capability. In particular, our work focused on understanding how processes suggested by these models and standards can be optimized taking into account the context in which an organization operates, and the market forces and other constraints to which it is subjected.

2.0 On Process Engineering and Optimization

Process Engineering and Optimization consists of devising the most efficient and effective ways of integrating material and human resources, methods, procedures and tools in order to achieve a given objective.

An optimal process is one that allows an organization to maximize the outcome offered by opportunities it has of meeting its business objectives, and to minimize the number and severity of problems it has to deal with in the course of pursuing these objectives. Process engineering and optimization is meaningless without having this definition in mind.

This is closely related to risk, since an optimal process can also be described as one that allows an organization to prevent undesirable situations from happening, and desirable situations from not happening.

One of the models used to optimize product development processes is the CMMI* for Development. The CMMI has five maturity levels as defined in Table 1 on page 24.

3.0 Optimal Processes

An optimal process, as defined above, is a theoretical concept. In order to be applied, the term "Process Capacity" also needs to be defined.

In theory, it is possible to envision a model describing an optimal process specifically designed for a given business area, for instance, software development. This process will then be associated with the ability of undertaking the development of a given range and a given scope of software products, in a way that will maximize the growth opportunities these products offer, while minimizing the number and severity of problems encountered during development and commercialization.

However, few organizations, if any, may have the capacity of implementing such a model. For instance, it may be found that an organization masters only 25% of the process suggested by this model. Which 25% can make an enormous difference. In order to achieve this ratio of 25%, referred to in this case as "Process Capacity", the organization may have implemented the process suggested by the model such that each practice making up this process is implemented in a way that satisfies 25% of its intent. Alternatively, some practices may be fully satisfied (i.e. 100%), some others may only be partially satisfied (e.g. 50%), and others yet may not be implemented at all (e.g. 0%), such that the resulting average is 25%. A higher percentage indicates that the organization has the ability to undertake the development of a larger range and broader scope of products for which the model was initially developed.

Data collected with respect to the CMMI* and other models suggest practices are not all equal, given the context in which an organization operates. Some practices have high risk-mitigation potential, in the sense that they are better at preventing undesirable events from happening, and desirable events from not happening in this given context.

It then becomes that much more important to identify which processes result in an optimal outcome for a given organization, taking various parameters into consideration, such as the business context in which the organization operates, the types of products that are being developed, resources available to the organization, and its culture.

* CMMI, CMM, and Capability Maturity Model are registered trademarks of the Software Engineering Institute

Given that a process typically consists of a large number of practices, the optimal set is one of a very large number of possible combinations. For example, if a process is made up of 100 practices that can be applied to take advantage of 50 opportunities and to prevent 50 problems from occurring, and if the importance of each practice, the potential of each opportunity, and the consequence of each problem are characterized using a scale of 5 degrees of significance (e.g. very important, somewhat important), a total of 250,000 combinations must each be examined to determine the optimal process. Furthermore, if the degree of each practice implementation and the likelihood of each opportunity and each problem are quantified with three bits (i.e. 8 levels, for example six increments of 20%, an unknown status, and a not applicable status), the number of combinations increases to 16,000,000.

Level	Characteristics
Initial	The process is informal and largely improvised, and performance is unpredictable.
Managed	A process is defined within the scope of each undertaking (e.g. task, work package, enhancement, project). Focus is placed on stabilizing the approach used to carry out the work associated with each individual undertaking. This approach may substantially differ for each undertaking, even within a given category, and this is acceptable at maturity level 2.
Defined	An organizational process is in place and consequently, the emphasis is directed at defining such a process from the best practices implemented in connection with past and current undertakings. The resulting process is then adapted to the needs of each new undertaking. Maturity level 3 also stresses the establishment and use of a repository in connection with future work, in which the data gathered as part of performing the work is consolidated.
Quantitatively Managed	The process defined at maturity level 3 is instrumented, quantified and characterized statistically, and the focus is placed on controlling the process outputs with respect to statistical parameters. When enough information has been gathered on the process, its outputs can be monitored in order to determine whether or not they are under control, in the sense that the measurements that characterize them fall within the allocated ranges for the categories of undertakings in the organization.
Optimizing	The quantitative data is used to improve the process by tightening the control parameters established at maturity level 4, in order to improve productivity and reduce costs. The causes of random variations observed with collected measurements are investigated in order to determine if they can be removed or reduced, which would result in a more accurate planning, more efficient execution, better products and a more capable process. Continuous improvement becomes a way of life in order to satisfy the business objectives of the organization.

Table 1: The five CMMI maturity levels.

4.0 Generalization of Information Theory Principles

Our involvement in process engineering and optimization has led to the generalization of a theorem, which was established at the Massachusetts Institute of Technology by Claude E. Shannon in 1948, and dealt with the transmission of information in noisy channels [8]. This theorem, although less well known, represents for the field of communication what Einstein's relativity theory represents for the field of physics.

The generalization of Shannon's theorem applied to product or service development leads to the following conclusion:

For any organization, there is at least one process that will allow that organization to reduce to an arbitrarily low value the risk of not being able to fulfill its business objectives, as long as this process does not exceed the capacity of the organization to apply it.

In other words, there is at least one set of key practices that will allow an organization to fulfill its objectives, in light of the constraints that characterize it, such as the business context in which the organization operates, the types of products it develops or services it provides, its available resources, and its culture. This is summarized by the two graphs presented in Figure 1 and Figure 2.

It is assumed in these graphs that the organization can deal with a likelihood of not being able to fulfill its business objectives less than or equal to 20%. This is defined as the margin of efficient operation.

Figure 2 shows that even for an organization characterized by a low process capacity, a good process results in a likelihood approaching zero that the organization will not fulfill its business objectives.

The difficulty, and this directly stems from Shannon's theorem, is that the optimal set of key practices for a given organization is unknown a priori. To make matters worse, it is reasonable to assume that the optimal process is not static but is organization-dependent and time-dependent, and will have to be modified as the context in which the organization operates evolves.

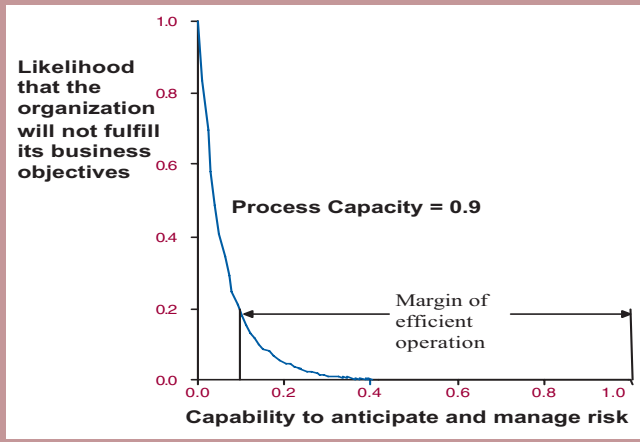

Figure 1 – Organization with a high process capacity

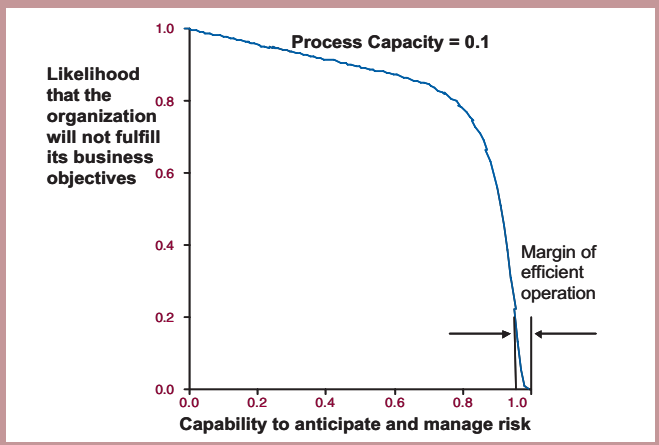

Figure 2 – Organization with a low process capacity

Any significant deviations in the way the process matches the opportunities to exploit or the problems to prevent, which may have been caused by the loss of a few key personnel or a change in market conditions, result in the likelihood that the organization will not fulfill its business objectives suddenly increasing to an unacceptable value.

There is obviously a cost in minimizing the likelihood that an organization's business objectives will not be fulfilled. In a way similar to encoding and decoding schemes that are devised to correct errors in information transmitted over a noisy communication channel, without directly contributing to the quantity of transmitted information, processes that do not directly contribute to fulfilling business objectives must be devised to prevent undesirable situations from happening, and desirable situations from not happening.

5.0 Example

Assume that Figure 1 represents Organization X, the industry leader in a given business area, and Figure 2 represents Organization Y, a small enterprise in the same business area.

The degree to which good business practices are applied, in the case of Organization X, is very high, which explains the high concavity of the curve. For Organization Y, this takes the form of a convex curve indicating the low capacity of its process. From its past performance, it can also be assumed that the degree to which Organization X is capable of anticipating and managing undesirable situations that are liable to happen, and desirable situations that liable not to happen, is also very high. Therefore, the projection of this value on the graph displayed in the right part of Figure 1 translates into a very low likelihood that Organization X will not fulfill its business objectives. Based on this graph, one can conclude that Organization X has achieved a level of success that Organization Y can hardly conceive.

Is Organization Y therefore condemned, at best, to mediocre achievements as a result of the low capacity of its process?

Not necessarily. In fact, the generalization of Shannon's theorem described in the preceding section leads us to believe that it is illusory for Organization Y to think of being able to emulate Organization X. Organization Y simply does not have the capacity to do so. However, the graph shown in Figure 2 suggests that this is not a hopeless issue. There is a margin within which Organization Y can achieve success. However, in order to do so, Organization Y must be fully aware of the opportunities it can realistically exploit and the challenges it faces, which in turn, makes it recognize situations liable to jeopardize fulfillment of its business objectives, and devise a process that will compensate its limitations.

Two choices are available to Organization Y to reduce the likelihood of not being able to fulfill its business objectives. Organization Y can, in one case, seek a higher degree of applying good business practices that make up the model corresponding to its particular business area, and thus reduce the convexity of graph of Figure 2. Alternatively, Organization Y can choose to eliminate practices that brings little or nothing, and instead focus on those that help identify situations to which it is vulnerable, in light of its limitations, while implementing corrective actions as appropriate. This second choice leaves the process capacity of Organization Y unchanged, which remains relatively low. In this second case, the curve convexity of the graph in Figure 2 remains the same, but there is an increase in the capability of Organization Y to anticipate and manage undesirable situations that are liable to happen, and desirable situations that are liable not to happen. The most promising approach will likely be a combination of both approaches. In theory, self-assessments with a model compatible with the business context Organization Y is pursuing, either on a continuous or a periodic basis, will help the organization achieve a satisfactory performance that takes into account the context in which the organization operates, the types of products it develops or services it provides, its available resources, and its culture, in other words, the constraints and limitations with which it must deal on a daily basis. This assumes that the reference model on which Organization Y has based its process is a "good" model, without necessarily implying that it is the optimal model. As suggested in the present document, other models can also be used for the same purpose.

The margin within which Organization Y can expect to fulfill its business objectives essentially differentiates it from Organization X. From the graphs presented in Figure 1, Organization X has a much better capacity to overcome the obstacles it faces. In the case of Organization Y, certain events are susceptible to make it cross the aforementioned margin threshold, such that the likelihood of not fulfilling its business objectives will sharply increase to a value that effectively eliminates its chances of achieving them.

6.0 Conclusion

Canada is benefiting from its proximity to the United States in terms of commercial trade, but this proximity also makes the industry involved in manufacturing products or providing services drawing on technological development and maintenance vulnerable. Statistics Canada has repeatedly found that Canadian industry has a lower productivity than its counterpart in the United States. This is compounded by the fact that the United States, China and India, among others, have been aggressively pursuing an improvement of their business and industrial capability in this area since the mid 1980's, and Canada could find itself in the unenviable position where an exceedingly large part of its technological industrial complex is controlled by foreign-owned companies.

It then becomes that much more important that Canadian industry find innovative ways to optimize its technological development processes in order to improve its performance and become more competitive, since it often takes years before an organization having embarked in improvement initiatives is able to see the return on its investment. Delays in undertaking such initiatives will simply make competitive advantages more difficult to achieve for Canadian industry, by increasing the number of parties with whom it is necessary to compete or by widening the gap with industry leaders.

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About the Author

Mr. Poulin is involved in assessing the capability of software development organizations, and in developing risk assessment methodologies and risk management applications. He holds a Bachelor degree in Engineering Physics, a certificate in Naval Engineering and a Master's degree in Electrical Engineering. Prior to his active involvement in software engineering, Mr. Poulin served in the Canadian Navy as a Combat Systems Engineering Officer. He is a member of the Institute of Electrical and Electronics Engineers and a Fellow of the Engineering Institute of Canada.

Chroniques en Biotechnologie et Modélisation Biomédicale

Par *Alain Zarka M.Sc*
SEA-Network

Chers collègues et membres de l'IEEE Canada, C'est avec plaisir que je commence dans ce numéro de la Revue canadienne de l'IEEE une chronique qui se penchera sur les aspects scientifiques et techniques touchant les nombreux professionnels et membres de l'IEEE oeuvrant dans les domaines de la santé et de la biologie.

Dans cette chronique, j'invite nos fidèles lecteurs à transmettre leurs connaissances et expériences – et ainsi à mettre de l'avant le dynamisme canadien en biotechnologies et en modélisation biomédicale.

1.0 Généralité

Pendant longtemps la médecine a évolué grâce aux idées souvent ingénieuses, parfois périlleuses, de médecins, anatomistes et cliniciens qui ont su adapter des outils à leurs besoins ou qui en ont conçu de nouveaux. De nos jours, la technologie progresse tellement vite que des aptitudes et connaissances en génie (mécanique, électrique, logiciel, ...) deviennent nécessaires dans le cadre d'équipes multidisciplinaires. Il est donc naturel que de plus en plus de personnes prennent la décision drastique de quitter leur domaine initial pour franchir la limite qui sépare la médecine des différents génies.

Lorsque nous commençons à nous intéresser aux liens entre la médecine et la technologie, de nombreux thèmes nous viennent à l'esprit. Afin de poursuivre l'enrichissement rédactionnel de la Revue, je vous propose entre autre des thèmes trop souvent négligés.

2.0 Thèmes suggérés

2.1 Les appareils et méthodes de mesure

Le premier thème est éminemment technique. Il concerne la vaste panoplie d'instruments, appareils et technologies plus perfectionnés les uns que les autres sur laquelle la médecine actuelle se base. La présentation de ces appareils de nouvelles technologies et une comparaison avec des technologies concurrentielles forment ce premier thème. Ingénieur(e)s qui nous lisez chez des fabricants, nous serons heureux d'avoir votre point de vue !

2.2 Modélisations biomédicales

Le second thème privilégié dans cette chronique est la modélisation. C'est aussi un créneau en pleine explosion. Devant la complexité des systèmes auxquels s'attaquent les biotechnologies, des modèles mathématiques et des logiciels très spécifiques sont développés dans nos nombreux laboratoires et entreprises. J'invite nos lecteurs à proposer et soumettre des articles décrivant ces nouvelles méthodes et à les comparer avec de plus anciennes, et ainsi à en suivre l'évolution actuelle. Ceci est en lien direct avec le troisième thème :

2.3 Histoire des sciences

Le troisième thème auquel je vous invite est l'Histoire des sciences. J'ai eu la chance et le privilège pendant mes cours de neurosciences prodigués par le Prof. André Parent de l'Université Laval (QC) de pouvoir consulter des ouvrages rares et anciens telles des éditions originales de Vesale, Descartes, Charcot, et des atlas photographiques sur le cerveau datant du début du siècle. Quel bonheur! La publication d'images et appareils anciens sera certainement une façon originale de voir ou de revoir l'évolution d'une technologie qui aura marqué l'histoire des sciences au Canada

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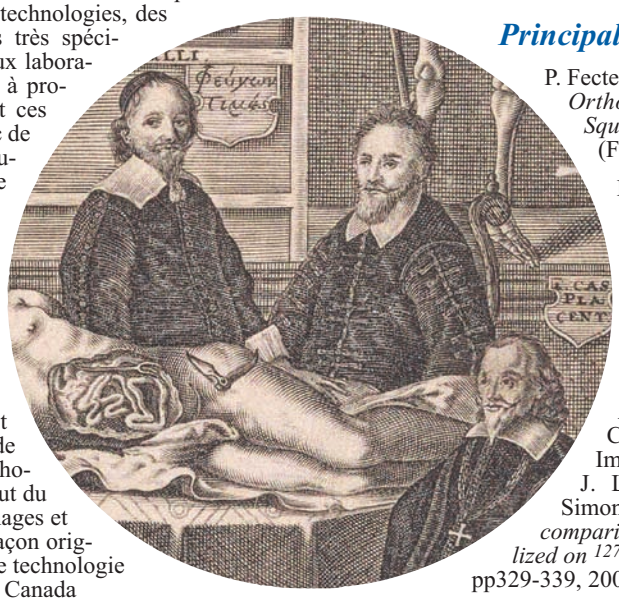


2.4 L'éthique et la science

Finalement, on peut difficilement aborder le domaine de l'histoire des sciences sans parler d'Éthique, surtout lorsque l'on réalise soi-même des projets de recherche qui touchent à l'être humain et aux animaux. Rappelons que des représentants du Génie ont participé à l'Énoncé de politique des trois conseils : Éthique de la recherche avec des êtres humains (1998) . Je souhaite donc que nous animions des échanges sur l'éthique et la science.

2.5 Livres, chercheurs et laboratoires

Finalement, la Revue se veut aussi une lecture agréable qui complète les publications scientifiques et les ouvrages plus complets. Si vous voulez faire connaître un livre, un collègue ou un laboratoire particulier, soumettez-nous vos écrits. L'apport de nos membres et collègues à la communauté canadienne doit être reconnu.

Je vous invite cordialement à m'envoyer vos suggestions, courriers ou articles, à l'adresse suivante: azarka@ieee.org. Vous pouvez me contacter de vive voix au Centre de Recherche Eximo au (418) 654-1212.

Editor's Note

This new regular column of the IEEE Canadian Review will address issues related to engineering in medicine and biology, including the following themes: Equipments and Measurement Methods, Modeling, History, and Ethics. Members and readers are invited to submit contents and articles.

Note de la rédaction

Cette nouvelle chronique régulière de la Revue canadienne de l'IEEE se penchera sur des sujets de génie biomédical, incluant les thèmes suivants : Équipements et méthodes de mesure, Modélisation, Histoire, et Éthique. Nos membres et lecteurs sont invités à soumettre du contenu et des articles.

Principales présentations et publications

P. Fecteau and A. Zarka, *"Asymétrie de la Posture Orthostatique (APO) et Douleur Musculo-Squelettique Chronique"*, Conf. à Marseilles (France), Mai 2005

P. Fecteau and A. Zarka , *"Bilan de la recherche à la Clinique de Posturologie de Québec"*, Conf. à Sintra (Portugal), Mai 2005

A. Zarka, *"Project Management Optimization Based on an Optical Cavity Laser Modelization"*, In IEMC 2005 Proceedings, Sept 2005, pp.798-903

A. Zarka, A. Abou-Zeid, D. Chagniot, J.M. Chartier, J.F Cliche, 0. Cip, C.S. Edwards, F. Imkenberg, P. Jedlicka, B. Kabel, A. Lassila, J. Lazar, Y. Millerioux, M. Merimaa, H. Simonsen, M. Tetu, JP. Wallerand, *"International comparison of eight semiconductor lasers stabilized on $^{127}I_2$ at $\hat{A} \approx 633$ nm"*, Metrologia Vol.37 No4, pp329-339, 2000.

Biographie

Alain Zarka a reçu son diplôme d'ingénieur de l'IPSA (France) en 1993. En 2001, il reçoit une équivalence de Maîtrise en Génie électrique de l'université Laval (Québec, QC). Travaillant depuis 2003 sur des projets médicaux, il a commencé, en 2006, un Doctorat en neurobiologie à l'université Laval afin de compléter certaines connaissances essentielles au travail en équipe multidisciplinaire qu'il dirige. Il est récipiendaire d'une bourse doctorale du FRSQ pour ses travaux visant à comprendre et optimiser les traitements en réadaptation des personnes atteintes d'accidents vasculo-cérébraux (AVC), par leurs actions sur la plasticité du cerveau. De 1987 à 2000, il a travaillé au BIPM (Sèvres, France) sur les étalons de fréquences et plus spécialement sur les lasers à semi-conducteur asservi sur la structure hyperfine de l'iode. Les travaux de recherche réalisés lui ont permis alors d'appliquer de nombreuses techniques et connaissances en physique, en optique, en mécanique, en électronique et en traitement de signal.

Depuis 2000, il a fondé et co-dirigé de nombreuses entreprises technologiques au Québec dont la dernière en date est EXIMO robotique inc. Il vient d'être invité comme expert scientifique par l'Association de Posturologie et d'Équilibre (France) pour aider aux révisions des normes des plate-formes de force, utilisées en stabilométrie. Il est membre de l'IEEE depuis 2000.

Event Report: Canadian Summer School on Communications and Information Theory, 2007

By *Dan Sirbu, Co-chair, University of Alberta IEEE Student Branch*
Dr. William W. Armstrong, Treasurer, IEEE Northern Canada Section
Professor Emeritus, Computing Science Department, University of Alberta

The 2nd Canadian Summer School on Communication and Information Theory was held August 20-22, 2007 at the Banff Park Lodge (Banff, Alberta). Under the guidance of Christian Schlegel, the summer school was organized by the High Capacity Digital Communication (HCDC) group at the University of Alberta, and made possible by sponsorships from IEEE Northern Canada Section, iCORE, PIMS, and MITACS. This event served the dual purpose of a workshop and a summer school: Morning tutorials were followed by graduate student research presentations in the afternoon.

Four invited plenary speakers gave tutorials on topics of current research interest in communications and information theory. Brian Hughes (North Carolina State University) discussed the effects of correlation, coupling, and noise upon compact multi-antenna systems. Steve Wilton (University of British Columbia) covered user and vendor techniques for the optimization and modelling of power consumption in FPGAs. Martha Steenstrup (Clemson University) presented a tutorial on the topological control of mobile networks. Lastly, Sumit Roy (University of Washington) spoke broadly about the 802.11 IEEE Standard, and delved more deeply into management principles for high density mesh networks. There were about 40 delegates from the University of Alberta, University of British Columbia, University of Calgary, and Carleton University, with some graduate students giving seminar presentations of their research projects. All the tutorials and the talks were at a high technical level; they gave rise to audience questions and some sparked healthy differences of opinion, illustrating the importance of the face-to-face contacts offered by the summer school.

Occasional light showers failed to dampen the enthusiasm of participants who were able to enjoy the best of what Banff had to offer, including an organized mountain biking tour, hikes around Lake Louise and Lake Moraine, and a profusion of beautiful scenery!

Left to Right: Dr. Christian Schlegel, lead organizer (University of Alberta); invited plenary speakers: Dr. Brian Hughes (North Carolina State University), Dr. Steve Wilton (University of British Columbia), Dr. Martha Steenstrup (Clemson University), Dr. Sumit Roy (University of Washington)

Safety in Engineering Design: Innovation through Competition

By Marc A. Rosen
- Member of Board of Directors, Minerva Canada
- Dean, Faculty of Engineering and Applied Science
University of Ontario Institute of Technology

Safety is touted as a top priority in the profession of engineering, as the results of unsafe practices can be very significant. Each year, for instance, thousands of workers are injured on the job, leading to serious human and economic costs. Work related injuries cause 8-12% of the workforce to be incapacitated at any time, while billions of dollars are lost through reduced productivity, health care expenses and benefit payments.

Research shows that attention to safety and its management is an important value of successful corporations, and that productive companies have leaders who understand the benefits of safety, health and environmental management and are committed to it. As a consequence, ways to enhance safety – in the workplace and for the public – are continually sought. Innovative designs that eliminate or reduce potential hazards are highly desirable, and new tools to help manufacturers and workplaces integrate safety into new or retrofitted designs are also needed. Safety-conscious planning and design can help reduce workplace illnesses and injuries.

The Minerva Canada James Ham Safe Design Competition was initiated in 2006 by Minerva Canada Safety Management Education Inc. to foster these objectives and, in the long term, to reduce occupational illnesses and injuries through safe design in engineering.

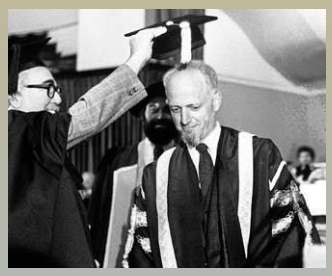
The awards for the inaugural competition were presented April 16, 2007 in Toronto at the Annual Health and Safety Conference and Trade Show of the Industrial Accident Prevention Association and witnessed by several thousand attendees. The winning entries displayed the safety innovation that the competition is intended to foster:

- A unique stair-climbing delivery device that should aid in preventing back injuries took the top award of $3500. Submitted by a team from McMaster University, the device allows industrial gas cylinders and other heavy objects to be transported safely up stairs with minimal effort. The stair climber looks similar in concept to a heavy-duty, two-wheel dolly but with a m echanical system that vertically lifts the whole device up stairways one step at a time. The students chose this particular challenge inspired by a delivery process in one of the engineering buildings. A compressed gas cylinder delivered to the building is currently carried by four people to the second floor since a service elevator is not available. While safety precautions are in place, the stair-climber device would almost eliminate potential hazards while improving productivity.
- An innovative automatic door opening mechanism that stores energy in the form of compressed air each time the door is manually opened, and thereby allows doors to remain functional during power failures, received the second place prize of $1500. Developed by a team from the Faculty of Engineering and Applied Science at University of Ontario Institute of Technology (UOIT), the energy stored from the mechanism could be utilized in many different ways; however, the prototype uses it to power the automatic opening function of a door for physically challenged users. The door will not only remain functional to individuals who would otherwise be confined within the building during an emergency situation or power loss, but also provide energy savings during normal use because it does not rely on electricity for operation.

Minerva Canada James Ham Safe Design Competition

Initiated by Minerva Canada Safety Management Education Inc., these awards were made possible through funding from the Workplace Safety and Insurance Board of Ontario, recognize original and unique contributions to integrating safety into engineering design. The aim of the competition, which is open to engineering student teams in Ontario, is to encourage engineering students and faculty to integrate safety into all designs, to produce safer designs of devices, processes and systems, and to raise awareness of safety, health and environment. All fields of engineering are eligible.

The Safe Design Competition honours well-known engineer James Ham, whose Royal Commission Report on Health and Safety led to the creation of Ontario's Occupational Health and Safety Act and to the adoption of the Internal Responsibility System in Ontario workplaces. Trained as an engineer with a secondary field of study in sociology, he was awarded the Order of Canada in 1980 and passed away in 1997. Ham believed that the engineering profession should serve society by the creation, management and maintenance of systems, processes and products to meet human needs.



James Ham in 1978 receiving his cap as President of the University of Toronto.

Minerva Canada is a not-for-profit corporation dedicated to improving industry and business effectiveness through education in safety and its management. It targets tomorrow's leaders by encouraging colleges and universities to embed safety management into the curricula of engineering and business programs. Key industry sponsors include organizations committed to principles that combine efficiency and productivity within an effective safety, health and environmental management culture. Minerva Canada's vision is that future leaders in engineering and business will strive for excellence in occupational health and safety as an essential component of their operations and management.

The competition was successful in encouraging engineering faculty to incorporate health and safety into design curricula. Dr. Remon Pop-Iliev, an associate professor with UOIT's Faculty of Engineering and Applied Science and NSERC-GMCL Chair in Innovative Design Engineering, was the academic sponsor for UOIT's entry, which was originally a part of his fourth-year capstone design course. He included safety considerations in his course and commented, "We regard design engineering as the central focus of the engineering profession because it provides practical solutions to tangible problems. Our design strategy is founded on creating a strong design engineering focus and providing the basis for training students in both critical thinking and engineering competence."

The innovative approaches to incorporating safety into engineering designs demonstrated by students through the Minerva Canada James Ham Safe Design Competition bode well for the future. By applying engineering creativity and know-how to safety concerns, workplaces and products and ervices provided to the public will almost certainly become safer.

About the Author

Dr. Marc A. Rosen is founding Dean of the Faculty of Engineering and Applied Science at University of Ontario Institute of Technology in Oshawa, Ontario and President-Elect of the Engineering Institute of Canada. He served as President of the Canadian Society for Mechanical Engineering, and is a Fellow of that society as well as the Engineering Institute of Canada, the Canadian Academy of Engineering, the American Society of Mechanical Engineers and the International Energy Foundation.

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2006 Minerva Canada James Ham Safe Design Competition

Presented April 16, 2007

Industrial Accident Prevention Association
Annual Health and Safety Conference and Trade Show

McMaster University Team with Mrs. Mary Ham

From left to right: Stephen Niedojadlo, Jonathan (Chin Hung) Lo, Mrs. Mary Ham and Jonathan (Kwok Kin) Ho

The McMaster team with a scaled-down version of its industrial stair-climber delivery device operated as follows. The device is pulled backwards towards the step, a button is pressed, and the stair climbing pad rises up. Once the pad is raised, the cart can be pulled backwards onto the next step, which it uses for support on its travel up. The process is repeated for each step.

University of Ontario Institute of Technology Team with Minerva Canada President Mr. Tony Pasteris

From left to right: Mr. Tony Pasteris, Mike MacLeod, Ben Fagan, Mark Bernacki and Matt Van Wieringen

The UOIT team's entry is an automatic door opening mechanism that stores energy in the form of compressed air each time the door is manually opened, thereby allowing doors to remain functional during during an emergency situation or power loss. Designed primarily to enable physically challenged users to operate a door in such situations, the device also provide energy savings during normal use because it is not electrically powered.

Engineering Management: What's New in the Literature?

On: How Leaders Think, NAFTA, Hiring-Paying-Enhancing-Firing Employees, and Out-sourcing Risk

by Terrance Malkinson

Governor — Engineering Management Society

◆ We can all learn from the experiences of others. Lessons learned from how others manage challenges that we all face provides valuable insights allowing us to be more effective in our careers and personal life. We sometimes think "How might someone else handle this situation?" In "How Successful Leaders Think" (*Harvard Business Review*, 85(6), pp. 60-67, June 2007, www.hbr.com), Roger Martin discusses the practice of emulating what others do applying their experience and lessons learned to our own situation. The author correctly suggests that simply copying what others do is not a good approach. What works in one context may not work in another situation. A better approach is to analyze how successful leaders think and apply their analysis process to your issue. The results of his research based on interviews of more than 50 effective leaders suggests that a process of consideration of various ideas at once some of which may be conflicting results in the synthesis of a new and superior idea. He calls this approach "integrative thinking" and provides a four-stage decision making process to help you make good decisions.

◆ The North American Free Trade Agreement has now been in effect for 20 years. This agreement followed by the North American Free Trade Agreement transformed many aspects of business. In: "Free Trade @20" (*Policy Options*; 28(9): 14-103; October 2007; www.irpp.org/po/) the editors have published a special issue on twenty years of FTA experience. How it happened, and what we have learned are but a few of the topics discussed in the various articles. The publisher (The Institute for Research on Public Policy; www.irpp.org) is an independent national non-profit organization that seeks to improve public policy through research and debate. The leaders of this initiative 20 years ago were Ronald Reagan and Brian Mulroney. The lead article by Craig Wright and Derek Holt "Canada's Free Trade Lessons for the World" provides you with insights on the agreement's economic impact, and discusses eight negative myths regarding the FTA that have been debunked by twenty years of experience. On the same topic a recent special issue of *Canadian Business* (80:20, October 8, 2007, www.canadianbusiness.com) focuses on Canada in 2020: Strategies for a Canadian advantage in the globalized economy. An interesting fold-out guide features an examination of ten areas where Canada can succeed as a global leader.

◆ On the topic of human resources; recent articles provide you with valuable information on current practices. In today's competitive business and employment market it is important that we have an understanding of human resource practices both from the point of view of management and from the employee. The career savvy individual takes the time to understand why management does what they do.

◆ In many regions of Canada finding, hiring and retaining the best employees is challenging. In: "The Smart Hiring Guide" (*Alberta Venture*; 11(11): 35-44; November, 2007 www.albertaventure.com) Shannon Sutherland provides you with an effective step-by-step manual for human resource management. A reader-friendly article that will provide you with valuable guidelines.

◆ Motivating employees by providing them with valued incentives has been a subject of discussion since ancient times when the first superior/subordinate relationships were established. In "Weighing Pay Incentives" (*HR Magazine*, 52(6), pp. 65-68, June 2007, www.shrm.org/hrmagazine), Joanne Sammer discusses current thinking about incentive plans that motivate employees to perform at high levels of performance. Online resources for additional information about designing incentive plans are provided in the article. The author particularly emphasizes the importance of the following: determining the correct incentives for your company and employees; what business objectives an incentive plan should support; reviewing the plan to maintain relevance; and detailing the plan in writing.

◆ An organization's success is dependent upon the skills and talents of its human resources. In "Make your Company a Talent Factory" (*Harvard Business Review*, 85(6), pp. 68-77, June 2007, www.hbr.com), Douglas Ready and Jay Conger discuss the approaches of two companies (Procter & Gamble and HSBC Group) in their development and retention of key employees. Both companies focus on talent processes that support strategic and cultural objectives, and have managements whose emotional commitment is reflected in daily actions.

◆ What can you do to achieve an elite level of performance? In "The Making of An Expert" (*Harvard Business Review*, 85(7/8), pp. 115-121, July/August 2007, www.hbr.com), K. Anders Ericsson, Michael Prietula and Edward Cokely discuss new research that shows that outstanding performance is the product of years of focused practice and coaching, and not necessarily the result of any innate talent or skill. Insights are provided on expertise and what to look for when judging it, and how to enhance your skills so that you can become a real expert.

◆ How an employer treats an employee when they have chosen to leave an organization through resignation is an important component of an effective human resources policy. In "Smoother Separations" (*HR Magazine*, 52(6), pp. 94-97, June 2007, www.shrm.org/hrmagazine), Nancy Hatch Woodward discusses best practices for business, remaining employees, and for the departing employee. An interesting inset provides you with information on important elements for a company's effective separation policy.

◆ Today, many jobs are being outsourced. In "Today's Solution and Tomorrow's Problem: The Business Process Outsourcing Risk Management Puzzle" (*California Management Review*, 49(3), pp. 27-44, Spring 2007, cmr.berkeley.edu), Yuwei Shi provides a comprehensive overview of the different types of risk that might result from business process outsourcing. Among the many important issues raised in this interesting article the author suggests that the "effects of outsourcing on the firm's immediate bottom line may not always be consistent with the effects on the long-term well-being of the firm." Risks include impacts on customer services, overall operations costs, information security, and business continuity to name but a few. The author concludes with the statement "Perhaps it will be better to require senior management and even board-level scrutiny of business process outsourcing projects to recognize and deal with the more strategic risks before it is too late."

About the Author

Terrance Malkinson is a Governor of the Engineering Management Society, international correspondent for IEEE-USA Today's Engineer Online, editor-in-chief of IEEE-USA Today's Engineer Digest, and editor of IEEE Engineering Management. The author is grateful to the Haskayne School of Business Library at the University of Calgary. He can be reached at malkinst@telus.net .

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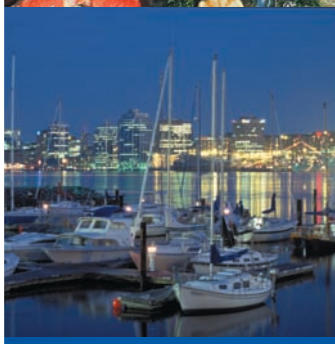

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WEST ...

Working IEEE/IFIP Conference on Software Architecture (WICSA)
2008-02-18...22, Vancouver, BC
http://www.wicsa.net/

Int'l Symposium on Advanced Control of Industrial Processes (Adconip)
2008-05-04...06, Jasper, AB
http://www.adconip2008.org

IEEE Instrumentation & Measurement Technology Conference (IMTC)
2008-05-12...15, Victoria, BC
http://www.ieee-ims.org/imtc/imtc_2008.php

IEEE Int'l Symposium on Electrical Insulation (ISEI)
2008-06-09...12, Vancouver, BC
http://www.deis.nrc.ca/calendar.htm#2008

14th Symposium on Electromagnetic Launch Technology (EML)
2008-06-10...13, Vancouver, BC
http://www.emlsymposium.org

30th Annual Int'l Conference of the IEEE Engineering in Medicine and Biology Society (EMBS)
2008-08-20...25, Vancouver, BC
http://www.embc2008.com/

IEEE Vehicular Technology Fall Conference (VTC)
2008-09-21...24, Calgary, AB
http://www.vtc2008fall.org

IEEE Industry Applications Society Annual Meeting
2008-10-05...09, Edmonton, AB
http://www.ieee.org/ias2008

2nd IEEE Int'l Conference on Digital Game and Intelligent Toy Based Learning (DIGITEL 2008)
2008-11-17...19, Banff, AB
http://www.ask4research.info/digitel/2008/

IEEE Electrical Safety, Technical and Mega Projects Workshop (ESTMP)
2008-11-19...21, Edmonton, AB
http://ewh.ieee.org/soc/ias/tmp/index.html

Electrical Power Conference (EPC)
2008 - (Fall), Vancouver, BC
http://www.ieee.ca/epc08/

EAST ...

2nd Annual IEEE Int'l Systems Conference
2008-04-07...10, Montréal, QC
http://www.ieeesystemscouncil.org/conference-2008/sysconference2008.asp

2nd IEEE Int'l Workshop on Safety of Systems (IWSS)
2008-04-07...10, Montréal, QC
http://ieeesystemscouncil.org/IWSS-2008/IWSS2008.asp

6th Annual Communication Networks and Services Research Conference (CNSR)
2008-05-05...08, Halifax, NS
http://www.cnsr.info/Events/CNSR2008/

IEEE Int'l Workshop on Medical Measurement and Applications (MeMeA)
2008-05-09...10, Ottawa, ON
http://www.sermis.polito.it/memea/

IEEE Int'l Symposium on Technology and Society (ISTAS)
2008-06-26...28, Fredericton, NB
http://istas08.ca/

IEEE Int'l Professional Communication Conference (IPCC)
2008-07-13...16, Montréal, QC
http://ewh.ieee.org/soc/pcs/index.php?q=node/2

OCEANS 2008
2008-09-15...18, Québec, QC
http://www.oceans08mtsieeequebec.org/

IEEE Sections Congress
2008-09-19...22, Québec, QC
http://www.ieee.org/sc2008

CENTRE ...

21st IEEE Canadian Conference on Electrical and Computer Engineering (CCECE-CCGEI)
21e Conférence Canadienne de Génie Électrique et Informatique
2008-05-04...07, Niagara Falls, ON
http://www.ewh.ieee.org/reg/7/ccece08/

24th Biennial Symposium on Communications (QBSC)
2008-06-24...26, Kingston, ON
http://www.ece.queensu.ca/symposium/

IEEE Int'l Symposium on Information Theory (ISIT)
2008-07-06...11, Toronto, ON
http://www.isit2008.org