Fall / Automne 2011
No. 67

IEEE Canadian Review

La revue canadienne de l'IEEE

Revitalizing the Aging Power Industry Workforce

- Protocol Engineering: A Historical Perspective
- Sections Congress Reports
- Remembering Wally Read

Canada Post—Canadian Publications Mail Sales
Product Agreement # 40592512

IEEE Canada
The Institute of Electrical and Electronic Engineers Inc.

IEEE Canada

Officers

Director/President - Om Malik
Vice President & Director Elect - Keith Brown
Past Director/President - Ferial El-Hawary
Secretary - Raed Abdullah
Treasurer - Gerard Dunphy

Director Emeritus - Wally Read
Director Emeritus - Ray Findlay
IEEE Canadian Foundation President - R. Alden

Groups & Committees

External Relations - Bruno DiStefano
Educational Activities - Kostas Plataniotis
Industry Relations - Branislav Djokic
Other Societies - Saman Adham
Professional Develop. - A.Anpalagan
Section/Chapter Suppt. - Bruno DiStefano
Teachers in Service Program - A. Benyamin

Member Services - Denard Lynch
GOLD - April Khademi
- Aurum Newsletter: E. Soleimankhani
Life Members - Dave Kemp
Membership Develop. - Lawrence Whitby
Student Activities - Denard Lynch
Student Representative - Kanishka Jayawardene
Women in Engineering - Behnaz Ghoraani
History Committee - vacant

Publications & Communications - Hilmi Turanli
Canadian Review - Amir Aghdam
CJECE - Vijay Sood, Robert Dony
Electr. Newsletter - Scott Yam
Publicity & Advertising - Marcelo Mota
Translation - Christian Pépin
Webmaster - Ahsan Upal

Other Committees
Awards & Recognition - Hussein Mouftah
Conference Advisory - Sridhar Krishnan
Strategic Planning - Keith Brown
Humanitarian Initiatives - Alfredo Herrera
Adhoc Wireless Communications - D. Michelson

Area Chairs

Canada Central: Kash Husain
Canada East: Wahab Almuhtadi
Canada West: Jeremy Gates

Section Chairs

Canadian Atlantic - Jason Gu
Hamilton - David Bauslaugh
Kingston - Shahram Yousefi
Kitchener/Waterloo - Amir Mobasher
London - Maike Luiken
Montréal - Nazih Khaddaj Mallat
New Brunswick - Esam Ghanem
Newfoundland & Labrador - Lori Hogan
Ottawa - Sreeraman Rajan
Peterborough - Sean Dunne
Québec - André Morin
North Saskatchewan - Daniel Coode
Northern Canada - Mooney Sherman
Saint Maurice - Alexis Bilodeau
South Saskatchewan - Raman Paranjape
Southern Alberta - Ronnie Minhaz
Toronto - Wai-Tung Ng
Vancouver - Mazana Armstrong
Victoria - David Gregson
Winnipeg - Shaahin Filizadeh

IEEE Canada Administrator

Cathie Lowell

IEEE Canadian Review
General Information

The *IEEE Canadian Review* is published three times per year: mid March, end of June and mid October. 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
2 - International Affairs
3 - Industry
4 - Education
5 - Power
6 - Communications
7 - Computers
8 - Electronics

Advertising Policy

Organizations are invited to place corporate advertising in the IEEE Canadian Review. For information regarding rates and copy requirements, please contact the Advertising Manager.

Circulation

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

Information for Authors

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.

Annual Subscription Price

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.

Reprint Permission

Abstracting is permitted with credit to the source. Libraries are permitted to photocopy for private use of patrons. Instructors are permitted to photocopy isolated articles for non-commercial classroom use without fee. For other copying, reprint or republication, please write to the Managing Editor. The IEEE Canadian Review is printed in Canada, postage paid at Toronto, Ontario.

Change of address

- ***Do-it-yourself with MyIEEE: http://www.ieee.org/myieee***
- ***Email: address.change@ieee.org***
- ***Tel: 1 (800) 678-4333***
- ***Mail:*** ***IEEE Service Center***
  445 Hoes Lane, P.O. Box 1331
  Piscataway, NJ 08855-1331, USA

Member of / membre constituant de
Engineering Institute of Canada
l'Institut canadien des ingénieurs

The National Library of Canada
ISSN 1481-2002
La Bibliothèque
nationale du Canada

Editorial / *Éditorial*

Amir Aghdam SMIEEE, Rédacteur en chef / Editor-in-Chief

A very busy summer has culminated with the publication that you now hold in your hands. Much has happened since I last wrote. I am pleased to report that I have achieved one of my primary goals: the formation of an Advisory Committee for the magazine. In addition to former Editor-In-Chief Eric Holdrinet's ongoing support, I am very grateful to Bob Alden, Dave Kemp and Vijay Sood for agreeing to constitute this committee. Their combined publications expertise at all levels of IEEE make its counsel invaluable; the committee has already made suggestions resulting in a change in style for some of the articles— something to look for in the introduction of our authors in this edition

Not all the news over the summer was happy, however: I am truly sorry to report that Wally Read passed away on August 15. As past president of IEEE Canada and IEEE, he has left us with a significant legacy as well as many positive memories. Indeed, the value of his extraordinary contribution to Region 7 is reflected in the prestigious IEEE Canada Award under his name: W. S. Read Outstanding Service Award. I would like to offer my sincere condolences to everyone who knew this great man, especially to his family.

Fittingly, two IEEE Canada members with their own outstanding records of achievement pay tribute to Wally Read in this issue: Ray Findlay, another Canadian President of IEEE (2002), and Bob Alden, President of IEEE Canada (1988-89). Elsewhere in the magazine, members from our region have written a thorough report from IEEE Sections Congress, which was held August 19-22 in San Francisco. As you'll read, IEEE Canada members had a strong representation in this congress, contributed significantly to it, and received major awards. We also have an informative article on aging work force, plus practical solutions on how to address this growing problem – especially in the power industry in Canada, including suggestions for effective collaboration between industry and academia. The other feature article is from the recipient of 2011 McNaughton Gold Medal, Dr. Gregor Bochmann, with some interesting information about the evolution of computer communication network protocols over the past 40 years. He argues that many of the advanced protocols are, in fact, based on the same basic concepts. To wrap up this well-rounded issue, we also have excellent contributions from regular columnists Alexandre Abecassis and Terrance Malkinson, who provide some news items of interest for electrical engineers across Canada.

I hope you will enjoy reading this Autumn 2011 edition of the IEEE Canadian Review. After all, it is a reflection of all our efforts!

Mes collaborateurs et moi nous sommes activés tout l'été afin de produire le présent numéro de la revue canadienne de l'Institut des ingénieurs électriciens et électroniciens (IEEE). Il s'est passé bien des choses depuis la dernière livraison… D'entrée de jeu, je me réjouis de vous annoncer que j'ai atteint l'un des grands buts que je m'étais fixés : doter la revue d'un comité consultatif. À ce sujet, je veux souligner le soutien indéfectible d'Eric Holdrinet, notre ex-rédacteur en chef. De plus, je remercie vivement Bob Alden, Dave Kemp et Vijay Sood, qui ont accepté de mettre sur pied ce comité. Compte tenu de leur expérience combinée dans le domaine des publications et à tous les échelons de l'IEEE, ils nous prodigueront assurément de précieux conseils. Ainsi, leurs récentes suggestions nous ont amenés à modifier le style de certains articles, notamment la présentation des auteurs. À coup sûr, vous profiterez, en tant que lecteur, de ces améliorations.

Hélas, l'été n'a pas apporté que de bonnes nouvelles. En effet, j'ai le regret de vous annoncer que Wally Read nous a quittés le 15 août dernier. Cet ancien président d'IEEE Canada et de l'IEEE nous laisse un riche héritage et plein de bons souvenirs. M. Read s'était à ce point dévoué pour la région 7 que le prestigieux Prix d'excellence de service W. S. Read d'IEEE Canada porte son nom. Je souhaite offrir mes plus sincères condoléances à tous ceux et celles qui ont côtoyé ce grand homme, avec une pensée toute particulière pour les membres de sa famille.

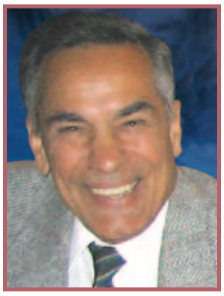
Du reste, deux membres d'IEEE Canada – qui comptent eux-mêmes de remarquables réalisations à leur actif – rendent hommage à Wally Read dans ce numéro : il s'agit de Ray Findlay, autre président d'origine canadienne de l'IEEE (2002), et de Bob Alden, président d'IEEE Canada en 1988-1989. Vous trouverez par ailleurs dans nos pages un compte rendu détaillé du Congrès des sections de l'IEEE, qui s'est tenu du 19 au 22 août derniers à San Francisco. Vous constaterez que les membres d'IEEE Canada ont participé en grand nombre à l'événement et y ont reçu plusieurs prix importants. Nous vous proposons aussi un reportage sur le vieillissement de la population active, assorti d'idées concrètes pour contrer cette tendance. Ce reportage vise plus particulièrement le secteur énergétique canadien; vous y découvrirez notamment quelques propositions de collaboration fructueuse à établir entre intervenants de l'industrie et chercheurs universitaires. Un autre article de fond, rédigé par Gregor Bochmann, Ph. D. et lauréat de la médaille d'or McNaughton en 2011, brosse un portrait de l'évolution des protocoles de transmission des données dans les réseaux informatiques depuis 40 ans. Il tente également de prouver que la plupart des protocoles avancés se fondent en fait sur les mêmes concepts de base. Pour clore cette livraison bien garnie, nos chroniqueurs habituels, Alexandre Abecassis et Terrance Malkinson, traitent de nouveaux enjeux d'intérêt pour les ingénieurs électriciens du Canada.

Je vous souhaite bonne lecture, et j'espère que vous apprécierez le fruit de nos efforts communs : le numéro d'automne 2011 de la revue canadienne de l'IEEE!

Table of Contents / *Table des matières*

Cover Photograph courtesy of AltaLink Management Ltd.'s Engineer in Training (EIT) Program. Shown is an EIT group at the AltaLink Foothills Technical Services Building (FTSB) in Calgary, Alberta.

Dear Friends in IEEE Canada:



It is with a great sense of loss and sorrow that I mention the passing away on August 15 of great friend, mentor and a wonderful IEEE volunteer Wally Reed. Wally was a past-director of IEEE Region 7 (Canada) and IEEE past-president. Numerous friends and well wishers have been writing about their fond memories of Wally. The IEEE Board of Directors passed a resolution and observed a moment of silence in memory of Wally at its meeting on August 22.

The triennial IEEE Sections Congress was held August 19-22, 2011, in San Francisco, along with the IEEE Board meeting. Attendance was more than 1,100, with representation from 292 Sections worldwide, IEEE volunteers from 92 countries, plus IEEE staff. In addition to training sessions for Section delegates, a major activity is prioritizing a list of recommendations received from all ten IEEE Regions. Recommendations are voted upon by the primary delegates to the Congress, one from each Section. This year delegates cast ballots on 34 recommendations, with the top four shown below:

1. IEEE to develop a comprehensive long-term strategy to increase the number of next generation youth pursuing science and engineering careers.
2. As members maintain their IEEE membership over their years, IEEE must reward them for their loyalty. Rewards ought to be tangible and useful and can be done simply and inexpensively. Create Global Fidelity Programs including: (a) Continue membership Recognition 5-10-15-20 years of membership (b) Bonus for specific Benefits (e.g., reduced fee, IEEE merchandise, etc).
3. IEEE membership (including e-Membership) should include a Society membership as part of the basic membership fee.
4. Increased support to students in technical activities with grants to attend conferences and organization of technical competitions.

Over the next three years the IEEE MGA Board will pursue the implementation of these recommendations in association with the other IEEE Boards i.e. Board of Directors, TAB, EAB, PSPB, USAB and Standards Board, as appropriate.

Your comments and suggestions on any aspect of the operation of IEEE Canada are welcome. I look forward to hearing from you at maliko@ieee.org. I hope you all had a nice and relaxing summer and I wish you all the best.

Chers amis de IEEE Canada:

C'est avec une grande tristesse et douleur que je vous annonce la disparition le 15 août dernier d'un grand ami, mentor et bénévole merveilleux de l'IEEE, Wally Reed. Wally fut directeur de la région 7 (Canada) de l'IEEE et Président de l'IEEE. De nombreux éloges ont été faits en mémoire de Wally. Le conseil des directeurs de l'IEEE a passé une résolution et a observé un moment de silence en mémoire de Wally lors de sa réunion du 22 août.

Le congrès triennal des sections de l'IEEE s'est tenu les 19-22 août 2011, à San Francisco, de concert avec la réunion du conseil d'administration de l'IEEE. Il y avait plus de 1100 participants, représentant 292 sections dans le monde entier, des bénévoles de l'IEEE de 92 pays, plus le personnel de l'IEEE. En plus des sessions de formation pour les délégués de section, une activité importante consistait à attribuer des priorités à une liste de recommandations reçues de chacune des dix régions de l'IEEE. Les recommandations ont été votées par les délégués primaires au congrès, un provenant de chaque section. Cette année 34 recommandations faisaient l'objet d'un vote de la part des délégués, avec les quatre principales énumérées ci-dessous :

1. L'IEEE doit développer une stratégie à long terme complète afin d'augmenter le nombre de jeunes de la prochaine génération désirant poursuivre des carrières en Science et en Génie.
2. Pour les membres qui maintiennent leur adhésion à l'IEEE à travers leurs années, l'IEEE doit les récompenser pour leur fidélité. Les récompenses doivent être tangibles et utiles et peuvent être faites et de façon simple et économique. Création de programmes globaux de fidélité comprenant : (a) La poursuite de la reconnaissance des 5-10-15-20 ans d'adhésion (b) Bonis pour les avantages spécifiques (par exemple, frais réduits, articles de l'IEEE, etc.).
3. L'adhésion à l'IEEE (incluant l'adhésion électronique) devrait inclure une adhésion à une société en tant qu'élément des frais d'adhésion de base.
4. Appui accru aux étudiants dans des activités techniques avec des allocations pour assister à des conférences et pour l'organisation de compétitions techniques.

Au cours des trois prochaines années le conseil MGA de l'IEEE poursuivra l'implantation de ces recommandations en association avec les autres conseils de l'IEEE c.-à-d. le conseil des directeurs, TAB, EAB, PSPB, USAB et le conseil des standards.

Vos commentaires et suggestions concernant n'importe quel aspect de l'opération de IEEE Canada sont les bienvenus. J'attends avec intérêt d'avoir de vos nouvelles à maliko@ieee.org. J'espère que vous avez tous eu un été magnifique et relaxant et je vous souhaite mes meilleurs voeux.

Dr. Om Malik, P.Eng., LFIEEE, FCAE, CEIC, FEIT, FEIC

2010-2011 IEEE Canada President and Region 7 Director

MGA Outstanding Section Award Presentations, August 19, 2011 Opening Ceremony, Sections Congress, San Francisco CA

Ottawa Section representatives receive the MGA Outstanding Large Section Award. Left to right are Section members Voicu Groza, Alfredo Herrera, Anissa Shady and Sreeraman Rajan. To the far right, making the presentation, is Howard Michel, Chair, Member and Geographic Activities Board.

London Section representatives are presented with the MGA Outstanding Small Section Award. Left to right are Section members Murray MacDonald, Weiming Shen and Maike Luiken. To the far right, Howard Michel, Member and Geographic Activities Board Chair, offers his congratulations.

Group Term Life
Group 10-Year Level Term Life
Group 20-Year Level Term Life

The future is powered by the expertise and vision of professionals like you.

Let us help secure your place in that future with life insurance plans exclusively created for IEEE members in Canada, the U.S. and Puerto Rico. IEEE Group Life Insurance plans are underwritten by one of the most financially stable insurance companies in the United States, while featuring affordable group rates and outstanding service.

You know anything's possible. And that's the best reason to help protect your future and your family's security. Since 1962, IEEE members just like you have chosen the IEEE Member Group Insurance Program to help protect their family's financial future.

To learn more about plan features, costs, eligibility, renewability, limitations, exclusions and plan availability in your region, visit **www.ieeeinsurance.com/review.**

IEEE

IEEE Canada

To learn more, visit www.ieeeinsurance.com/review or call 1.800.493.IEEE (4333).

This program is administered by Marsh U.S. Consumer, a service of Seabury & Smith, Inc., d/b/a in CA Seabury & Smith Insurance Program Management. CA Ins. Lic. #0633005. AR Ins. Lic. #245544.

The Group Term Life, 10-Year Level Term Life and 20-Year Level Term Life plans are available only for residents of the U.S. (excluding territories), Puerto Rico and Canada (excluding Quebec). Coverage may vary or may not be available in all states or provinces. Visit www.ieeeinsurance.com/review for plan availability in your area. These plans are underwritten by New York Life Insurance Company, 51 Madison Ave., New York, NY, 10010 on Policy Form GMR. IEEE prohibits discrimination, harassment and bullying. For more information, visit www.ieee.org/web/aboutus/whatis/policies/p9-26.html.

53051 9/11

Canadian Newslog / Coupures de presse canadienne

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

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

Send any news clippings you would like to contribute via e-mail to alexandre.abecassis@ieee.org

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

TORONTO, ONTARIO, August 8, 2011. ViXS Systems Inc. has announced the availability of a product which offers a Blu-Ray PVR solution with the ability to add features such as Multiple HD Transcoding, 3D Graphical user interfaces, live video streaming to iPAD, etc. ViXS is a multimedia solution provider for processing, managing, securing and distributing high quality video and audio.

TORONTO, ONTARIO, June 28, 2011. BlueCat Networks has announced it has acquired patents from Intellectual Ventures and has become a customer of Intellectual Ventures IP for Defense program. BlueCat Networks provides a technology for addressing the transition to IPv6, reducing IT management costs and launching new services. Intellectual Ventures has a portfolio of more than 35,000 intellectual property assets.

OTTAWA, ONTARIO, August 22, 2011. Espial has announced today that its new product can now be used by a wide range of devices including Smart TVs, digital media players and set-top boxes. The product, which is a browser, supports more than 25 languages, and is capable of enabling access to many websites such as Google, Daily Motion, Picasa, Facebook, Twitter, ESPN, etc.

MISSISSAUGA, ONTARIO, August 26, 2011. Ricoh Canada Inc. has announced that it has introduced a paper product made entirely from sugar cane husk that can be used on its line equipment. This paper product is biodegradable and compostable, and can also be recycled alongside traditional paper. It is interesting to note there can be two harvests per year with sugar cane, making the raw material for the process more economically attractive than would otherwise be the case. The product has been created with paper manufacturer TreeZero.

TORONTO, ONTARIO, August 25, 2011. Comwave, one of the largest Voice over IP (VoIP) providers, has announced the launch of a phone application for the BlackBerry Playbook which uses Adobe Flash.

TORONTO, ONTARIO, September 6, 2011. Rogers Communications has announced the launch of its Long Term Evolution (LTE) network in Toronto. Rogers has been the first telecommunications company to introduce LTE in Canada with a launch in Ottawa in July 2011. LTE compatible smartphones and portable media devices can support download speeds up to 100 Mbps.

MONTREAL, QUEBEC, September 5, 2011. McGill University has obtained an overall ranking of 17th in the 2011 World University Rankings, published annually by the British firm QS. University of Toronto received rank 23. University of Montreal took the 137th spot. Sadly, a majority of the fourteen Canadian universities ranked saw their position drop compared to 2010.

TORONTO, ONTARIO, August 29, 2011. Magna International Inc. and the province of Ontario have announced they will invest $432 million Cdn over six years to develop electric vehicle technologies. The Canadian province will invest up to $48.4 million Cdn. Electric car concepts, parts for electric cars, lightweight materials and components, etc. will be developed during the course of the project and hundreds of jobs will be created.

OTTAWA, ONTARIO, August 30, 2011. All over the air broadcast TV networks in Canada have now been required to convert from analog to digital signals as of August 31, 2011. This requirement is applicable for all stations in urban centers as well as in other areas. The same change was made in the U.S. three years ago, followed by a subsequent spectrum auction. In Canada, the proceeds of the coming spectrum auction could amount to 4 to 6 billion dollars according to analysts.

WATERLOO, ONTARIO, August 23, 2011. The Canadian government approved commercial ties between Libyan rebels and Aeryon Labs Inc., a UAV manufacturer, for provision of drones to that country's National Transition Council for collecting real-time video image. The drone weighs about 1.3Kg and is about the size of an open umbrella. This type of drone is typically used for observing positions and planning tactical moves. The price of each drone is between $100,000 and $150,000.

OTTAWA, ONTARIO, September 1, 2011. Mosaid Technologies Inc. has announced that it has acquired Core Wireless Licensing S.a.r.l. a company that holds 400 patent families, consisting of approximately 2,000 patents and patent applications originally filed by Nokia. About one hundred of the above patent families have been declared essential to second, third and fourth-generation communication standards, including GSM, UMTS, WCDMA and LTE. The rest of the portfolio comprises 800 wireless implementation patents.

OTTAWA, ONTARIO, July 11, 2011. Apple, Microsoft, Research in Motion and three other leading technology companies have received approval to buy wireless patents from bankrupt Nortel Networks for $4.5 billion. The portfolio comprises 6,000 patents and patent applications. The auction started with an initial bid of $900 million made by Google.

VANCOUVER, B.C., September 1, 2011. The University of British Columbia (UBC) announced it has received a $2.9 million boost from the Canada Foundation for Innovation (CFI) to support research in climate change, chemistry, medical imaging and physical therapy. The CFI opportunity Fund will support 20 UBC projects by providing funding for research equipment, facilities and other infrastructure.

TORONTO, ONTARIO, May 11, 2011. The University of Toronto's Department of Chemical Engineering and Applied Chemistry's food engineering laboratory has helped set the Guinness Book of World Records May 10 for the largest ice cream cake ever made. This event was sponsored by Dairy Queen to mark the 30th anniversary of its ice cream cakes. The cake fully assembled weighed more than 10.1 tons. The previous biggest cake was smaller by more than two metric tons.

The author, Alexandre Abecassis, at the Great Wall in China earlier this year.

A View from the West

On: Leading BC Companies; Vancouver's NGO Boom; Head Office Growth in Calgary; Labour Shortages; Engineering Mergers; Keystone XL; Gaming: Fits Like a Glove; University Rankings; Celebrating Canadarm

By Terrance Malkinson

British Columbia

The July issue of *BC Business* [www.bcbusinessonline.ca] highlights an analysis of British Columbia's leading companies "Top 100 Companies in BC". Leading the list for revenue is Telus Corporation, followed by Teck Resources Ltd, and Jim Pattison Group. Other rankings including performance, public corporations, and by business sector are provided as well as a number of profiles of business leaders.

A report in *BC Business* [June, 2011] by Steve Burgess "Thinking Globally: Vancouver NGO's" describes why Vancouver is an ideal base from which to do international development. NGO's comprised of volunteers working with a small group of professional staff provide housing, clean water, medical services, economic development, and sanitation often faster and cheaper than larger organizations.

Alberta

Reflecting a diversity of companies; 121 corporations on this year's list of FP500 companies are headquartered in Calgary. These leading corporations are profiled in ["Calgary Head Office Feature". *Business in Calgary*. 21(8):69-84. August, 2011. www.businessincalgary.com]. This represents a ten per cent increase over last year. Although energy companies topped the list - Suncor Energy Inc., followed by Imperial Oil Ltd. and Husky Energy - many other industries also ranked well reflecting the increasing diversity of the Calgary economy.

Alberta's energy industry is believed to be heading towards a labour crisis. In an article in the July issue of *Alberta Venture* [www.albertaventure.com] "The Boomsday Clock" Geoff Morgan describes how retiring workers are presenting challenges maintaining their labor force. In 2011 it is estimated that 3,924 will be needed and the trend is expected to continue upwards until it peaks in 2019 at 4,383 positions. The article contains interviews with some of the retiring "baby boomers" as well as human resource managers in the energy industry on issues related to this projected labor shortfall.

In an article by Cheryl Mahaffy in the March 15 issue of *Alberta Venture* ["Architectural and Engineering firms are Locked in a Dance of Buy or be Bought"] the author describes how many architecture and engineering firms are merging, giving up autonomy in the hope of greater shared success.

The Keystone XL pipeline from Alberta to the Gulf Coast proposal has generated considerable attention because of environmental and safety concerns ["Power Play" *Business in Calgary.* 21(8): 36-40. August, 2011]. Derek Sankey discusses the project and its challenges with TransCanada Corporation's CEO Russ Girling.

Saskatchewan

An innovative gaming glove developed in Lloydminster called the Peregrine Gaming glove is being called a "revolutionary interface" in the high technology marketplace. Shannon McArton in an article in *Saskatchewan Business Magazine* [April-May, 2011] describes the development, features and visions for the future for the developers at Iron Will Innovations.

As is the case with Alberta, Saskatchewan is also facing labor shortages particularly in the mining sector. This is described in an article by Penny Eaton "Building Partnerships" in *The Saskatchewan Mining Journal* 32(4): 8-13, 2011. Over 18,000 vacancies are projected in this sector by 2017. Other articles in the same issue related to the resource industry in Saskatchewan include "Uranium: A Strategic Resource for Saskatchewan and "Coming on Strong" a story about Diamond mining in the province.

Other articles of interest

Quacquarelli Symonds (QS) is a British company specializing in world university rankings. It recently released its latest report, evaluating approximately 600 universities. In the category of electrical and electronic engineering, University of Toronto ranked 13th, University of British Columbia (UBC) ranked 30th and McGill 31st. For computer science and information systems, McGill ranked 23rd, UBC 26th and University of Waterloo 36th. Rankings are based on academic reputation, employer reputation, student/faculty ratio, citations per faculty, international faculty, and international students.

In the early days of planning for the space shuttle NASA needed a way for astronauts to precisely manipulate the massive equipment that the shuttle would carry in its cargo hold. In 1975, NASA accepted a proposal from a group of relatively untested Canadian companies that included Spar, CAE Electronic, and DSMA Atcon. Overseen by the National Research Council, the group designed, built and tested the equipment, aided by $108 million in funding from the Canadian government. The legendary success they achieved is described by Jordan Timm in "The Ode: Canadarm (1981-2001)" [*Canadian Business*. 84(13) pg 11. August 15, 2011. www.canadianbusiness.com].

About the Author

Terrance Malkinson is a communications specialist, business analyst and futurist. His career path includes technical supervisor and medical researcher at the University of Calgary, business proposal manager for the General Electric Company, and research administrator with the School of Health and Public Safety at SAIT Polytechnic in Calgary. He is currently an international correspondent for IEEE-USA *Today's Engineer*, associate editor for *IEEE Canadian Review*, and a member of the editorial advisory board of IEEE *The Institute*. He was Vice-Chair of the IEEE-USA Communications Committee (2004-2010), and editor-in-chief of IEEE-USA *Today's Engineer Digest* (2004-2008). He is the author of more than 420 publications, and an accomplished triathlete, having recently competed in Subaru Ironman Canada 2011, as seen above crossing the finishing line. malkinst@telus.net

N.Ed. This issue of the *IEEE Canadian Review* marks Terry Malkinson's 40th as an Associate Editor—an unprecedented record of sustained contribution. In addition to this department and his Engineering Management department, Terry has written extensively on the subjects of health and wellness, career development opportunities through writing, and the engineering associated with sports activities. We salute him, and express our most sincere appreciation.

We'd love to publish companion departments to the one on this page to keep readers abreast of business developments in central and eastern Canada. If you'd care to contribute to this, please contact me at aghdam@ieee.org. Or, if you have your own ideas for topics of relevance across all or most areas of technical specialization, I'd be pleased to explore with you how we might be able to make them a regular part of the magazine.

Replenishing the Aging Work Force in the Power Industry

By Daniel Wong[1], Randy Kimura[2]
[1] AltaLink (Alberta)
[2] SUBNET Solutions Inc. (Alberta)

Abstract

This paper discusses the program to develop, and more importantly, to attract the interest of the next generation of technical experts. The respective roles of industry and academia are discussed. Replenishing the aging work force is discussed as a four step approach starting with increasing the size of the available work force supply pool by presenting the profession as an appealing career choice. Encourage and support career entry by making the process a seamless transition into the power industry. Effectiveness of the new work force is accelerated through fast tracked training and development. Strong retention programs reduce departures from the industry.

Sommaire

Cet article discute du programme à développer, et d'une manière plus importante, la façon d'attirer l'intérêt de la prochaine génération d'experts techniques. Les rôles respectifs de l'industrie et du milieu universitaire sont discutés. Le comblement de la main-d'oeuvre vieillissante est discuté en tant qu'approche en quatre étapes commençant par l'augmentation de la taille du bassin de main-d'œuvre disponible en présentant la profession comme un choix attrayant de carrière. L'encouragement et le support de ce choix de carrière en facilitant le processus de transition dans l'industrie énergétique. L'efficacité de la nouvelle main-d'œuvre est accélérée par la formation et le développement rapides. Les programmes de rétention forts réduisent les départs de l'industrie.

1.0 Introduction

Aging work force is a frequently discussed topic at the forefront of many organizations' management planning. The power industry has known for years that the current trend will eventually result in a shortage of qualified personnel required to maintain and support the well being of the business. If there is no corrective action to reverse this trend, then who will keep the lights on? Today's recruiting and retention must replace outgoing personnel, but, more importantly, it must bring new blood into the power industry.

In general, resource development is the responsibility of industry and academia, requiring a joint and/or independent approach. Academic institutions provide the initial instruction for students. Industry focused instruction is provided to new graduates by their employers.

The power industry needs to be very visible as a valuable, meaningful, and long-term career choice. Technical training and career development for new recruits should be recognized as an effective investment in the work force supply. Within the power industry, appropriate business plans/models are necessary for identifying the work force requirement. Succession planning (for the business) and professional advancement (for employees) need to complement each other. This approach, when applied diligently, will replenish the aging work force and keep the lights on.

2.0 Increase the Size of the Work Force Supply Pool

The power industry work force is rapidly aging, and the experienced resource pool is getting smaller. Nowadays, typical demographic in a power utility shows mainly two major groups. One group is the well-seasoned veterans (or old-timers), and the other is the eager rookies (or new-comers). There are not many in between the two groups. In order to ensure constant and adequate work force resources, the power industry needs to look closely at the work force supply and demand situation.

2.1 Identify the Root Cause

During the early nineteen nineties, many power industry companies were downsized, re-organized and re-engineered. Especially in the power utility business, work force reduction was top priority with various early retirement incentives and hiring freezes across the whole organization. Employment opportunities were very limited, even for the highly educated, new graduates from Power Engineering Departments of well-known universities. Because of this negative employment impact, enrollment in Power Engineering in many universities diminished over the years. With low enrollment, various universities reduced the teaching faculties in Power Engineering. In fact, some universities stopped offering Power Engineering courses because of extremely small class size. When course offerings were not readily available, fewer students were able to take any Power Engineering courses. Since employment opportunities in the power industry became scarce, less students were interested in Power Engineering. With this vicious circle, many universities could not adequately support the Power Engineering program, in terms of faculty size or teaching resources. On top of that, the boom of "Dot Com" activities and the popularity of Information Technology (IT) enterprises in the nineties created a sizeable drain from the limited available resources for Power Engineering towards the supply pool for Computer & Software Engineering. This was clearly demonstrated by the increase in student enrollment and financial grants in Computer & Software Engineering, with an almost equal decrease in student interest, course availability and financial support in Power Engineering. This unfortunate situation is the root cause of the problem, which resulted in a big void in the supply side of Power Engineering graduates, especially in the late 2000s when the power industry needs to replenish the aging work force.

2.2 Collaboration between Industry and Academia

In order to rebuild and strengthen the supply side of Power Engineering graduates, both power industry and academia must recognize the fact that they need each other in order to be successful. Then, mutual collaboration is the essential strategy for all parties involved. With that in mind, the power industry needs to support academic institutions with financial contribution, curriculum review and suggestions, power industry insight and career opportunity outlooks. In return, academic institutions need to revitalize the Power Engineering program by increasing the size of Power Engineering teaching faculty, aligning it with work force requirements and work force projection, offer more industry courses and produce more well-educated industry graduates.

Similar to situations elsewhere, power industry in Alberta, Canada encountered the same problem of short supply in Power Engineering graduates from academic institutions within the province. To rectify this supply side problem, several key players in the Alberta power industry joined forces with a provincial university in 2007 to form the Alberta Power Industry Consortium (APIC), which is a non-profit organization that represents an excellent example of "collaboration between industry and academia" for the ultimate good of society.

APIC's mission statement states that: "Bring Alberta power companies together, with University of Alberta as the coordinating organization, to solve technical problems of common interest, to produce more well-educated graduates, to support professional development of current employees, and to promote cooperation and exchange in Alberta power engineering community." As indicated by this mission statement, in addition to increasing the "work force supply pool" by producing more graduates, there are many other tangible benefits to all participants of the consortium.

Within APIC, there are six core members and two supporting organizations.

The Six core members are:

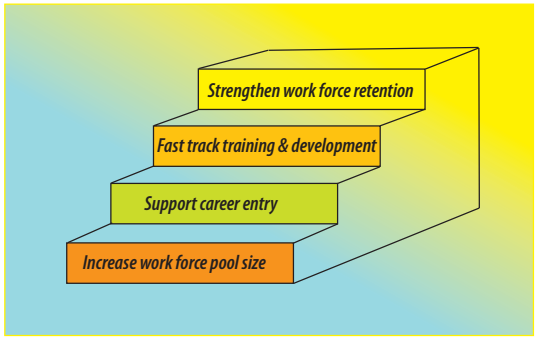
- Alberta Electric System Operator - Utility Regulator
- AltaLink Management Ltd. - Transmission Utility

- ATCO Electric - Transmission & Distribution Utility
- EPCOR - Transmission & Distribution Utility
- Fortis Alberta - Distribution Utility
- University of Alberta - Academic Institution

The two supporting organizations are:

- iCORE (Informatics Circle Of Research Excellence) - Albert's provincial government research agency.
- NSERC (Natural Science and Engineering Research Council of Canada) - Canada's federal government research agency

In terms of financial input to the consortium, each core member committed a multiple-year contribution of financial grant, with the exception of University of Alberta. The total financial grant from the consortium members was then matched by a grant from the provincial government (i.e. iCORE). Furthermore, the total financial grant including the provincial contribution was then matched once again by a grant from the federal government (i.e. NSERC). Management and usage of these financial grants became the accountability of the consortium, especially in the case of University of Alberta acting as the coordinating organization.



Steps to "keeping the lights on"

In the spring of 2008, an Industrial Research Chair in Power Quality was appointed at University of Alberta as a result of APIC's initiatives. Based upon the funding allotted to this research chair, more new faculty members will be hired in the discipline of Power Engineering. With this new infusion of teaching faculty bench-strength, more Power Engineering courses are planned and will be offered to target and attract new students. Higher enrollment in Power Engineering studies will produce more Power Engineering graduates. Therefore, this particular strategic move is expected to increase the size of the power industry work force supply pool.

For the purpose of alignment with real-life requirements and future outlooks of power industry, the existing Power Engineering curriculum was reviewed by APIC. Constructive recommendations were accepted by University of Alberta to enhance course development in this industry.

Besides the increase in size of work force supply, other tangible benefits generated by APIC are as follows:

(1) Solving technical problems through collaborative research

- Completing and delivering projects with common interest to APIC members
- Working with project collaborators from the power industry
- Coordinating joint projects from various APIC members
- Assisting in technology and human resources transfer

(2) Supporting professional development

- Offering six continuing education courses in the next five years
- Offering four research-project-based courses on specific subjects
- Reporting and technology transfer of projects

(3) Promoting industry-wide cooperation

- Implememting joint efforts in project research & collaboration
- Holding an annual conference/forum
- Participating in workshops and seminars organized by APIC

Since the formation of APIC in 2007, the feedback from consortium members were very positive. There were many valuable and visible achievements. One good example was the First Annual Power & Energy Innovation Forum held in November 2008. During this one-day forum, technical staff from each consortium member did a presentation to highlight interesting projects or activities in their organizations. The objectives were to promote technical innovation, to exchange knowledge and ideas, and to share real-life experience and learning.

3.0 Encourage and support career entry

Recruiting and staffing must evolve and adapt to the business and economic climate. In many instances, the traditional approach of recruiting from graduating classes is insufficient. Collaboration programs provide employers an early start in the recruiting process. It also helps potential employees (students) to start career planning and development prior to graduation.

3.1 Student Programs

The future of today's companies lies in the hands of the students who are completing their degrees. In a few years, these students will be entering the job market as full-time employees, their potential bounded only by their imagination. In an effort to engage and challenge the minds of these students, while opening their eyes to the possibilities of what the future can hold, work experience terms not only involves the students in the everyday workings of the business, but challenges them to develop innovative and imaginative solutions to complex problems. Through these programs, employers can open the imagination of the students to the possibilities of life after school.

The academic phase of a career focuses on developing core knowledge and skills, which is often biased towards theory. The working phase of a career then applies this knowledge and skill to industry specific applications, bridging the gap between theory and real-life. It is advantageous for both an employee and employer to have these two career phases overlap thereby permitting the real-life application of academic studies as early as possible. Work-term experience programs provide this opportunity, allowing students to put what they have learned into practice. In addition, these work-term experience programs also provide an introduction into an industry sector. Employers can promote the power industry, and more importantly, the wide range of career paths available within the industry.

3.1.1 Summer Students

Summer students are employed for the shortest period, 4 months, which limits the scope of learning and experience. A summer student's training is typically limited in scope, focusing on a specific topic. Summer employment provides students an entry point into an industry before they qualify for a co-op or internship program. Hiring summer students allows employers to evaluate future talent, which can be encouraged into co-op programs, internships and permanent employment.

3.1.2 Co-op Students

Co-op students are available for 4 or 8 months with the longer 8-month term being preferred. The longer period allows for more diverse training than can be provided for summer students, and can include additional topics or span across multiple departments (cross functional training). The longer duration also allows for longer duration tasks; in many cases, small projects can be executed by a co-op student.

3.1.3 Interns

Long internships, which are typically 12 to 16 continuous months, are more effective than co-op and summer placements because they most closely resemble full time employment. Interns participate in personal career planning programs managed by Human Resources. Experiencing a "Performance Review" or "Goals and Objectives" session teaches an intern career management.

Interns follow the same development process as first year technical staff, and all technical training is required. Even though an intern may remain in an office setting, the training required for field services personnel will also be assigned. Environmental Health and Safety courses, such as "Lock Out Tag Out" and "Confined Spaces," allow an intern to appreciate the activities that occur outside of the office place.

The local engineering governing body, the Association of Professional Engineers, Geologists, and Geophysicists of Alberta (APEGGA) acknowledges and recognizes the value of the experience gained during an internship. Students who have completed an internship program are granted one year of engineering experience credit towards the experience requirement for professional engineer registration.

3.2 Active Recruiting

Recruiting must be a continuous, ongoing process, especially for students and new graduates who are often unfamiliar with potential employers. A common mistake is to wait and start the recruiting only when a staffing position becomes available.

3.2.1 Campus Ambassador

The Campus Ambassador (representing an employer) promotes an organization within academic institutions through on-campus relations/recruiting activities such as: career fairs (or career day), employment information sessions, industry tours, industry lectures, and sponsorships.

The Campus Ambassador roles and responsibilities include:

- Being an active member of the Campus Executive Team in developing and executing a strategy for promoting the employer on-campus, and directly supporting the Campus Recruiting Leader and other executive team members, before and during campus recruiting
- Promoting corporate events on campus, and assist in distributing corporate information and recruiting materials, including corporate publications
- Creating on-campus awareness for corporate internship and full time employment opportunities
- Serving as the on-campus contact person for the student body as well as career days, job fairs, and pre-recruiting meetings
- Actively seek and report new opportunities for on-campus exposure for the employer

3.2.2 Career Fairs

Career fairs are an established method for recruiting staff, however, it is important to target a diverse audience. Career fairs associated with academic institutions tend to attract mainly students and recent graduates while the "open market" career fairs tend to attract more experienced people.

The focus of a career fair can vary, from skill sets (e.g. engineering), sectors (e.g. power industry) to new graduates. Considerations should be given to attending a wide range of career fairs. If an employer expands the career fair attendance to include all general events, exposure of the employer will be broadened in the following ways:

- It introduces and promotes a business to people that may not be familiar with the organization
- Attendees who are directly interested may forward information to friends and contacts
- It creates awareness for people with transferable skills who are currently working in different industries

3.3 Leveraging Academic Alumni

An effective recruiting team should contain members that are similar to the people attending the career fair. For example, new graduates and former interns/co-op students should be part of the recruiting team at a career fair held at an academic institution.

For on-campus recruiting, it is advantageous to have an employee, who is a recent alumnus of that academic institution, as a member of the on-site recruiting team. Since this employee is very familiar with the campus, the academic programs, the departments, the faculties and the students, the whole recruiting effort will be more efficient and productive.

3.4 Referral Bonus

A Talent Referral Program is a recruiting tool designed to encourage current employees to refer qualified external candidates to fill open positions throughout the business. If the referred candidate is hired, a cash award will be paid to the employee making the referral. One half of the payment will be processed shortly after the new hire's start date, the remainder after 6 to 12 months, provided both the referring employee and new hire are still on the payroll.

Talent Referral Programs are usually associated with experienced staff recruiting. This is also an effective tool for recruiting the next round of co-op and internship students. Allowing the current students to participate in recruiting the next round creates more interest on campus.

4.0 Fast Track Work Force Training & Development

Accelerating professional development increases an employee's effectiveness by yielding results in a shorter period of time. Mentoring programs promote the transfer of useful knowledge and experience to junior staff. Mentors use every opportunity to teach- in house, in the field and at conferences.

Photo Credit: AltaLink Management Ltd.—EIT Program.

Power industry succession planning requires attracting young graduates with the help of both industry and academia, through incentive programs such as professional development and fast-track internships.

4.1 Training

Having a well designed work force training program in place is very important as it sends the correct message about the employer's strong commitment to develop new talents.

4.1.1 In-House Training

Formal, classroom style, training is a valuable starting point as it falls in the comfort zone for students and new graduates. Unstructured training must be minimized as too much sends the wrong message. Publishing the curriculum is another essential step in building confidence in the training program.

The structure of the formal training component incorporates the introduction and promotion of the power industry and the career paths within. Using a diverse group of instructors, from different industry sectors, is required to represent the various career paths. For example, an electric utility and equipment supplier illustrate the diverse, yet sometime similar, career paths. Exposure to multiple departments and business units within an organization further promotes the diverse career opportunities.

The goal of the formal training is to build a broad foundation of knowledge from which a career can grow. The program is designed to insure experiences are not limited to an assigned department or organization, for example:

- Students and new graduates assigned to a project integration team should be familiar with the activities of a product development team
- Protection department members should be familiar with the activities of a SCADA/communications department
- Students and new graduates working for an equipment supplier should have an understanding of careers within a power utility

More detailed knowledge is acquired through assigned tasks; for example, the concept of DCE (Data Communications Equipment) is introduced in the Serial Communications training module, and setting up a specific device will only be done as an assigned task. This allows all of the participants in the program to be introduced to the technology used and the associated career path in SCADA/communications.

4.1.2 On-the-Job Training

On the job or "hands on" training complements the formal sessions by providing an opportunity to put into practice the lessons learned. Task assignment must be carefully planned to promote continuous development.

Task duration must also be given careful consideration. Short-term tasks are good as they can be used to expose a person to a variety of topics and skills. The short duration also provides the opportunity to complete the cycle—see a task through from start to completion.

Longer duration tasks are equally important and at least one should be ongoing. Focusing on an assignment for a longer period of time promotes planning and multi-tasking. A long duration task should be chosen for co-op and internship students to align with their academic obligations which are typically in the form of status and project reports.

4.1.3 External Training

Employers should take advantage of available job-related, structured training. This training is a critical component of the overall development for targeted employees' career placement purpose. Some examples of external training include:

- Power industry related courses provided by academic institutions
- Power industry sponsored workshops, seminars and courses
- Short courses organized by technical societies (such as IEEE) and industrial/professional associations

4.2 Site/Facility Visits

Classroom training and facility visits are complementary activities, each reinforcing the information provided by the other. Learning about a 400 MVA transformer does not fully convey the size of the equipment. Viewing a transformer in a substation switchyard completes the learning experience. One cannot appreciate the size of a 400 MVA transformer without seeing one.

The approach used for formal training is also applied to facility visits. The program should include a diverse range of facility visits, encompassing multiple departments and organizations. Ideally, multiple end users (covering the aspects of transmission, distribution, generation, energy and industrial applications) and equipment suppliers are targeted for site and facility visits, which can include: substation, control center, manufacturing plant and factory acceptance test room.

4.3 Networking

Networking is one of the most effective and frequently used career development techniques. It is never too early to start developing alliances, connections and relationships. Networking at industry and professional events will broaden the exposure to valuable learning and career possibilities.

4.3.1 Local Volunteering

When local technical events are held, there are many opportunities to participate and support the local organization. This is a good venue for new comers to interact with industry experts and experienced peers. There are two ways to achieve the desired result: employee volunteering or employer nomination. The experience gained from these events, which can include workshops, seminars, conferences and technical meetings, is not restricted to the technical domain. Other tangible benefits include the following:

- Developing diverse interpersonal skills by interacting with attendees including international delegates.
- Improving the business understanding of the power industry companies.
- Building self-confidence through peer networking in a social environment.
- Learning professional and communication skills by attending and observing presentations.

4.3.2 Conferences

Besides providing opportunities for students and new staff to gain a greater understanding of the power industry, conferences also offer the means for meeting and interacting with a wide range of industry experts. Exposure to end users, consultants, vendors, etc. showcases the broad range of career paths within the power industry.

A common trap is to limit conference attendance to senior or more experienced staff. Everyone is faced with a finite budget for conference attendance and a "smart spending" program can increase attendance level without increasing the overall cost. For example, the cost difference between flying and driving several people from one location to another location to attend a conference, can be used to include an additional attendee, thereby increasing the benefit for the same cost. This enabled students and junior staff to attend the Western Power Delivery Automation Conference and the Western Protective Relay Conference.

This concept of staff development through conference attendance must not be limited to local events. Larger and high profile events provide a greater opporunity to learn from and network with peers.

4.4 Mentoring & Fast-Tracking

For the purpose of fast-tracking, on-the-job mentoring is an essential and critical part of competency development. In addition to providing technical advice to the protégé, the mentor also offers guidance in professional and networking skills, techniques for information gathering and analysis.

Besides the on-going mentoring, one interesting concept is the "pairing of senior engineering leader (mentor) with junior engineering staff (protégé)" for attending conferences. At a technical gathering, a mentor can provide real-life and real-time coaching and support to his/her protégé. As an invaluable benefit to the protégé, the mentor offers face-to-face networking introduction for the protégé to all the peers at the event. For example, one power utility applied this concept at IEEE T&D Conferences (North America) and CIGRE General Sessions (Europe), and the results were very positive.

Job shadowing is another useful method to speed up staff development. By assigning a junior engineering staff to work with a senior technical member of another department for a short period of time will give the jounior staff a brief insight of other departments.

Another fast-tracking tool is the appointment of an EIT (Engineer In Training) coordinator. This appointee (a mid-level engineer) is accountable for managing the EIT program and assisting the company orientation program, by providing technical and adminstrative assistance. As a win-win situation, the EIT coordiantor will develop leadership skills while the EIT's will have the necessary guidance and support.

5.0 Strengthening Work Force Retention

If the power industry follows the strategic approach outlined earlier, the work force supply pool will be adequate and sustainable, career entry for new technical staff will be effective and orderly, work force training and career development will be efficient, timely, proactive and productive. When all these efforts produce an appropriate work force, the next question is how to minimize turnovers or early exits. In other words, power industry got the people they need, but what is the power industry doing to make the people stay (or in other words, to keep the people)?

With the ultimate intent of retaining the work force to look after a successful business, power industry needs to address the following aspects discussed in the sequel:

5.1 Career Management

For an employee to proactively manage his/her career, he/she needs to know the career progression inside the organization. If the employer has a clear and visible process for career advancement, such as a company policy, this would certainly help the employee to know what position level he/she is at, and how to move to the next higher level. This policy must clearly state all available position levels in the organization, requirements, qualifications and criteria for each level, and the advancement procedure to move from one level to the next. This will become a road map for the employee to follow in order to achieve a successful career. For example, a well-defined and formally declared company policy on "Engineer Level and Development" in one power utility actually lists the engineer levels from Entry Level EIT (Engineer in Training) to Advanced Specialist (i.e. Chief Engineer). In addition, it also specifies the timing and process for promotions.

To transform a simple job-continuation into a meaningful career management, position responsibility and accountability must be mutually agreed between employer and employee. Performance expectation needs to be clearly communicated to the employee, and he/she must plan and execute his/her actions to align with the expectation of the employer.

Regular and timely feedback on job performance is very important in terms of career progression and management, besides the annual performance review. For a well-designed performance review and development (PRD) process, the following activities need to be implemented:

- Beginning of the year: Clear goals and the associated activities need to be established and agreed between the employee and employer. A formal record will be required to document the goals and activities.

- End of the year: The employee needs to list all the results of the activities identified at the beginning of the year. Then, the employer and the employee will jointly review the results to determine if the identified goals are met. A formal record will be required to document the goals, activities and results.

The bottom line is that, a well-run performance assessment needs to be open, clear, fair and timely. In addition, both the employee and employer must have a common understanding of the performance expectation.

5.2 Encouragement on Professional & Technical Exposure

With respect to career advancement, technical committee participation is beneficial to both employers and employees. The output of these committees is typically a standard or technical publication, however, it is often unclear what the committee's intentions are. Supporting the involvement of an employee allows an employer to know the details of the journey that resulted in the publication. Knowing how and why a decision was made is always better than just knowing what the decision is.

For an employee, participating in a technical committee reflects the acceptance from the peers and industry. Committee work raises the profiles of the employee and employer, especially for organizations with international coverage. Conference organizing committees provide a unique opportunity for employees and employers to gain insight into industry practices.

Other opportunities for professional and technical exposure are volunteering in technical organizations and professional societies. Examples are as follows:

- Volunteering for local IEEE section or chapter is a good investment in terms of getting to know the peers in various industries and also allowing other like-minded professionals to get to know the volunteer. Building professional relationship amongst peers and learning the operations of the organizations are definitely some of the desirable benefits.
- Volunteering for technical events (such as workshops, seminars, conferences, etc.) held locally is another excellent way to meet new peers and friends, to gain new experience and to learn new things.

These volunteering opportunities will further enhance peer networking and personal skills development, especially leadership skills that are extremely useful for the employee.

5.3 Continuous Learning and Development

Most of the training, learning and development processes and opportunities have been outlined in the "Fast Track Work Force Training & Development" section. However, for the purpose of continuous improvement on employee competency, a company-wide approach for providing and supporting regular training must be formally established. Allotment of opportunities and funding must be fair and align with business plan and business requirements. A well-defined training plan for each employee needs to be set up at the beginning of the year, and this plan should dovetail into the "goals and objectives" of the performance review and development process. If the plan is carried out timely, the employee will achieve his/her training goal and the employer will have a better trained work force. It is a win-win situation and it will certainly help in work force retention.

5.4 Work/ Life Balance

Nowadays, employees in any organization are under a lot of stresses at work and at home. These are the result of rapid and frequent changes in workplace and technologies, fast pace life style, non-stop connectivity, information overload and various social pressures. To maintain a healthy work force, any organization must pay genuine attention to the work-life balance of the employees. In order to achieve this balance, flexible work arrangements are effective means.

Flexible work arrangements assist a company in attracting and retaining valued employees by leveraging flexible work schedules to create an inclusive environment that encourages growth for both the business and the employees. Existing and potential employees generally want work time flexibility and employer support to meet a variety of needs. There are several flexible work arrangements that can be implemented, as follows:

- Flextime: Full-time employees vary the start and end times of their workdays. Flextime is a low-cost option to introduce and maintain, and it can have great benefits in terms of improved morale and greater productivity.
- Compressed Workweek: Employees compress a full-time workload into fewer than five days per week. Wherever state or local law/country requires overtime to be paid after 8 hours, compressed workweeks will not be offered.
- Reduced Hours: Reduced hours is an option where an employee may work 30 hours or more and maintain full benefits. An employee working reduced hours is considered a full-time head for staffing purposes.
- Part-Time Work: Employees reduce their workload and consequently their hours decrease to fewer than the standard workweek requirements with a corresponding reduction in pay and adjustment of benefits.
- Job Sharing: Two employees with reduced workloads and corresponding reduced schedules share the responsibilities of a single full-time position. It is a variation of a part-time arrangement and each job sharer is individually on a reduced schedule; part-time policies apply.
- Telecommuting: Employees perform full-time work responsibilities up to several days a week at sites other than their primary location - usually their home or a satellite office.
- Remote Work: Employees perform full-time work responsibilities exclusively from a location outside the primary work site - usually their home or a satellite office.

Depending on the employee's particular situation, one of the above mentioned flexible work arrangements might be an ideal work structure to have. If the employer is open for this arrangement, the employee will certainly be less stressful, and work force retention will be easier to achieve.

5.5 Succession Planning

To run a successful business in the power industry, there needs to be an adequate work force. More importantly, the complements within the work force must be at the appropriate levels in terms of capabilities and accountabilities. Therefore, succession planning needs to be proactive and must also take into consideration the existing work force structure and positions. As indicated earlier, employers should make the accountabilities and qualifications for all positions known and visible to employees. They should also think ahead and develop a realistic and functional succession plan. This plan would have potential candidates identified for various position moves (usually in terms of promotions). Once the plan is in place, the employer needs to discuss the potential career moves with the identified candidate. By doing this, the employee will know the possibility and opportunity of career advancement, and the employer will know the "acceptance and success" level of the plan. This key activity will strengthen the work force retention for sure.

5.6 Employee Benefits

For an employee to stay with an employer, the employee must be satisfied with the overall offering from the employer. This overall offering covers a lot of tangible and intangible items. Employment benefits from an organization are some of the items employees are very interested in. These benefits can include the following listings:

- Health and dental care - to offset the cost for prescription drugs, eye glasses, dental check up and required works, ambulance ride and hospital stays
- Health spending account - to pay for eligible health or dental expenses that are not covered by insurance
- Employee life insurance - employer paid insurance for employee up to two times the annual earnings
- Health care insurance(beyond the basic provincial health-care plans) - employer and employee jointly paid health care insurance for employee and his/her family
- Out of country medical emergencies coverage - insurance to protect the employee and his/her family for medical emergencies while away from the country
- Short term & long term disability - employee coverage against illness lasting a prolonged period
- Retirement savings - various forms of pension plans and retirement saving plans
- Education assistance - financial support provided by employer to offset the cost of further education for the purpose of career advancement
- Company scholarship - financial support provided by employer to

support higher education for children (or grand children) of the employees

- Annual vacation - paid time-off every year for employee to enjoy
- Sabbaticals - half paid leave up to eight weeks, offered to employee at regular intervals (e.g. 4 years)
- Earned rest days - one day-off per month for employee to take to address personal needs
- Memberships - professional memberships paid by employer for employee, including technical society membership if applicable
- Incentive pay - annual bonus payment depending on job performance and business results
- Wellness fund - financial reimbursement for expenses on fitness and wellness activities
- On-site fitness facility (Gym) - employer sponsored on-site facility for employee use
- Networking Friday afternoon - monthly, employer sponsored event for employees to interact and socialize

It should be noted that not all employers provide all the above benefits. An employer may select a combination of the benefits from the above listings. If benefits offered with employment are expanded or enhanced, the employee will be more satisfied with the overall offering from the employer, and this will further reinforce work force retention.

5.7 Retirement

Typical demographic in a power utility shows mainly two groups, namely the veterans and the rookies. In order to keep the veterans working in the power utility as long as possible, for the purpose of knowledge transfer or technical guidance, a phasing retirement program is a very reasonable and attractive tool. The potential retiree may be offered a reduced work schedule, such as three days a week, for a period of time before full retirement. The advantage of this arrangement to the potential retiree is to phase in the upcoming retirement at a slower and controlled rate. The benefit to the employer is the continuation of service provided by the potential retiree. If this program is carried out appropriately and proactively, this will strengthen the capability of the work force without any major disruption.

An employer should be open to the concept of leveraging retirees from other companies within the power industry. To be effective in this approach, the employer needs to be flexible to adjust the time (reduced work hours), location (off site) and assignment (the task acceptability may be very selective) to accommodate the special desire of the employee. Employers need to value and appreciate the proven expertise provided by these employees and should take every opportunity to maximize the benefits.

6.0 Conclusions

The work force shortage can be addressed by increasing the size of the work force pool, attracting new talent, fast tracking development and retaining experienced personnel. Increasing the size of the work force pool is approached by introducing and promoting careers within the power industry. Encouraging career entry must start with students through partnership programs with academic institutions. Work force development is most effective when it is addressed by the industry, not a single employer. End users and suppliers working together can develop a more versatile work force. Strong retention programs insure the investment in attracting and developing talent is not lost.

About the Authors

Randy Kimura received his Bachelor of Science and Master of Science in Electrical Engineering from the University of Alberta. Randy is a member of the IEEE Substations Committee Working Group C12 and C14, Western Power Delivery Automation Conference committee, IEC/TC57 Working Group 10, 17 and 19, CIGRE Working Group B5.39, and the DNP3 Technical Committee. He is a registered Professional Engineer in the province of Alberta. Randy is currently the VAR/OEM Manager for SUBNET Solutions Inc. Outside of working hours, Randy's passion is wildlife photography. To the right, he zooms in on several nests of the American Avocet, containing both adults and chicks. Originally concentrating on large mammals (e.g. bears, elk, bighorn sheep), birds were a natural progression, he says.

Daniel Wong received his B.Sc. EE in 1975 from the University of New Brunswick. His work experience includes UNB & NB Power (NB: 1976-1981), TransAlta (Alberta: 1981-2000) and General Electric (Alberta; 2000-2005). In NB Power and TransAlta, Daniel held many key roles in Power System Protections. At GE, his major accountabilities were Lead Protection Engineer, Product Line Manager and Asia Sales Liaison. Since June 2005, Daniel is the Principal Engineer (Protection & Control) at AltaLink (Alberta). He is an IEEE Senior Member, a Professional Engineer (Alberta & NB), and the Chair of Alberta Power Industry Consortium. He and his wife Kimberley enjoy overseas travel, with trips to Europe and the Middle East. To the left, they were thrilled to find such lush greenery in an oasis near Muscat, Oman.

News From the IEEE Canadian Foundation

By: M. E. El-Hawary, Dalhousie University; VP Development, ICF

The IEEE Canadian Foundation relies on donations to support McNaughton Centres across Canada, and award scholarships and grants to innovative projects. It also administers donor designated funds that support a variety of humanitarian projects and peer recognition programs of IEEE in Canada. For further information see:
http://ieeecanadianfoundation.org/EN/index.php

We are pleased to announce awarding of the following.

IEEE Canada Women in Engineering Prize

The IEEE Canada Women in Engineering Prize administered by ICF recognizes excellence in young women engineering professionals and supports the Women In Engineering Affinity Group within IEEE in Canada. For 2011, the recipient is Susan Ryan, Membership Development Committee Chair of Newfoundland and Labrador Section. A graduate of Memorial University, Ms. Ryan currently works at Newfoundland Hydro. The amount of the prize is $1,000.

IEEE Canadian Foundation Scholarship Winners

As part of its support for students, the IEEE Canadian Foundation Scholarships funding will remain at the levels $5000 for Universities and $2500 for Colleges; the maximum number is determined by the annual budget -- typically five. Four fully eligible nominations were received and funded this year in the amount of $5,000 each (total of $20,000), to:

Jeffry Arcand; University of Ottawa (Shervin Shirmohammadi Student Branch Counsellor)

Bea (Emily) Landry; UBC Okanagan, (Jonathan Holzman, Student Branch Counsellor)

Alexander (Sasha) Kougiya; University of Saskatchewan (Li Chen Student Branch Counsellor)

Daphne Ong; Carleton University, (Calvin Plett, Student Branch Counsellor)

2011 IEEE Canadian Foundation Special Grants

As part of its Special Grants activity, ICF awarded the 2011 IEEE Canada WIE Conference a one-time Special Grant of $1500. In addition, two special grant applications were received and funded:

A one-time Special Grant in the amount of $2,000 was awarded to the FIRST Robotics team of Glebe Collegiate of the Ottawa Carleton Board of Education to support entry in the 2011 FIRST Robotics Competition. FIRST robotics competitions require the students, working alongside mentors from the fields of engineering and programming, to design, proto-type, build and program, in a six-week time frame, a robot to do a specific task. Once the six-week time frame is finished, the robot is transported to a regional event, where it competes against other FIRST robots to determine which was best designed to do the same task.

A one-time Special Grant in the amount of $2,000 was awarded to the UBC IEEE Student Branch for a Field Trip to Germany. The eleven-day excursion featured visits to some of the leading companies in the German high-tech industry such as: Vossloh Kiepe, Vodafone, ABB Corporate Research, GE Global Research, and Bombardier. Students gained first-hand experience of professional engineering in Germany, includng insight into various research and development endeavours in the country's technological sector.

IEEE Vehicular Technology (VT) Travel Awards

The ICF and the Grants Committee approved a single VT Travel Grant of up to $2,400 or two VT Travel Grants with a total value of up to $2,400 be offered each year beginning in 2011. One application for a VT Travel Grant has been received and was approved (not to exceed $1200) to Maurice Khabbaz from Concordia University.

Call for nominations: IEEE Canada Awards, EIC and MGA Awards

IEEE Canada Awards and Recognition Committee (ARC) seeks nominations for IEEE Canada awards and for other awards that are available to IEEE Canada members, including those from the EIC and the IEEE Member & Geographic Activities Board. Nomination Forms and guide lines can be found at the web page http://www.ieee.ca/awards/nominate.htm. Please note that the nominations deadline for the 11 IEEE Canada Major Awards is November 30th, while the deadline for EIC Medals and Fellow nominations is November 15th.

Appel pour des nominations pour des prix-IEEE Canada,ICI et MGA

Le comité des prix et distinctions d'IEEE Canada (CPD) est à la recherche de nominations pour des prix d'IEEE Canada et pour d'autres prix qui sont àla disposition des membres d'IEEE Canada, y compris ceux de l'ICI et du conseil des activités géographiques et pour les membres. Les formulaires de nomination et les lignes directrices associées se retrouvent sur la page Web http://www.ieee.ca/prix/icanprix.htm.Veuillez prendre note que la date-limite pour 1es nominations en vue des prix majeurs d'IEEE Canada 11 est le 30 novembre tandis que la date-limite pour les médailles de l'ICI et les nominations de Fellow est le 15 novembre.

Gordon R. Slemon (1924–2011)

Internationally known power system specialist Gordon Slemon passed away this September in Toronto. An IEEE Life Fellow, Dr. Slemon was a founding member of the IEEE Mechanics Society, recipient of the Mechanics Society Achievement Award (1997), the IEEE Centennial Medal (1984), the Nikola Tesla Award and Gold Medal (1990), and the Third Millennium Medal (2000).

Dr. Slemon was Professor Emeritus in Electrical and Computer Engineering at the University of Toronto where he served as Department Head from 1966 to 1976, and as Dean of its Faculty of Applied Science and Engineering from 1979 to 1986. Specializing in magnetics as applied to electric machines and drives, he made contributions to the development of permanent magnet motors and high-speed magnetically-levitated and propelled interurban vehicles. He was a co-founder and director of Vehicle Research Ltd., a company developing electric cars in the 1980s. In the same decade he established the Innovations Foundation at the University of Toronto to commercialize the results of university research. He was a co-founder and director of the company, Inverpower Controls Ltd., a director of the IDEA Corporation in Ontario and inaugural chairman of the Microelectronics Development Centre. He was a consultant to some 70 industrial corporations and organizations.

A Fellow of the Engineering Institute of Canada (1989), Dr. Slemon received its highest award, the Sir John Kennedy Medal, this past spring. He also twice received its Ross Medal. He played a major role in the establishment and early operation of the Canadian Academy of Engineering and was its President in 1998. He was among the founders of the Canadian Conference on Engineering Education and received its first Canadian Engineering Educator of the Year Award in 1992. He received the Canadian Centennial Medal in 1967, the Queen's Golden Jubilee Medal in 2002, and the Professional Engineers of Ontario's Engineering Excellence Medal in 2005. In 1995 Dr. Slemon was made an Officer in the Order of Canada.

Announcing 6th Annual IEEE International Systems Conference

March 19 - 22, 2012
Vancouver, British Columbia, CANADA

Conference Theme

The theme of the IEEE International Systems Conference is Engineering of Complex Systems, to include Systems-of-systems, Systems Engineering, Systems Integration, and Systems Thinking.

REGISTERING FOR THE CONFERENCE

The Conference fees are as follows:

Category	Advance	Late/Onsite
IEEE Member	595 USD	695 USD
Non-Member	745 USD	845 USD
IEEE Life Member/Student	175 USD	225 USD

Registration opens December 1, 2011

To Register for the conference or view more information, please visit the registration page of the SysCon 2012 Website at:
http://ieeesyscon.org/content/registration

HOTEL

The 2012 IEEE International Systems Conference will be at the beautiful Marriott Vancouver Pinnacle Hotel in Vancouver.

Vancouver Marriott Pinnacle Downtown
1128 West Hastings St
Vancouver BC CANADA V6E 4R5
The Vancouver Marriott is about 12 miles, 20 km from the Vancouver Airport. Taxis, Buses and shuttles are available.

Rates: $205 CAD
Reservations: 1-800-228-9290 or 604-684-1128
Reserve by February 20 to get the discounted conference rate.
Reference IEEE Systems Conference to receive the conference rate.
Conference rate available for 5 days prior to and 5 days following the conference.

For more hotel and bookings information please go to:
http://ieeesyscon.org/content/hotelvenue

IEEE Systems Council Member Societies

IEEE Aerospace & Electronic Systems Society
IEEE Circuits And Systems Society
IEEE Communications Society
IEEE Computational Intelligence Society
IEEE Control Systems Society
IEEE Instrumentation & Measurement Society
IEEE Microwave Theory & Techniques Society
IEEE Oceanic Engineering Society
IEEE Power Electronics Society
IEEE Product Safety Engineering Society
IEEE Robotics & Automation Society
IEEE Systems, Man & Cybernetics Society

CALL FOR PAPERS

Conference Objectives

This conference seeks to create an interactive forum for the advancement of the practice of systems engineering across the multiple disciplines and specialty areas associated with the engineering of complex systems. The conference will provide a venue for systems engineering practitioners, managers, researchers, and educators to exchange innovative concepts, ideas, applications, and lessons learned addressing:

- **Applications-oriented topics on large-scale systems and system-of-systems in topics noted below**
- **Systems engineering, education, standards, processes and methodologies for the system-of-systems environment**
- **Research opportunities and results relating to system-of-systems**

To view the full list of paper topics, please visit:
http://ieeesyscon.org/content/call-papers

THERE'S STILL TIME TO SUBMIT ABSTRACTS

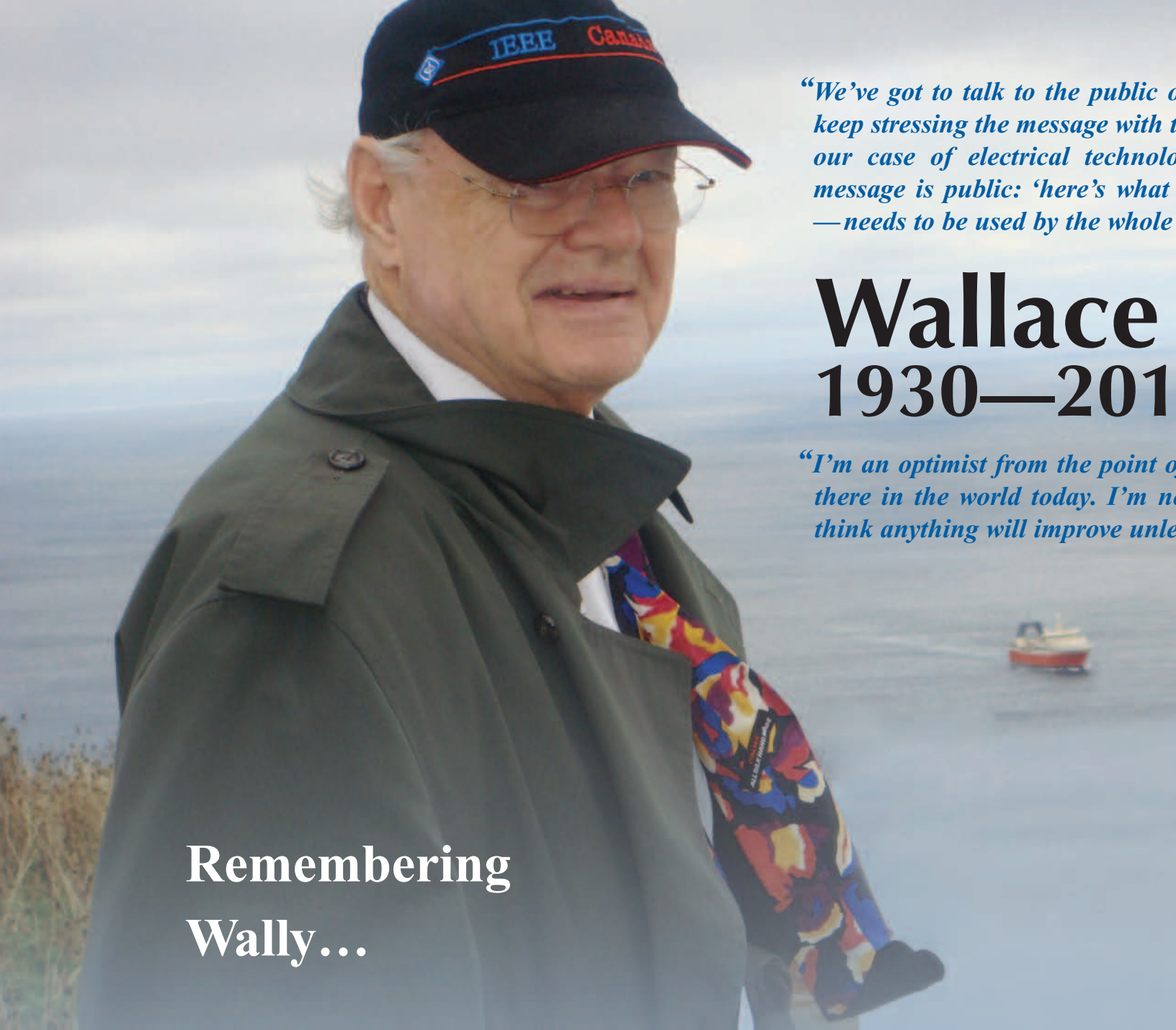
Important Dates:

Abstract deadline: November 23, 2011
Acceptance Notification: December 1, 2011
Final Paper Deadline: February 15, 2012

We invite authors to submit EITHER a 300-500 word abstract with outline OR an extended abstract of 2-4 pages in length. Abstracts should be submitted electronically to the EDAS Website at www.edas.info. Please submit to IEEE SysCon 2012.

GET INVOLVED WITH IEEE SYSTEMS COUNCIL

- Interested in joining a Technical Committee, or participating in the Distinguished Lecturer Program, contact Theodora Saunders, VP Technical Operations (TSaunders@SIKORSKY.COM)
- Interested in participating in a conference, starting branch workshops, contact Bob Rassa, VP Conferences (rcrassa@raytheon.com)
- Interested in starting a Systems Council chapter or joint chapter, contact Bob Lyons, President Elect (lyonsrp1@earthlink.net)
- Interested in submitting articles, special sessions to the Systems Journal or participating as a reviewer, contact Mo Jamshidi, Editor IEEE Systems Journal (moj@wacong.org)



"We've got to talk to the public o keep stressing the message with t our case of electrical technolo message is public: 'here's what —needs to be used by the whole

Wallace 1930—201

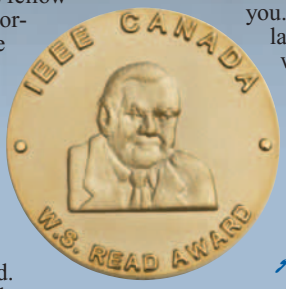
"I'm an optimist from the point o there in the world today. I'm n think anything will improve unle

Remembering Wally…

The life of Wallace Stanley Read touched so many friends, colleagues, and yes, admirers; we count ourselves most fortunate to have been all three for more than 35 years. Wally taught not by lecturing but by example. He was a model volunteer and above all he demonstrated non-wavering love of his province, country, his fellow humans and indeed, his profession. In recognition of his enormous contributions, IEEE Canada named its highest service honour the "Wallace S. Read Outstanding Service Award," as well as appointing him as its first Director Emeritus.

One of Wally's more recent areas of service to IEEE has been through the IEEE Fellow Evaluation Committee, and we cherish our recollections of the time we spent together there. We also share with so many colleagues and friends fond memories of Wally's sense of humour, as noted in these pages. But Wally's unique way of making you feel the most important person in the room will also be sorely missed. Wally: "We'll meet again, don't know where, don't know when; But I know we'll meet again, some sunny day."

Ferial and Mo El-Hawary, Canadian Atlantic Section



I have been a long-time admirer of Wally for more than 20 years; receiving the "W. S. Read Outstanding Service Award" for 2011 has meant a lot to me. Wally had an ability to captivate you. His warm personality drew you to him. He took an interest in what you were doing and was always ready to share his knowledge and experience with you. It was never a stern talk, but rather one full of comedy, laughter and plenty of wisdom. He could, however, be firm with his position, but always showed respect for your opinions. He was always full of energy, and despite his failing health, participated in IEEE activities and was always the first to volunteer. Now that's an example we should all strive to follow. He will forever be remembered.

"The smile you send out returns to you" – an inscription on the back cover of the Beach Boys "Pet Sounds" LP.

Ashfaq (Kash) Husain, London Section

* Wally Read, an oral history conducted in 2009 by Michael Geselowitz, IEEE History Center, New Brunswick, N.J., USA. In these excerpts, Wally is responding to a question on the future of IEEE.

*of the world, and we've got to the importance, particularly in ogies, to make sure that the we've done, great technology world—but don't misuse it.'" **

S. Read

1

*of view that I see the need out ot an optimist in that I don't ess we work at it." **

Wally was a wonderful human being—warm, helpful, inspiring. To my knowledge, everyone who met him thought of him as a friend. To me, he was one of my IEEE family, perhaps a very special uncle. It is my honour to share with you the Canadian aspects of his enormous contributions to IEEE.

Respect for Wally came from every quarter. A very distinguished leader in industry, Wally served as vice president of Newfoundland and Labrador Hydro before becoming president of the Canadian Electrical Association. He was recognized by his country with its highest honour by being elected a Member of the Order of Canada. Academia recognized him with two honorary doctorates. His profession conferred on him its highest awards, recognizing him by election as a fellow of IEEE, the Engineering Institute of Canada, and the Canadian Academy of Engineers.

Wally's 35–plus years as an IEEE volunteer began as a member of the executive of the Newfoundland subsection of the Canadian Atlantic Section, serving as chair in 1976–1978. He became chair of the Eastern Canada Council in 1979 and continued on the Canadian Region committee, becoming Region Director in 1984. This was the IEEE centennial year, celebrating the creation of the American Institute of Electrical Engineers (which merged with the Institute of Radio Engineers in 1963 to form the IEEE). Wally decided to create a book, *Electricity: The Magic Medium*, to commemorate the achievements of the electrical industry in Canada over the previous hundred years and longer. He collected together an impressive group of contributors and asked Harry Prevey to be the editor. He convinced IEEC Inc. (the predecessor of the IEEE Canadian Foundation) to support the publication with a $15,000 grant. This book is truly of archival quality. A few copies are still available from IEEE Canada, and PDF files can be viewed on the IEEE Canada website under "Digital Library."

Wally had the gift of making people feel good while he guided them to improve themselves and opened doors for them. He used humour to relax people—his story telling and his theatrics were legendary. At the 2009 IEEE Canada Board spring meetings in St. John's NL, he arranged for a visit to a local pub, where in a private room upstairs, about 50 of us were inducted as "Honorary Newfoundlanders;" however, one had first to pass a "competency" test. This consisted of drinking tots of screech, singing a very difficult song incredibly quickly, and finally, kissing the lips of a large cod (one kept in the freezer especially for this purpose by the pub owner). In this special tribute to Wally, you'll find many similar such stories—remembrances that poured in from all across the Region as word of his passing spread.

Bob Alden, Toronto Section

Like all great leaders, Wally not only worked hard to achieve a vision, but could inspire those around him to do the same. Volunteers are not an easy group to motivate. Yet Wally did it with humour and guile. I well remember his last meeting as IEEE President, as he was about to hand over the reins to his successor. Wally pulled out several hats—a cowboy hat to illustrate "riding herd" on the group, a toque to point out that sometimes the atmosphere gets a little chilly, a fedora to imply that formality is sometimes required, and so on. This combination of keen human insight plus individual talent played no small part in his many successes at the international level—both within IEEE and in industry. Outlining these successes is indeed an honour.

I first met Wally in 1985, shortly after I was appointed as the Student Activities Committee (SAC) Chair. That was a signal year for Wally, too, as he was Director of Region 7, and became the first full-time President of the Canadian Electricity Association (CEA) that year as well. The CEA is the national voice for the electric utility industry and provides input to federal regulatory agencies. In that position, he worked to promote the interests of Canadian electric utilities and acted as spokesperson on issues of national and international concern to its members.

Wally invited me to dinner with him early in my tenure as SAC Chair, to share his ideas on the importance of helping our young engineers and engineering students to achieve great things in their careers. Wally believed strongly that of all the professions, engineers are uniquely qualified to create technologies for the benefit of mankind, and that we should imbue our graduates with the need to innovate.

Subsequently, our paths crossed often, and in many ways. One of Wally's missions was international standards, which he promoted first as President of CEA, and subsequently within IEEE. He was elected as IEEE Vice President (Standards) for the term 1993–4, where he had the opportunity to lead the Standards Association to reorganize and to become a more influential body on the international standards stage. In 2005, I had the great pleasure to present the 2005 IEEE Charles Proteus Steinmetz Award to Wally in recognition of his work around the world on standards. He was also the recipient of the John Jenkins Award from the Canadian Standards Association.

Following the completion of his term as Director of Region 7 (Canada) in 1985, Wally's progression towards IEEE President was furthered in 1988 when he served as IEEE Secretary. He served as Treasurer in 1989–90, before rising to President-Elect in 1995. As President, he carried his message forward, especially on the importance of IEEE as a global entity, and the need for service to the public. About this time, Wally became my mentor, as he expected me to follow in his footsteps to carry his message. However, it was not without some anguish on my part. Wally had a unique management style; he expected results and chivied his troops to accomplish them. When I was elected as Vice President (RAB) in 1996 he pointed out that IEEE members on the US West Coast had complaints that had not been adequately addressed.. (He gave me a "D" for failing to solve the crisis in a timely manner!) Needless to say I worked assiduously to resolve the issues. Wally definitely expected a lot from those he worked with; however, he gave back much more than he got.

On his award of the Honorary Doctoral degree from Memorial University, the orator noted: "... his capacity to keep the long view of a problem while working on detail and implementation, his ability to inspire ongoing enthusiasm and commitment in people from different backgrounds who are engaged in a particular piece of work, and perhaps the most telling characteristic, is his genuine recognition of the potential of other people in the workplace and his gift for helping them develop and contribute. Technocratic and bureaucratic skills are not sufficient in themselves to move mountains; to these Wallace Read adds a gift for problem-solving with people, which makes the essential difference." A great tribute for a remarkable man. To those who knew him, it was no surprise when Wally was appointed a Member of the Order of Canada, the country's highest civilian honour, in 2003.

Ray Findlay, Hamilton Section

Lori Hogan, Newfoundland & Labrador Section

Some visitors from IEEE Japan Council were in town last fall. Despite having some health problems at this time, Wally made the trek from Corner Brook to St. John's to meet them. He then enlisted some help from the Section to make sure that the visitors got to see two of the three IEEE History Milestones we have in NL—the one for Marconi on Signal Hill, and the underwater cable station at Heart's Content. Wally and Helen personally escorted the visitors to these sights and more, picking them up at the airport and meeting them at their hotel each day. His sense of hospitality was impeccable, and the effort he put into making these visitors welcome would tire me. Wally is an IEEE legend; everyone involved in IEEE in some way anywhere in the world likely knows his name. I feel very fortunate to say I knew the man, at least for a bit. He was charming and genuine. I've had a few friends accompany me to various IEEE functions and they all remember Wally for that. We'll miss him.

Mooney Sherman, Nothern Canada Section

I have only known Wally for a few years but it felt as if I have always known him. Wally was very caring, gentle, and passionate in his beliefs. He had great dedication and gave sound advice. One could feel his energy and compassion. I will miss him very much.

Cathie Lowell, IEEE Canada Administrator

Over the years we shared many stories, jokes and songs; some mornings before the Region meeting started he would sing to me. You could always count on Wally to mingle at the student congresses, where he usually had a crowd of students around him listening to his stories. Wally was the perfect gentleman, offering a coat when you were cold, a cheerful story when he knew you were down, and a song to make you smile. Region 7 meetings will never be the same.

Dan Coode, North Saskatchewan Section

The first regional meeting I ever attended on behalf of my section, Wally was the first to sit next to me and engage me in conversation. He was not only a terrific ambassador for the IEEE and Canada, but a really good person. I wish I had had more opportunity to get to know him better.

Sreeraman Rajan, Ottawa Section

Wally's contribution to the IEEE is countless. He was a great mentor, a passionate volunteer and a man with a big heart. His presence at IEEE meetings was always special to all of us. He always made it a point to talk to everyone and find out their welfare. He made us feel that IEEE is indeed a family and volunteerism is a long lasting bond. He along with his contributions will always be part of IEEE. He will be missed by everybody.

Marc Provencher, Québec Section

C'est une personnalité importante que perd IEEE. J'ai eu l'occasion de rencontrer Wally à plusieurs occasions et je l'ai toujours vu traiter les gens avec dignité. Ainsi, à ma première rencontre lors d'une ECC à Montréal fin 70 et malgré mon peu d'expérience comme président de la section, il avait le don de me mettre à l'aise et ce avec respect. Aussi, lors du Section Congress de Toronto de 1990 je le voyais discuter avec tout le monde, comme si chacun était la personne la plus importante. Même lors de mes rencontres avec lui lorsqu'il était président de l'IEEE je pouvais discuter avec lui en sentant une écoute.

Bref, je crois que Wally faisait partie du club select des personnes qui plaçaient les intérêts de IEEE avant les siens. Personnellement, je garde un très bon souvenir de lui et je le considère comme un grand président de l'IEEE.

Rob Anderson, Southern Alberta Section

Wally approached everything in life with passion and enthusiasm. He was the quintessential volunteer, never telling or directing but gently guiding by example. He went out of his way to make you feel like you were part of the family. I remember flying into Newfoundland for a Region meeting. Wally was at the airport to greet you and make sure you had a ride to the hotel. Always willing to share his wisdom and stories of his work and personal experiences, Wally could be regularly found with a group of students, all intently listening as he talked. Wally had a wonderful magnetic and charming personality; his warmth and gentle smile put people at ease and made him very approachable. Wally's extended family will miss him a great deal. Long may his big jib draw.

Scott Lowell, Hamilton Section

An amazing life led by an amazing man. May he rest in peace and those who had the privilege to know him never forget him.

Bill Kennedy, Southern Alberta Section

At a CCECE banquet in Halifax a few years back, I had my twin nephews in tow. The entertainment for the evening was Wally demonstrating to the assembled masses how to properly eat a lobster. Dressed in bright yellow full sou'wester gear, he walked on stage with a lobster held in front of him, joined by Cathie Lowell suitably attired in a red raincoat, carrying the microphone. Wally then arranged a dozen shot glasses containing a dark fluid. He proceeded to drink the first and then tell us how to eat a lobster, explaining that as a young boy, lobster was garbage food that got in the fishing nets and ruined them. He then downed another shot. One of my nephews exclaimed, "Uncle Bill! Is he going to drink *all* of them?" As if in answer, Wally offered a drink to

Cathie, who, with convincing trepidaton, accepted it. Next the lobster was taken apart and with another shot or two, Wally proceeded to eat it, beginning to slur his words. My nephews exclaimed, "He's getting drunk." I explained then to them that Wally didn't drink. The glasses contained coke. But they insisted he was and Wally was slurring his words more and more, and continuing to eat the lobster. Finally Wally took one of the claws and put it in his mouth and with an audible crack, opened it. The assembled masses groaned audibly. Then he took another drink and continued. What we all didn't know was Wally broke a crown with that bite, but didn't stop eating the lobster. After the "show" I introduced my nephews to a very "sober" Wally, and as with all young people, they received a warm reception from him.

Wally and Helen at IEEE Canada's annual spring conference in Calgary, May, 2010. A highlight of the weekend was celebration of Wally's 80th birthday, commemorated with a surprise birthday cake enjoyed by all.

N.Ed.

Many IEEE Canada members have shared with us their wonderful memories of Wally, and payed tribute to his achievements and contributions on so many levels. We appreciate the efforts of everyone. In particular, we heartily thank Bob Alden and Ray Findlay for their perspectives on working with Wally at the Region and International levels, respectively. We also owe a debt of gratitude to Mo and Ferial El-Hawary for recounting additional details of Wally's unparalleled record of service, and for the photo that forms the basis of the background image for this and the previous two pages.

Protocol Engineering: A Historical Perspective

By Gregor v. Bochmann
University of Ottawa

Abstract

During the 1970s and '80s, the first computer communication networks were designed and implemented in the research and commercial sectors. Many of the protocols developed during that time are still in use today. This paper starts by giving an overview of these developments. Then it concentrates on the development of protocol engineering, that is, the methods for the specification of communication protocols and services, the verification of protocols and their implementation and testing. After personal views of the developments in the 1970s, the basic concepts developed at that time are explained. The standardization of Formal Description Techniques in the 1980s is discussed in the following section. The purpose of the paper is to show the long way we have come and to suggest that many of the basic concepts have not changed too much during these years, although more detailed aspects have evolved and given rise to new technological developments.

Sommaire

Le premier réseau de communication informatique fit son apparition au cours des années 70 et 80. Il fut implémenté pour les domaines de la recherche et du secteur commercial. Plusieurs des protocoles développés à ses débuts sont encore utilisés aujourd'hui. Ce document débute par un aperçu de ces développements. Par la suite, il se concentre sur le développement du protocole d'ingénierie, qui est, l'ensemble des méthodes de spécification des protocoles et services de communication, la vérification des protocoles, leur implémentation et les tests. Après plusieurs évaluations des développements effectués durant les années 70, les concepts de base développés à cette époque sont expliqués. La normalisation des techniques de rédaction est abordée dans la section suivante. L'objectif de ce document est de démontrer le progrès réalisé depuis les débuts des réseaux de communication informatiques, d'illustrer certains concepts de base qui ont peu changé et les aspects qui ont évolué afin d'intégrer le développement technologique.

1.0 Introduction

In the 1960s, most computers were used in a batch processing mode. But this was also the time when the first time sharing operating systems were developed, allowing the use of a single computer by several interactive users. However, the transmission quality over the communication lines was not perfect, and it was common to experience transmission errors leading to wrong characters being received. Therefore, this was also the time when the first communication protocols were designed for obtaining reliable data transmission over unreliable communication links.

The next decade was the time when the first computer networks were developed, including the precursors of the Internet. This required a number of different communication protocols for different purposes, e.g. routing, and it became customary to introduce some form of hierarchical layering in order to organize the complexity of the protocols involved. The first protocol standard for computer networks was introduced by the International Telecommunications Union (ITU) under the name X.25, and many computer manufacturers developed their own proprietary communication protocols for their line of computers and terminals.

The 1980s brought further technological developments, including personal computers and local area networks. But this time was also characterized by an effort to come up with global standards for computer communications, not only at the link and network layer, but also at the higher layers involving the applications. The OSI standardization effort, which had the goal to allow for the interworking between heterogeneous systems from different manufacturers, was however not successful. Finally, in the early 1990s, the protocols of the Internet were largely adopted in practice, including the newly developed Web protocols HTML and HTTP and rudimentary Internet e-mail protocols developed in the 1970s. Since then, many more protocols have been developed, e.g. for wireless networks and for various applications running over the Internet.

This paper does not so much deal with these protocols, but it gives a perspective of how the engineering methods that are used to design these complex protocols have been developed over the years. These engineering methods, sometimes called "protocol engineering", have to deal with the distributed nature of the protocols, and must include methods for (a) specifying the protocols, (b) verifying that a protocol works correctly and provides some desired communication service, (c) implementing the protocol in software or hardware, and (d) for testing if a given implementation conforms to the requirements of the protocol definition.

The need for such protocol engineering methods was felt during the early times of protocol development in the 1970s, and much work was done during the 1980s in the context of OSI standardization. The purpose of this paper is to describe the early developments of protocol engineering in the 1970s and '80s from the perspective of my own involvement in this field[1].

The paper is structured as follows: In Section 2, we give an overview of the development of computer communications protocols in the 1970s and '80s. In Section 3, we first provide some comments on our own research path during the 1970s, and then explain the basic concepts of protocol engineering that were explored and defined by the research community during those years. In Section 4, we give a short overview of the development of Formal Description Techniques (FDTs) for communication protocols and services, which took place during the 1980s in the context of the standardization of protocols for Open Systems Interworking (OSI). In the conclusions, we discuss the impact of the early work on protocol engineering on the current methods and tools that are used for developing distributed applications for data processing and communications.

1 This paper is based on a draft from 2009, which was also used for [Boch 11]. Compared with the latter, this paper does not include the contribution by Colin West about his work on SNA and OSI standardization, nor the section on standardization of conformance testing contributed by Dave Rayner.

2. Computer communications in the 1970-80s

2.1 The first computer network protocols

The 1970s and '80s were stimulating times for people working in the area of computer communications. In the late '60s, the first link-level protocols were introduced for remote access, over leased lines, from terminals to host computers. In 1968, Lynch described a protocol with positive and negative acknowledgments which was not fully reliable, as pointed out by Bartlett et al. in 1969 [Bart 69]. During the same time, IBM had introduced the Bisync protocol which was used for long time (a superficial look at its definition seems to indicate that it had similar flaws as the protocol of Lynch).

Then in the early '70s, a new generation of link protocols was introduced with bit-oriented framing and sequence numbering (initially represented by 3 bits with values from 0 to 7). IBM's SDLC strongly influenced the international standard HDLC developed within the International Standardization Organization (ISO). This protocol was used in 1976 by the International Telecommunications Union (ITU) for their standard network access protocol, called X.25. Note: IBM, at that time, had a dominating market position as computer and software manufacturer, similar to Microsoft in the software domain nowadays.

In the late 1960s, several research projects had been established to experiment with the concept of packet switching. The first two operational packet switched networks were the ARPAnet in the USA and the NPL network at the National Physical Laboratory in the UK. Larry Roberts led the ARPAnet team that had the first nodes of a wide area network operating by December 1969. See Figure 1 for the UCLA ARPAnet node.

Donald Davies led the NPL team that had the world's first local area network operational by 1970. Davies coined the term "packet switching" in 1966 and co-invented the concept along with Paul Baran of the original ARPAnet team. ARPAnet is seen as being the forerunner of today's Internet. The French Cyclade network project, led by Louis Pouzin, introduced the concept of an unreliable datagram service at the Network layer over which an end-to-end Transport layer protocol would build a reliable connection-oriented service, sometimes called "virtual circuits" [Pouzin 1973]. These concepts were later adopted for the IP/TCP protocol hierarchy of the Internet as we know it today.

Figure 1: Leonard Kleinrock (UCLA) with an ARPAnet node. The first demo of the ARPAnet (with protocols very different from the later Internet) included three network nodes in different cities. When Kleinrock tried to establish a connection with one of the other nodes, the latter crashed. The next day, the team was able to make a successful demonstration

During this time, it also became apparent that one needs some standards for interconnecting different packet-switched networks. Protocols that could be used for this purpose were called Internet protocols. An international group of experts was formed in 1972 under the name INWG which became affiliated with the Technical Committee for Communications Systems (TC-6) of the International Federation of Information Processing (IFIP), as Subgroup 6.1. This group met quite frequently and elaborated a set of Internet protocols which included precursors of IP and TCP, a virtual terminal protocol and others. I participated in some of these meetings and had the impression that Vint Cerf from ARPAnet and Louis Pouzin from Cyclade were the principal leaders of the group. Towards the end of the 1970s, these IP/TCP protocols were implemented for the interconnection of Ethernets and satellite networks on an international basis, and the original protocols of the ARPAnet disappeared[2].

2.2 Commercial computer networks

At the same time, the common carrier companies and governmental PTT ("post-telephone-telegraph") organizations had realized that standards for commercial packet-switched networks were required and started to discuss possible approaches within the ITU. Following their tradition of telephone network technology, they opted for a network service of reliable virtual circuits. This meant that at the interface between a host computer and the network, there was the requirement of supporting a large number of such circuits with separate flow control. Therefore, the interface standard X.25 that was adopted in 1976 was much more complex than what would be required for providing a datagram service.

During the mid-70s, there was much polemics concerning the question whether a datagram or a virtual circuit network service would be more appropriate for packet-switched networks. The INWG group had submitted their proposal for datagram and end-to-end Transport protocols to the ITU and tried to convince the PTT experts that their approach was preferable over the virtual circuit approach. However, the ITU stuck to the virtual circuit approach and produced in X.25 a standard network access protocol supporting several multiplexed virtual circuits. Later, a similar standard, called X.75, was defined for the interconnection of different packet-switched networks.

Although the datagram approach had not been adopted by ITU for the network access protocol standard, discussion continued whether this technology would be advantageous to be deployed within a network, internally. The Datapac network developed in Canada by Bell-Northern-Research did use internally datagrams with alternative routing. On the other extreme was the French Transpac network which used virtual circuits internally - where each circuit, when established, was allocated to a fixed route. Arguments were related to resilience against different types of hardware faults and resource requirements in terms of memory requirements in the switches (in case of Transpac) and transmission overhead due to lengthy packet headers (in case of datagrams, plus the Transport protocol required for reliability).

In the meantime, different computer manufacturers had also started developing proprietary protocols for computer communications. The previous decade had seen batch-oriented computer systems evolve towards interactive systems. A systematic approach to providing shared communications facilities that permitted large numbers of terminals to access a variety of applications running on large host machines was needed. The Systems Network Architecture (SNA) defined by IBM in 1974 was much deployed to enable users to access data processing services and devices over distance. SNA was defined as a layered architecture including data link control, routing, flow control, management of shared resources and presentation services.

2.4. Application layer protocols

Given that proprietary computer networking protocols had been developed by different manufacturers - besides SNA, similar protocols had been developed by Digital Equipment Corporation, Honeywell and others - interworking between systems provided by different manufacturers was difficult. In order to simplify the interworking between such systems, the standardization project on Open Systems Interworking (OSI) was initiated within ISO in 1977. It was mainly aimed at standards for distributed applications that would use the X.25 standard as the basic communication service over which the application protocols would run (see [Green 80] for the situation around 1980).

The work on OSI extended over more than 10 years until the early 1990s. As usual, not all parties participating in the standardization meetings were really interested in successful standards, and there were a variety of different interest, which led to relatively complex standard proposals that had options for all kinds of situations. For instance, much discussion took place about the Transport protocol, which is not really required over X.25, but is required if the datagram service is used in the network layer. Because of the input from the Internet community, a Transport protocol Class 4 was introduced, quite similar to TCP. In fact, there were altogether 4 classes of Transport protocols.

We note that the ARPAnet (later called Internet) was continuously in service for the university and research sector within the USA and also in other countries since the mid '70s. Later these protocols were supported by the Berkeley Unix software which was available free of charge within the research community and became widely used in this context. This continuous use of the Internet is the main reason why it finally became the de-facto standard for the current global Internet - much helped by the Web application (originally developed at CERN, Geneva) in the early '90s.

To finish this section, let me mention just two other interesting protocol developments in the 1980s: In 1980, the ITU had defined the Teletext standard. It may be called the Web standard of the '80s. Like the current Web service over the Internet, Teletext was based on the Hypertext concept with its pages, links and anchors. The service was implemented, for instance, in France and Germany, and the Canadian version included graphic images. The main problem was the lack of suitable terminals to display the pages (since desktop computers were not very common at that time). Special Videotext terminals were manufactured and could be rented. Together with my colleague Jan Gecsei and other people, I was involved in several research projects related to Videotext (see e.g. [Tompa 81]).

Within the OSI framework, many application-layer protocols were developed. For the description of these protocols, aspects related to the data structures of the parameters of service primitives and protocol messages are usually much more important than the temporal ordering of interactions specified by state machine models. To describe these data structures, the ASN.1 notation was developed and used for most OSI application protocols. (Note: this was probably influenced by an earlier protocol for Remote Procedure Calls (RPC) developed at the Xerox Parc research center). ASN.1 also includes standards for encoding the structured information. Several encoding standards were developed, based on

2 An account of these developments and the emergence of the Internet as the general networking infrastructure in the 1990ies is given in [Hauben].

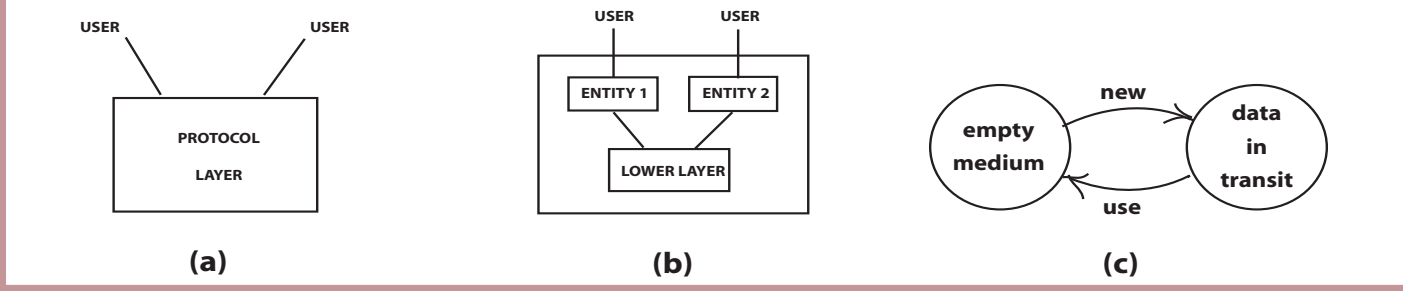


Figure 2: (a) service of a protocol layer, (b) protocol architecture, (c) behavioral specification of a simple service

octet-oriented encoding of tags and lengths indicators. In the mid-'80s, several tools were developed for automatically generating encoding and decoding routines for protocol messages defined using this description method. Nowadays, XML is often used for the same purpose, and associated encoding and decoding tools are available from various sources.

3.0 Development of protocol engineering methods in the 1970s

3.1. A personal view of early developments

In the early 1970s, I was working on compiler design, semantic attributes and methods for defining the semantics of programming languages. However, I was looking for a younger field of investigation with more open problems. In 1973 or '74, I attended a conference on computer communications where I met Louis Pouzin who was talking about the need for standard communication protocols to allow the interworking between different computer networks developed in different parts of the world. Pouzin told me that good methods for precisely defining the communication protocols were needed and so were methods for verifying that they provide the communication service that is expected. The question how these protocols and services could be formally defined was not known. His comments motivated me to work in this area, so I experimented with different specification paradigms for specifying protocols.

On the one hand, I explored the use of finite state machines, inspired by the paper by Bartlett et al. [Bart 69] on the alternating bit protocol which used a state machine formalism[3]. In this context, I developed the method of protocol verification by reachability analysis which I also applied to the X.25 protocol standard [Boch 78i]. On the other hand, I also tried a specification style using a programming language and assertions such that properties of specifications could be proven using program proving techniques for concurrent systems [Boch 75c]. A year later, a journal publication by Stenning appeared presenting a very similar protocol verification. It was clear that certain protocol features, such as sequence numbering, cannot be adequately described by state machines, although the state machine approach appears to be natural for many aspects of protocols. Therefore, I proposed in 1977 an approach combining both methods in the form of an extended state machine, adding state variables, interaction parameters and assignment statements [Boch 77c], very similar to today's UML state diagrams.

When I presented this paper at the IFIP Congress 1977 in Toronto, I met Pitro Zafiropulo who showed me some work he had done independently with Harry Rudin and Colin West at the IBM Research Lab in Zürich. They had developed a protocol verification technique very similar to mine [Rudin 78, Zafi 80]. Colin West had also built some automated tool for performing verifications which he applied to several protocols, including the ITU standard X.21 [West 78b]. (More details about the work of this group in the context of SNA and OSI standardization can be found in [Boch 11]).

3 After my discussion with Louis Pouzin, I found the paper by Bartlett et al. on the alternating bit protocol and I tried to develop a formal model of this protocol and to prove that it provides a reliable communication service. The paper by Bartlett included already a description of the protocol using a state machine model. The result of my work was written down in a working document in 1974 of which only a summary was included in my 1975 conference presentation [Boch 75d] because of lack of space. Later I applied the same method to the X.25 protocol; these results were included, together with the details of the 1974 document, in my presentation at the Liège conference [Dant 78]. .

The Computer Network Protocols Symposium [Danthine 1978] organized in February 1978 by André Danthine in Liège was the first international conference dedicated to the design of communication protocols. At this conference, for the first time, I met many people interested in similar questions, and I have kept contact with many of them over long time. There were many papers on methods for defining and verifying protocols, and also many papers related to special protocols, and in particular to the newly adopted ITU standard X.25 for computer communications. Several of the papers presented at this conference were later published in enhanced versions in Computer Network. This is also where I met Carl Sunshine who had already written some paper surveying different methods for protocol specification and verification, and with whom I wrote the survey paper that appeared in the [Boch 80a].

3.2. Some important concepts

Many of the important concepts for protocol engineering were elaborated during the 1970s. In the following, I will high-light some of these developments. More references for these topics can be found in [Boch 11].

3.2.1. Protocol layering - communication service

The concept of protocol layering became well-known through the OSI standardization effort which defined seven protocol layers. These ideas were first developed within the French Cyclade network in the early 1970s, distinguishing between an unreliable datagram network service and a reliable end-to-end transport service with corresponding protocols (see for instance [Pouzin 1973]). A protocol layer is characterized by its protocol (defined by the behavior of the protocol entities) and the communication service it provides. The importance of both, protocol and service descriptions, was clearly explained in our survey with Sunshine in 1980 [Boch 80a]. The architectural diagrams are shown in Figure 2 (a) and (b). The first formal model of a communication service was perhaps the (very simple) service of the alternating bit protocol shown in Figure 2(c) (taken from [Boch 78i] - by the New primitive one user submits data, which is received by the other user through the Use primitive). The formalized description of more complex communication services was discussed in [Boch 80e], where I made the distinction between local properties (related to the interactions at a single service access point - and therefore locally observed by each protocol entity) and global properties (relating interactions at different service access points - the properties of the communication service "proper"). This concept was generalized in my paper with Michel Raynal in 1983 [Boch 83a] to arbitrary multi-component architectures.

3.2.2. Interworking between heterogeneous networks

With the development of experimental packet-switched networks in several countries during the first half of the 1970s, and the development of commercial packet-switched networks in the second half, the interconnection of different networks and their interworking became a major issue (see for instance [Green 86]). The first paper I remember on the principles of interworking between heterogeneous networks was written by Gien and Zimmermann in 1979 [Gien 79]. They pointed out that the interconnection must be realized at the service level; it requires compatible services within the two interconnected networks. Much of the later work did not take this into account. My papers from 1990 "(e.g., see [Boch 90b])" tried to put these principles into a formal setting.

3.2.3. The role of protocol specifications

Towards the end of the 1970s, it became clear that a precise protocol specification is important because it should be (a) the starting point for the verification of the correctness of the protocol design (against the service specification), (b) the basis for the development of implementations on different computers that would be compatible with one another,

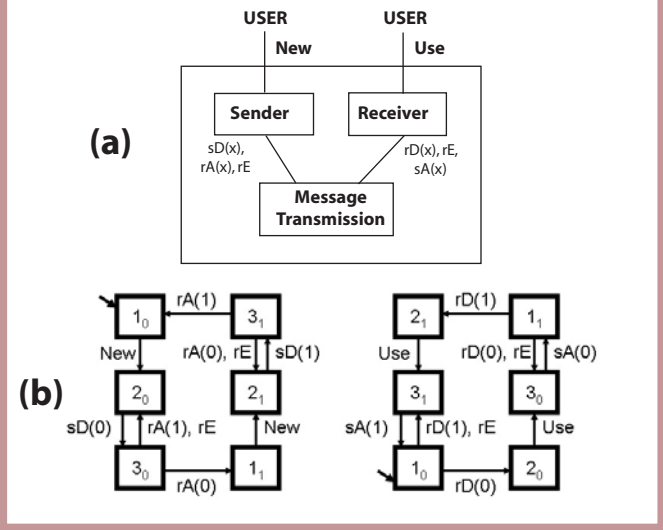


Figure 3: (a) architectural view, (b) protocol specification (dynamic behavior of the two protocol entities)

and (c) the reference for developing test cases by which a given implementation could be checked for conformance with the protocol specification. This fact is reflected in the title of the IFIP conference series on Protocol Specification, Testing and Verification (PSTV) which started in 1981, and also led to the formation of a working group on Formal Description Techniques (FDT) for OSI Protocols and Services within the OSI standardization effort of ISO (see below). At the 1978 workshop in Liège, John Day talked about the need for precise protocol specifications in the context of the OSI standardization, which had just started the year before.

One important aspect of protocol specifications is their relative abstractness. In particular, the interfaces of a protocol entity with the layer below and with the user in the layer above must be specified in an abstract manner in order to allow different realizations of these interfaces for different implementations. This led to the concept of "service primitives" which was used to define the OSI layer services. Abstractness is also required for the description of the dynamic behavior of protocol entities; for instance, often different acknowledgement schemes are allowed for a protocol and could be implemented in different manners.

The specification of a protocol consists of defining the dynamic behavior of the two protocol entities (see Figure 2(b)). As an example, Figure 3(b) shows the state machine models of the two entities of the alternating bit protocol, the sender on the left, and the receiver on the right. Figure 3(a) shows the system architecture including the service primitives New and Use and the interactions with the underlying message transmission layer ("s" means send, "r" means receive, "D" means data packet, "A" means acknowledgement packet, "E" means a received message with error, and the value of x represents the alternative bit - with value 0 or 1).

3.2.4 Protocol verification and reachability analysis

It soon was apparent that one has to be very careful when designing a new communication protocol. Already the paper describing the alternating bit protocol in 1969 [Bart 69] pointed out a bug in the design of an earlier bit-based protocol. Sunshine's surveys on protocol description and verification methods (and his collection of articles [Sunshine 1981]) show the many different approaches that were used to specify the properties of the dynamic behavior of protocol entities and related methods to show that their communications would lead to an overall desired behavior.

This work led to the distinction of general properties that each protocol should satisfy and specific properties that are required by the communication service that is intended to be provided by the protocol [Boch 80a]. The general properties state the absence of certain flaws, including well-known concepts such as deadlocks, but also the concept of "unspecified reception", first described by the IBM Zürich team. The first proofs that some (very simple) specific properties of the communication service are satisfied were included in my papers of 1975.

The term "reachability analysis" has been used to describe a verification approach where one considers a global system consisting of the protocol entities and the underlying communication medium and where the protocol specification is used to determine the possible state transitions that

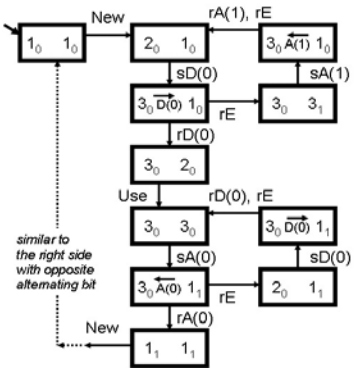


Figure 4: Reachability graph of the alternating bit protocol

may occur in the global system. Reachability analysis then consists of exploring all possible global states that can be reached from the initial state of the system. As an example, Figure 4 shows the global reachability graph of the alternating bit protocol, assuming that no message is completely lost. Each state of the graph is characterized by the state of the two protocol entities (e.g. "20 10" means that the sender is in state 20 and the receiver in state 10; any message in transit is also indicated.)

By analyzing this global reachability graph, one can determine whether the general properties and certain service requirements are satisfied. When I worked on these problems, I noted that such ideas had been proposed in a more general context. In the context of communication protocols, the state transitions are usually associated with the sending or receiving of protocol messages or with the loss or error in the transmission medium. This led to certain models for the communication medium that were incorporated in certain verification tools, and specific types of errors, such as "unspecified reception". For instance, the graph of Figure 4 shows that the service primitives New and Use are executed alternatively, as required by the service definition in Figure 2(c) - unless all messages are received in error.

While the reachability analysis for certain simple protocols have been done "by hand", any real-life application of this method requires automated tools because of the large number of reachable global states. As mentioned above, the first tools for this purpose were developed within IBM Zürich. Later many other tools were developed, not only for finite state machine models, but also for many other specification formalisms. Holzmann's SPIN tool [Holz 91], initially developed in the early 1980s and continuously improved, introduced the so-called bit-state representation where, through hashing, a global state is represented by a single bit; this allows the analysis of very large state spaces. Many of these tools have been extended to the realm of model checking, where in addition to the detection of deadlocks and unspecified receptions in the model, the designer can specify specific properties in temporal logic that will then be checked by the tool.

3.2.5 Constructive methods for protocol design

While protocol verification is intended for checking whether a given specification of a protocol has all the desired general properties and satisfies the requirements of the desired communication service, some researchers explored constructive methods for protocol design. The objective was to find methods for constructing automatically, or semi-automatically, a protocol specification that has the given desired properties. The obtained protocol designs would then be "correct by construction". We can mention a semi-automatic approach described in [Zafi 80], and the "submodule construction" approach proposed in [Boch 80d]; however, both methods require the user to input major parts of the protocol specification. The latter approach was later found to be useful for discovering the behavior of a protocol converter, for finding a controller in discrete-event control applications, for embedded testing, and possibly for component re-use.

I think that the following two methods proposed in the 1980s are more interesting for protocol construction. At the first PSTV workshop in 1981, Gouda and Yu presented an interesting method for designing communication protocols without deadlocks and with bounded communication channels (see journal version [Gouda 84]). The method starts with the specification of one protocol entity, and ignores the communication service. Its main contribution is to show how conflicting initiatives from the different protocol entities can be resolved.

Another protocol derivation approach was proposed in my paper with Reinhard Gotzhein in 1986 [Boch 86g]. Here it is assumed that the specification of the communication service is given, including two or more service access points. The method allows the derivation of the behavior of the protocol entities for each of the service access points, including the exchange of protocol messages between the different entities for coordinating the temporal order of service interactions at the different service access points. A reliable underlying message transmission service is assumed. Over the years, this method has been adapted to various specification paradigms, and it can be used for deriving component behaviors for distributed applications concerned with business processes, workflow and other systems where the dynamic behavior may be described by collaborations performed in some specific temporal order [Boch 08b].

3.3.6. Tools for protocol implementation

A verified protocol specification is clearly the starting point for protocol implementation. While finite state machine models are easy to implement in hardware and software, extended state models and the Formal Description Techniques (FDT) developed in the 1980s require more complex implementation structures, especially related to the concurrency of the model specifications. Automated tools (compilers) for generating implementation code have been developed for these specification languages since the early 1980s. These developments later led to commercial modeling tools, for instance for the SDL language, which now has been integrated into the UML modeling framework.

3.3.7. Specification-based testing

In the context of protocol standardization, conformance testing is an important issue. The question is how to test a protocol implementation to determine whether it conforms to the protocol standard. It is clear, therefore, that the test cases to be applied to the protocol implementation should be based on the protocol specification that defines the standard. Since the early 1980s, much research was aimed at test suite development, that is, developing methods for finding a set of test cases, based on a given protocol specification, that would find most faults that may exist in any implementation. The first publication on this topic was probably Sarikaya's paper at the 1982 PSTV conference, in which he adapts the so-called W-method, originally developed for testing software components, to protocol testing based on FSM models. In the subsequent journal paper [Sari 84], he also discussed the problems related to the synchronization between different interfaces—a problem specific to protocol testing.

Since then a large body or research results have been established by researchers around the world[4]. On the one hand, tests for specific faults were considered, such as output and transition faults for state machines. On the other hand, test development methods were adapted to extended state machine models and other specification languages, such as Input/Output Automata and process algebras. While most methods provide a fixed set of test cases, other methods consider adaptive testing where the next test input depends on the previous interactions.

3.4. Conferences on protocol specification, verification and testing

The first international conference concentrating on protocol specification, verification and testing was organized by Dave Rayner 1981 in Teddington (UK) under the title "Protocol Testing - Towards Proof ?". Sponsored by Working Group 6 of IFIP, this conference started the series of conferences under the name "Protocol Specification, Testing and Verification" (PSTV). This became the principal conference for the discussion of formal description techniques, and methods and tools for protocol verification, implementation and testing. In 1988, when the ISO FDTs had been standardized, Ken Turner started a second, parallel conference series called Formal Description Techniques (FORTE) which concentrated more on the FDTs, their tools and practical applications. Later in 1996, when the general interest in these FDTs had decreased, these two conference series were combined into a single conference under the name "Formal Techniques for Networked and Distributed Systems" (FORTE).

In 1988, also a conference series on protocol conformance testing was started by Son Vuong in Vancouver (Canada) under sponsorship from IFIP. Initially called International Workshop on Protocol Test Systems (IWPTS), it was later called International Conference on Testing Communicating Systems (TestCom) and became more recently a joint conference with the International Workshop on Formal Approaches to Testing of Software (FATES). Since that time, most of the research results on protocol testing have been presented at this specialized conference.

The bibliographical information and the tables of content for most of these conferences can be found on the Internet [conferences].

4.0 Standardization of formal description techniques for communication protocols and services

As noted above, the people involved in the standardization of OSI protocols and services were looking for description techniques that could be used to define protocols precisely and that would be associated with tools that would be helpful for verification, implementation and conformance testing. In 1980 an "FDT Group" was formed within ISO under the leadership of John Day. Initially, the group concentrated on writing guidelines about how to informally describe communication protocols and services, which were used by the various OSI subgroups for writing protocol and service descriptions. Then the group attacked the problem of defining formal techniques for which tool support would be possible to develop. The experts participating in the group had different interests and therefore various approaches to protocol specification were proposed. This led finally to the formation of three subgroups A, B and C with subgroups B and C developing different techniques. Subgroup B developed an extended FSM formalism, later called Estelle, in which I participated, and subgroup C developed a formalism based on rendezvous communication, later called LOTOS. The early stage of development of these languages is described in a paper by Vissers et al. [Vissers 83]. During the development of these FDTs, the OSI Transport protocol Class 2 was often used as an example to show the effectiveness of the FDT. Later, in order to provide some comparison between different FDTs, I published example specifications of this protocol in the three FDTs (Estelle, LOTOS and SDL) [Boch 90a].

At this time, the ITU had already defined the System Description Language (SDL) which had been developed over several 4-year study periods. This was in fact an FDT based on the extended FSM model, and therefore the question came up whether Estelle and SDL could be developed jointly into a single language. This gave rise to the first joint working meeting between ISO and ITU experts, which was held in Ottawa in 1984, and which I had the honor to chair. (Note that up to that time, the development of OSI protocols had been done by ISO and ITU in separate meetings.) It was decided that the FDT experts from OSI and ITU should get together and draft a proposal for a joint FDT as a candidate to be discussed afterwards by the respective parent organizations. However, the resulting document, called X.250 within ITU, was not accepted, and the development of these two languages continued independently.

During that time, the OSI experts were waiting for an FDT that they could use for describing the new OSI protocols. However, the development of the FDT's was not complete, and the question of which FDT should be used was very sensitive. The subgroup working on guidelines for conformance testing, led by Dave Rayner, expressed a strong need for an FDT, since they were looking for a language to define conformance test cases. Since the testing experts did not want to select one of the proposed FDTs, they finally decided to develop yet another language, called TTCN (acronym for Tree-Table-Combined-Notation, not related to any FDT), which has since then been used in the area of conformance testing.

Estelle and LOTOS became ISO standards around 1986, but were not used much. SDL was further developed within ITU and was used for the description of ITU protocol standards. An overview of the state of the art of protocol specifications using informal and formal techniques at that time is given in [Boch 90g]. Looking back to this time of FDT development, one has to conclude that these description methods and the related tools were not much used for the purpose they were developed (except for SDL). One can give different reasons for explaining this.

1. The community was not ready to use formal modeling approaches to define requirements for protocol implementations.
2. The implicit competition between the three different languages made it difficult for practitioners to make the choice.
3. The OSI protocols, for which the FDTs were originally intended, did not have much success themselves.

A further reason was that the specification techniques in use for OSI protocols were already quite good and extremely useful. For example, the OSI Session Layer was specified in terms of tabular finite state machines. In 1985 Colin West found it quite easy to transform these into

[4] An invited paper at the 1994 International Symposium on Software Testing and Analysis, gave a review of these methods and discussed their relevance to software testing in general [Boch 94].

an executable model that he validated using the reachability analysis techniques he used earlier for SNA [West 86]. A substantial number of errors were found.

5.0 Conclusions

This historical retrospective indicates that the basic concepts related to the specification of communication protocols and services, the verification of protocols and their implementation and testing originally developed in the 1970s and '80s are still valid today. Many things have remained the same, although over the years, the more detailed aspects have evolved and given rise to new technological developments. The IFIP conferences in the field of protocol engineering, namely PSTV, FORTE and TestCom, have played an important role in maintaining the tradition in this field and providing a forum for the discussions of new developments in these areas.

During the first half of the 1980s, there was some form of hype on Formal Description Techniques (FDT). Industry had high hopes that formal specifications of protocol standards, especially in the context of OSI, would lead to less ambiguous definitions of protocols, and would lead, through the use of automated tools, to simpler methods for verification, implementation and conformance testing. However, these hopes did not materialize, and in addition, the push for OSI protocols slowed down during the second half of the decade. This was a big disappointment for the FDT community.

We note, however, that the results of the work on protocol engineering, formal description techniques and the related tools for protocol verification, implementation and testing had an important impact by being carried over to the current state of the art, and having been used for many practical applications in different fields, as explained in the following paragraphs.

Layered protocol architecture: The conceptual layered architecture for communication protocols, as developed during the 1970s, and standardized as the OSI Reference Model in the early '80s, are nowadays part of each good text book on computer communications.

Model checking: In a sense, the reachability analysis tool of Colin West was the first model checker - able to check a model of several protocol entities for general types of flaws, such as deadlocks and unspecified receptions. The invention of "model checking" by Clark, Emmerson and Sifakis, in 1981, also provided for the checking of specific properties specified in temporal logic. During my visit at Havard University in 1982, Edmund Clark was excited about the fact that his model checking algorithm could not only check properties of a given state machine model, but also properties of protocols and provided communication services - by applying his algorithm to the global state model obtained by reachability analysis. The SPIN tool developed by Gerald Holzmann since the early 1980s is an example of a successful model checking tool that started out as a tool for reachability analysis and, over the years, incorporated many advances in the field, including checking temporal logic properties [Holz 91]. This tool has been used for many practical applications of hardware and software verification. The community of people using the tool has been growing over the years and meets at annual SPIN workshops.

UML tools: As mentioned above, the ITU had developed over the years (since the late '70s) a standard FDT, called System Description Language (SDL). It was used for describing many communication protocol standards and other industrial systems, and its commercial tools, developed in the 1990s, have been used for the development of commercial protocol implementations, for instance in the wireless telephony sector. The most successful tool was produced by the Swedish company Telelogic (recently bought by IBM); it includes code generation for model simulation and implementation, as well as advanced reachability analysis functions. Recently, SDL has been integrated into UML-2 as a profile, and the tools are adapted to this new context.

Model-driven development: This term has recently become a fashionable concept. Protocol engineering has used this approach since its beginning. The reason for this is the fact that a protocol specification should be relatively abstract (in order to allow for different implementations and APIs) and precise (in order to guarantee compatibility of different implementations). The protocol specification is therefore an abstract model of the final implementation, and protocol verification is done at the model level. In fact, the FDTs, SDL and Estelle, as well as Harel's State Charts of 1987 are languages based on the principle of extended finite state machines from the 1970s, and they can be considered to be ancestors of the State Diagram notation now part of UML.

References

[Bart 69] K. A. Bartlett, R. A. Scantlebury and P. T. Wilkinson, "A note on reliable full-duplex transmission over half-duplex links, ACM Communications," vol. 12, no. 5, May 1969, pp. 260-265.

[Boch 08b] G. v. Bochmann, "Deriving component designs from global requirements," in Proc Int. Workshop on Model Based Architecting and Construction of Embedded Systems (ACES), Toulouse, Sep. 2008.

[Boch 11] G. v. Bochmann, D. Rayner and C. H. West, "Some notes on the history of protocol engineering," Computer Networks, 54 (2010), pp. 3197–3209.

[Boch 75c] G. v. Bochmann, "Logical verification and implementation of protocols," Proc. 4th Data Communication Symposium (ACM-IEEE), pp. 7-15 to 7-20, Oct. 1975, reprinted in Communication Protocol Modeling, edited by C. Sunshine, Artech House Publ., 1981.

[Boch 75d] G. v. Bochmann, "Communication protocols and error recovery procedures," in Proc. ACM Symposium on Interprocess Communication, SIGOPS Review, vol. 9, no.3, pp. 45-50, 1975.

[Boch 77c] G. v. Bochmann and J. Gecsei, "A unified method for the specification and verification of protocols," in Proc. IFIP Congress, pp. 229-234, 1977.

[Boch 78i] G. v. Bochmann, "Finite state description of communication protocols," Computer Networks, vol. 2, 1978, pp. 361-372.

[Boch 80a] G. v. Bochmann and C. A. Sunshine, "Formal methods in communication protocol design," (invited paper) IEEE Trans. Communications, vol. 28, no. 4, Apr. 1980, pp. 624-631, reprinted in Communication Protocol Modeling, edited by C. Sunshine, Artech House Publ., 1981.

[Boch 80d] G. v. Bochmann and P. M. Merlin, "On the construction of communication protocols," ICCC, 1980, pp. 371-378, reprinted in Communication Protocol Modeling, edited by C. Sunshine, Artech House Publ., 1981.

[Boch 80e] G. v. Bochmann, "A general transition model for protocols and communication services," IEEE Trans. Communications, vol. 28, no. 4,Apr. 1980, pp. 643-650, reprinted in Communication Protocol Modeling, edited by C. Sunshine, Artech House Publ., 1981.

[Boch 83a] G. v. Bochmann and M. Raynal, "Structured specification of communicating systems," IEEE Trans. Computers, vol. 32, no. 2, Feb. 1983, pp. 120-133.

[Boch 86g] G. v. Bochmann and R. Gotzhein, "Deriving protocol specifications from service specifications," in Proc. ACM SIGCOMM Symposium, pp. 148-156, 1986.

[Boch 90a] G. v. Bochmann, "Specifications of a simplified Transport protocol using different formal description techniques," Computer Networks and ISDN Systems, vol. 18, no. 5, Jun. 1990, pp. 335-377.

[Boch 90b] G. v. Bochmann and P. Mondain-Monval, "Design principles for communication gateways," IEEE Journal on Selected Areas in Communications, vol. 8, no. 1, Jan. 1990, pp. 12-21; Russian translation: Express Information (overview of western publications), Information Transfer, 1991.

[Boch 90g] G. v. Bochmann, "Protocol specification for OSI," Computer Networks and ISDN Systems, vol. 18, Apr. 1990, pp.167-184.

[Boch 94d] G. v. Bochmann and A. Petrenko, "Protocol testing: Review of methods and relevance for software testing," (invited paper), ACM International Symposium on Software Testing and Analysis (ISSTA), Seattle, USA, pp. 109-124, 1994.

[Conferences] Computer Science Conferences and Workshops, see http://www.informatik.uni-trier.de/~ley/db/conf/index-f.html

[Danthine 1978] Computer Network Protocols Symposium, 13-15 Feb. 1978, organized by André Danthine, Université de Liège, Belgium. See also Computer Networks, vol. 2, no. 4/5, 1978.

[Gien 79] M. Gien and H. Zimmermann, "Design principles for network interconnetion," in Proc. VI Data Communication Symposium (IEEE/ACM), pp. 109-119, 1979.

[Goud 84] M. G. Gouda and Y.-T. Yu, "Synthesis of communicating Finite State Machines with guaranteed progress," IEEE Trans. Communications, vol. 32, no. 7, Jul. 1984, pp. 779-788.

[Green 80] P. E. Green, ed., IEEE Trans. Communications, special issue on Computer Network Architectures and Protocols, Apr. 1980.

[Green 86] P. E. Green, "Protocol conversion," IEEE Trans. Communications, vol. 34, Mar. 1986, pp. 257-268.

[Hauben] Ronda Hauben, Communicating across the boundaries of dissimilar networks, http://www.columbia.edu/~rh120/other/misc/finland416.txt

[Holz 91] G. J. Holzmann, Design and Validation of Computer Protocols, Prentice Hall, 1991.

[Pouzin 73] L. Pouzin, "Presentation and major design aspects of the cyclades computer network," in Proc. 3rd Data Communications Symposium, St. Petersburg, Florida.

[Rudin 78] H. Rudin, C. H. West, P. Zafiropulo, "Automated protocol validation: One chain of development," Computer Networks, vol. 2, no. 4/5, 1978, pp. 373-380.

[Sari 84a] B. Sarikaya and G. v. Bochmann, "Synchronization and specification issues in protocol testing," IEEE Trans. Communications, vol. 32, no. 4, Apr. 1984, pp. 389-395.

[Sunshine 81] C. Sunshine (ed.), Communication Protocol Modeling, Artech House Publ., 1981.

[Tomp 81b] F. W. Tompa, J. Gecsei and G. v. Bochmann, "Data structuring facilities for interactive videotex systems," Computer, vol. 14, no. 8, Aug. 1981, pp. 72-81.

[West 78c] C. West, "General technique for communications protocol validation," IBM Journal for Research and Development, vol. 22, no. 4, 1978, pp. 393-404.

[West 86] C. H. West, "A validation of the OSI session layer protocol," Computer Networks and ISDN Systems, vol. 11, no. 3, Mar. 1986, pp. 173-182.

[Viss 83a] C. A. Vissers, G. v. Bochmann and R. L. Tenney, "Formal description techniques," Proceedings of the IEEE, vol. 71, no. 12, Dec. 1983, pp. 1356-1364; translated into Russian.

[Zafi 80] P. Zafiropulo, C. H. West, H. Rudin and D. D. Cowan, "Towards analyzing and synthesizing protocols," IEEE Trans. Communications, vol. 28, no. 4, Apr. 1980, pp. 651-660.

About the Author

Gregor v. Bochmann (FIEEE) is professor at the School of Information Technology and Engineering at the University of Ottawa since 1998, after 25 years at the University of Montreal. He is a Fellow of IEEE, ACM and the Royal Society of Canada. After initial research work on programming languages and compiler design, he started work on communication protocols around 1974 and developed the field of "protocol engineering," applying software engineering principles to communication protocols.

In the early '80s, he participated in standardization committees of ISO and ITU and took a leading role in the standardization of Formal Description Techniques for communication protocols and services at the Canadian and international levels. He is internationally well recognized for his innovative work on modeling the behavior of distributed systems by extended finite state machines, and on their verification and testing. He has had many research collaborations with industry and, from 1989 to 1997, held the Hewlett-Packard - NSERC - CITI Industrial Research Chair on communication protocols at the University of Montreal.

Dr. Bochmann has received many prizes for his work, including the Thomas W. Eadie Medal of the Royal Society, the Award for Excellence in Research of the University of Ottawa, and in 2011 the IEEE A.G.L. McNaughton Gold Medal. His recent work has been in the areas of software engineering for distributed applications, peer-to-peer systems, quality of service and security management for Web applications, and control procedures for optical networks.

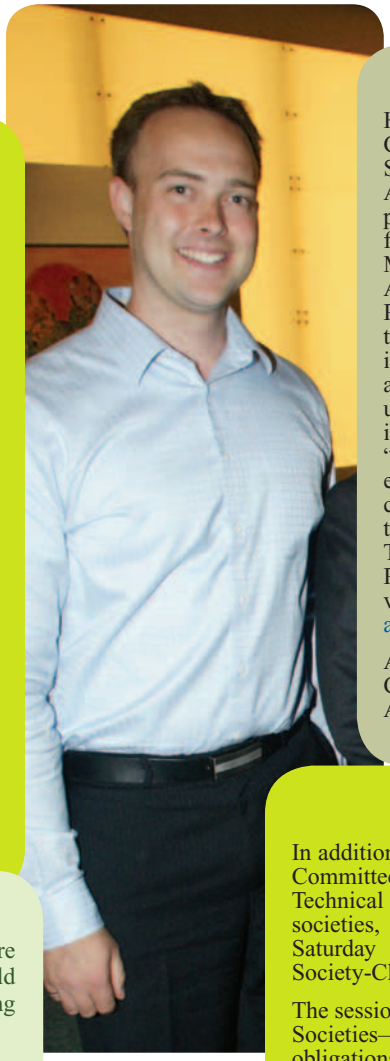
Gregor v. Bochmann in Düsseldorf (Germany) at the opening of an exhibition of paintings of his great-grandfather (see http://www.eecs.uottawa.ca/~bochmann/Maler/) with Bettina Baumgärtel (Art Museum Düsseldorf) and Wilhelm Körs (Galerie an der Börse), August 2002.

Growing up in an artistic family, Dr. Bochmann's mother was an art teacher and his father a sculptor; his father's grandfathers were both well-known painters in Düsseldorf and Schleswig-Holstein (in the northern part of Germany). Since about 1998, one of Dr. Bochmann's hobbies has been the establishment of web sites that show the works of his ancestors.

Empowering Members

IEEE Sections Congress 2011

August, 19–22
San Francisco



Celia Desmond, Toronto Section

I already knew this is one of the best events run by IEEE. I expected to learn about many new IEEE services, and to get some interesting suggestions for IEEE events and for work; I was not disappointed. I also met quite a few new Section and Chapter people and attended some meetings and sessions that provided some helpful ideas. In addition, I was able to help five or six volunteers to sign up for new activities, which is always gratifying.

There was high interest in the Technical Activities sessions and information provided at the related booth. The concept of a Technical Council was new to many—essentially groups of Societies working together in broad areas of technology. They sponsor member activities such as technical meetings, publishing, promoting educational activities, and developing standards. In the main sessions, there was a lot of cross pollination and networking, which is also beneficial.

The visit to the Computer Museum was a local touch that was also good, giving us the opportunity to meet the local Chapters. They have many Chapters and all are very active, attracting 40-200 people to 8-12 talks a year. Very impressive.

I would encourage anyone who attends Sections Congress to arrive with a clear calendar to allow taking advantage of all the offered events.

Simon DeWolf, Atlantic Canada Section

Leading up to Sections Congress, my expectations were mainly to do with gathering what information I could on improving future technical events and contributing to section operations.

But by the second day there, I realized there was much more to be gained, seeing the level of dedication I found in many of the other attendees. This was not only apparent in the success of academics and captains of industry who claimed awards that evening, but also in younger colleagues who I spoke to at the poster exhibits and around the dinner table. Including the keynote, there were at least three speeches that described humanitarian efforts as part of IEEE's focus in the coming years, and a break-out session show-casing projects already implemented in developing countries (such as Peru and Rwanda). Meeting the engineers who had built infrastructure in those countries and seeing the results of their effort was particularly inspirational.

Another thing I found encouraging was that three of the top five MGA recommendations voted on at Sections Congress were in support of helping students get into the field of engineering. I plan to communicate this to my section so we can put more action toward it in Atlantic Canada.

Bill Gruver, Vancouver Section

Having attended the previous Sections Congress in Quebec City in 2008, I noted the program was similar. However, SC2011 perhaps had closer cooperation with Technical Activities in the organization of sessions. It also included poster sessions for the first time, which I had responsibility for organizing, working closely with Dan Toland from the Member and Geographic Activities Board staff, and Loretta Arellano from San Fernando Valley Section; Loretta was also Program Committee Chair. The poster sessions had 44 participants from Regions, Sections, Chapters, and Societies including posters from each of the technical divisions. It was a proud moment for all of Region 7 as Vancouver Section unveiled its entry, presenting their current centennial activities as well as the past accomplishments. I also chaired the "Serve the World" track, and chaired a breakout session entitled "The IEEE Distinguished Lecturer Program –How it can Benefit your Section Members." The breakout session on the DL Program had speakers from IEEE Societies/Councils. There was a wide diversity of approaches among the DL Programs that were presented. The presentations can be viewed at http://www.ieee.org/societies_communities/geo_activities/sections_congress/2011/serve.html#sect8

A high point of SC2011 was a plenary presentation by Vint Cerf, who is recognized as one of the "fathers of the Internet." A very entertaining presentation was given at the Banquet by Grant Imahara, co-host of Mythbusters.

Meliha Selak, Vancouver Section

In addition to attendance by the IEEE Vancouver Section Senior Ex Committee members, I was honoured to represent Societies and Technical Councils. Together with colleagues from other technical societies, I was presenting at one of the Breakout Sessions held Saturday and Sunday. My session was entitled "Squaring the Society-Chapter-Section Triangle."

The session was about the relationships amongst Sections-Chapters-Societies—benefits that a chapter gets from a Section and what obligations a chapter has toward that section. The discussion included subjects related to chapter organizational aspects, and society services to chapters. A chapter can play a vital role in the professional life of its members, with services and support flowing both ways between chapters and societies. There is a need for coordination of chapter activities within sections, with plenty of benefits. Also, section members active in Graduates of the Last Decade (GOLD) and Women In Engineering (WIE) can be a real asset in Chapter Activities.

to Create the Future

Patrick Wong, Southern Alberta Section

During the Breakout Sessions at Sections Congress 2011 (SC2011), speakers shared information on specific topics with attendees. One topic of particular interest is enhancing the vitality of the geographic units. After all, the IEEE has over 5,000 local geographic units globally, and it is essential to recruit new volunteers and keep the current volunteers engaged.

Region 7 also participated in the discussion to increase awareness of local IEEE activities. The use of social media has been widely successful in several regions, and can be implemented for large events or affinity groups. In addition, IEEE Day has been very well received in many regions, and each geographic unit is encouraged to honour IEEE Day to build recognition locally. The presentations at the breakout sessions can be viewed at the following address: http://www.ieee.org/societies_communities/geo_activities/sections_congress/2011/enhance.html

With regards to our achievements, Region 7 had a very strong representation during the Member and Geographic Activities (MGA) awards announcement at the Opening Ceremony. The night opened with recognition for sections with outstanding longevity with the North Saskatchewan, Peterborough, Waterloo-Kitchener, Montreal and Vancouver sections reaching their 25th, 25th, 50th, 75th and 100th year anniversaries respectively. This shows the continuing commitment, support and enthusiasm of our local volunteers. Congratulations to the North Saskatchewan, Peterborough, Waterloo-Kitchener, Montreal and Vancouver sections.

The ceremony continued with recognition for the excellent work of a large section and a small section. The 2010 MGA Outstanding Large Section Award recipient was the Vancouver Section and the 2010 MGA Outstanding Small Section Award recipient was the Canadian Atlantic Section. For 2011, Region 7 (IEEE Canada) continued the momentum with Ottawa Section and London Section receiving these same awards, respectively. Activity highlights of the award recipients can be found at the following address: http://www.ieee.org/societies_communities/geo_activities/awards/recipients/outstanding_section.html

Congratulations to the Vancouver, Canadian Atlantic, Ottawa and London Sections for being selected for these awards.

Canada had a large presence in the IEEE Sections Congress 2011, from the breakout sessions to the award ceremonies. The support from the volunteers for local events and/or participation in them is vital to the success of the local sections, and ultimately the region. Let's continue the momentum in the coming years.

Mazana Armstrong, Vancouver Section

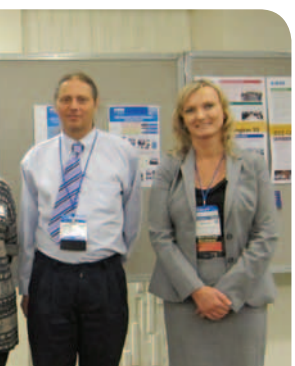
My expectations about the Sections Congress were definitely exceeded. This was the first time I attended, and it was more fun and more engaging than what I had anticipated. It was great to see so many sections from all over the world represented. We were able to meet IEEE staff from Piscataway and better understand the complete range of support to volunteers and member services.

As this is our centennial year, we faced some challenges regarding the compilation of our section's history records. Meeting the people from IEEE History Center and joining the discussion during the breakout session was helpful. We were also able to meet IEEE branding department and discuss our new section logo and plans for a future IEEE monument. Everyone was approachable and it felt like a big IEEE family reunion event. We connected many names with faces, and had an opportunity to meet IEEE leaders and staff from IEEE HQ, who make our volunteer duties easier and more rewarding. We were able to spend an hour meeting with Dr. Moshe Kam, the president of IEEE. We were pleased that he honoured our request to meet with him. One of the most valuable things I have learned is that both support and funding is available for sections' projects and initiatives. So we need to get inspired, set our goals high and good things will happen.

The Congress slogan was about empowering members to create the future, and I would extend that to empowering section volunteers to inspire existing and new members to become active and contribute to our IEEE community. We are the front line of IEEE, often the first and only "human" contact with potential and existing members. For us in the front lines, understanding how IEEE organization works and being aware of all available resources and opportunities can make a huge difference to the operation of any section, anywhere in the world.

I would like to commend IEEE on creating the video "Solutionists"; a truly wonderful tool that explains in very few words what we stand for. The video was shown during our centennial birthday event held just a day after the Congress had ended. We had numerous guests outside the IEEE community commenting on how powerful the video was. It also reminded us, IEEE members, that we have to be proud of the role we continue to play in advancing technology for humanity. The video can be found at the following link: http://solutionists.ieee.org/.

Vancouver Section was established on August 22, 1911 — turning 100 years old on the final day of the 2011 Sections Congress. With IEEE banners kindly loaned from that event, the Section celebrated with style the following day in Vancouver (see photo to right). The celebration included Centennial Awards to the many Section members who have contributed to the City and Province through their work. In the photo to the left, Section members (L to R) Kouros Goodarzi, Meliha Selak, Alon Newton, Mazana Armstrong (Section Chair) stand proudly in front of their entries in the poster contest at Sections Congress.



N.Ed. Many thanks to our writers: Celia Desmond, Simon DeWolf, Bill Gruver, Meliha Selak, Patrick Wong, and Mazana Armstrong. Thanks also to Alfredo Herrera for coordinating the creation of these reports.

Engineering Management: What's New in the Literature?

On: Breakthrough Technologies, Emerging Africa, Career Re-inventors, Today's Admired Companies, How to Retire Happy, India's Population I.D. System, Explosive Urbanization in Emerging Countries

by Terrance Malkinson

- Each year the editors of *MIT Technology Review* analyze technology advances over the past year and choose emerging technologies that they believe will have the greatest impact. A series of ten articles in the June 2011 issue [114(3):41-57, www.technologyreview.com] discuss "breakthroughs that are bursting into our lives." Criterion for inclusion in this annual feature is simple — "is the technology likely to change the world?" Emerging technologies discussed that provide promise to make our lives better include: social indexing, smart transformers, gestural interfaces, cancer genomics, solid-state-batteries, homomorphic encryption, cloud streaming, crash-proof code, separating chromosomes, and synthetic cells. In another emerging technology article published in *The Futurist* [45(3):16-24, May-June 2011, www.wfs.org]; two analysts, James Irvine and Sandra Schwarzbach describe twenty innovations that they believe will have significant impact in the near future and five other technologies that likely will have major long term repercussions. The authors provide interesting insights on "the socio-technological age progression" and "emergence of the new social structure" starting with the agricultural age and progressing through the industrial age, post-industrial age, information age and through to the robotic-biotech age projected for the future.

- Africa is considered to be the world's third-fastest growing region. Consumer pent-up demand is substantial and business opportunities are available in most of the nations of this large continent. African GDP over the past decade has grown by 4.7% a year. In 2009 GDP was valued at $1.6 Trillion. Mutsa Chironga et al in the McKinsey & Company's research study of Africa's economies ["Cracking the Next Growth Market: Africa," *Harvard Business Review*, 89(5):117-122, May 2011, www.hbr.org] analyze and provide strategies for business success that are available in this continent. This economic analysis concludes that we should not ignore Africa; rather we should increase our understanding of how to manage risks, deal with gaps in infrastructure and recognize the diversity of the African markets.

- Douglas Alden Warshaw provides strategies to re-invent yourself, no matter what your age or skill set in a world where job security and pension expectations have disappeared for most employees. ["Pulling Off the Ultimate Career Makeover" *FORTUNE* 164(1): 70-81, July 4 2011, www.fortune.com] The author accomplishes this through a series of five case studies where ordinary individuals believed in themselves and have turned employment setbacks into new sustainable and satisfying careers. An important inset in the article provides six rules for career re-inventors. In another cover story on managing your career, a series of interviews of fourteen company builders who discuss their successes, failures and lessons learned is provided in the July/August 2011 issue of *Inc.* ("How I Did It," pp. 58-73, www.inc.com). One of the best ways you can achieve career success is by learning from the experience of others. These real-life stories provide practical advice on how to do it and then having the courage to act. With respect to risk-taking and career success, failure is an essential component of personal growth. The April 2011 issue of *Harvard Business Review* [89(4), www.hbr.org] focuses on failure: how to understand it, learn from it, and recover from it. Eight comprehensive articles examine the art and science of failing well. Common types of failure, how to learn from failure and why some people don't, why should failure be tolerated, teaching of resilience, how to take the blame for failure and many other aspects of the topic are discussed.

- *FORTUNE*'s annual survey of admired companies started thirteen years ago and more changes occurred this year than in any previous survey. A new world industry and business order has emerged with the global shakeout. This year's survey is presented in "The World's Most Admired Companies." [*FORTUNE*, 163(4):109-147, March 21 2011, www.fortune.com]. Companies such as General Electric, which has led the ranking many times, fell victim. The reason — recession and financial crisis. Companies that were financially conservative, who avoided excessive debt and high priced acquisitions succeeded when others failed. They took advantage of the recession environment to improve their position. As Geoff Colvin states in his conclusion "Good times may be when you make the most money, but bad times may be your greatest opportunity."

- People are living longer, birthrates are dropping, and defined-benefit pension plans / defined contribution plans are often not adequate. Planning your finances in retirement is increasingly becoming the responsibility of the individual rather than considered to be a company or government entitlement. A special 16-page report "Falling Short" in the April l9, 2011 issue of *The Economist* [399 #8728, www.economist.com] provides a series of articles discussing important issues related to the sustainability of pensions. An overview of pension demographic problems is provided in the report's introduction; discussions include increasing the age of retirement, defined-contribution plans, changing employee behaviour to persuade them to make provisions for their old age, economics of public-sector pensions, valuing pensions and the outlook for pensions. First steps suggested in the article include increasing the retirement age and discouraging workers from retiring long before the official pension age. While on the topic of retirement, Ashlea Ebeling in her article "The Inheritors" [*Forbes*, 187(6):46-48, April 11, 2011, www.forbes.com] discusses six strategies that baby boomers might employ as 70% of this cohort group is estimated to soon inherit an estimated $8.4 Trillion. The cover story of the July 18, 2011 issue of *Canadian Business* "How to Retire Happy" [84(11/12):39-49] will provide you with several articles discussing strategies on how to make your "golden years" golden.

- In India a nationwide biometric project is being undertaken to provide a secure identification system for hundreds of millions of people, many of whom are impoverished. ["Identified" *Wired*. pp. 142-146. September 2011. Vince Beiser describes the rationale for this national project, and its challenges and opportunities.

- An article by Daniel Fisher et al, "Urban Outfitter," in the May 9, 2011 issue of *Forbes* [www.forbes.com], describes Siemens Chief Executive Peter Löscher's belief that an explosive worldwide growth of megacities is about to occur [pp. 90-98]. Currently 3.5B people are thought to live in cities worldwide; by 2050 it is estimated that this will grow to 6.2B as a result of mass migrations from rural to urban areas. Providing infrastructure and services will be challenging. A majority of this growth is expected to occur in emerging markets like Asia, Africa, and Latin America, presenting business opportunities. As a footnote, the world's population as counted on the US Census Bureau's Population Clock is quickly approaching 7 Billion [www.census.gov/main/www/popclock.html]. As of September 1 we stand at 6,959,562,432 people.

***Author biography*: see page 7**

Conferences: IEEE & Collaboration • Canada • 2012

CENTRE

2012 World Congress on Internet Security (WorldCIS)
2012-06-10...12, Guelph, ON
http://www.worldcis.orgv

WEST

IEEE Haptics Symposium (HAPTICS)
2012-03-04...07, Vancouver, BC
http://hapticssymposium.org

IEEE Electrical Safety, Technical and Mega Projects Workshop (ESTMP)
2012-03-19...21, Edmonton, AB
http://ewh.ieee.org/soc/ias/tmp

6th Annual IEEE Systems Conference (SysCon)
2012-03-19...23, Vancouver, BC
http://ieeesyscon.org

IEEE Int'l Magnetics Conference (INTERMAG)
2012-05-07...11, Vancouver, BC
http://www.intermagconference.com

…WEST

IEEE Photonics Society Int'l Conference on Optical MEMS and Nanophotonics
2012-08-05...08, Banff, AB
http://www.photonicsconferences.org/conferences

14th IEEE Int'l Workshop on Multimedia Signal Processing (MMSP)
2012-09-17...19, Banff, AB
http://www.mmsp2012.org

EAST

5th IEEE Int'l Conference on Software Testing, Verification and Validation (ICST)
2012-04-17...21, Montréal, QC
http://icst2012.soccerlab.polymtl.ca/Content/home

25th IEEE Canadian Conference on Electrical and Computer Engineering (CCECE)
2012-04-29...05-02, Montréal, QC
http://www.ieee.ca/ccece12

IEEE Int'l Conference on Communications (ICC)
2012-06-10...15, Ottawa, ON
http://www.ieee-icc.org/2012

IEEE/MTT-S Int'l Microwave Symposium (MTT)
2012-06-17...22, Montréal, QC
http://ims2012.mtt.org

79th ARFTG Microwave Measurement Conference (ARFTG)
2012-06-22, Montréal, QC
http://www.arftg.org

American Control Conference (ACC)
2012-06-27...29, Montréal, QC
http://a2c2.org/conferences/acc2012

11th Int'l Conference on Information Sciences, Signal Processing and their Applications (ISSPA)
2012-07-03...05, Montréal, QC
http://www.synchromedia.ca/isspa2012

IEEE Symposium on Computational Intelligence for Security and Defence Applications (CISDA)
2012-07-11...13, Ottawa, ON
http://www.ieeeottawa.ca/ci/cisda2012

IEEE Int'l Conference on Smart Grid Engineering (SGE)
2012-08-27...29, Oshawa, ON
http://www.ieee.org/conferences_events/index.html

2012 IEEE Vehicular Technology Conference (VTC Fall)
2012-09-03...06, Québec City, QC
http://www.ieeevtc.org/vtc2012fall

Contact:
Amir G. Aghdam
Dept. of Elect. and Comp. Eng., Concordia Univ.
1455 de Maisonneuve Blvd. W., EV005.139
Montreal, QC H3G 1M8 Canada
contact@ccece2012.org

Call for Papers and Proposals

The 2012 IEEE Canadian Conference on Electrical and Computer Engineering will be held in Montréal, Québec, Canada, April 29 to May 2 at Hotel Fairmont The Queen Elizabeth. CCECE 2012 provides a forum for the presentation of electrical and computer engineering research and development from Canada and around the world. **Plenary speakers** include **Alessandro Astolfi** from Imperial College London, **Gregor Bochmann** from the University of Ottawa, **Peter Caines** from McGill University, **Vahid Tarokh** from Harvard University and **Ke Wu** from École Polytechnique de Montréal.

Papers are invited, in French or English, for the following symposia (*Chairs below title*):

- **Circuits, Devices and Systems**
  Dr. Zahangir Kabir
  (Concordia University)
  Dr. Shahriar Mirabbasi
  (University of British Columbia)
- **Control and Robotics**
  Dr. Joshua Marshall
  (Queen's University)
  Dr. Stephen Smith
  (University of Waterloo)
- **Power Electronics & Energy Systems**
  Dr. Olivier Trescases
  (University of Toronto)
  Dr. Bala Venkatesh
  (Ryerson University)
- **Signal and Multimedia Processing**
  Dr. Fabrice Labeau
  (McGill University)
  Dr. Xianbin Wang
  (University of Western Ontario)
- **Biomedical and Health Informatics**
  Dr. Tiago H. Falk
  (Institut National de la Recherche Scientifique)
  Dr. Carolyn McGregor
  (University of Ontario Institute of Technology)
- **Computers, Software & Applications**
  Dr. Hamid Mcheick
  (Université du Québec à Chicoutimi)
  Dr. Jagath Samarabandu
  (University of Western Ontario)
- **Communications and Networking**
  Dr. Anader Benyamin-Seeyar
  (Concordia University)
  Dr. Mark Coates
  (McGill University)
  Dr. Shahram Yousefi
  (Queen's University)

NOTE: Selected papers accepted in this conference will be proposed for publication in IEEE *Systems Journal* and IEEE *Canadian Journal of Electrical & Computer Engineering*, after another round of review of extended versions. Authors wishing to submit papers that do not fit within any of the symposia topics listed above are encouraged to do so to the "general interest" symposium. All papers presented in this conference will appear in IEEE Xplore.

Regular Paper Submission

Please submit original full length paper(s) to the Technical Program Committee using the on-line submission process on our web site at http://www.ccece2012.org before January 7, 2012. Click on "Submit Paper" and follow the instructions provided.

Tutorial and Workshop Proposals Submission

Proposals for half-day tutorials and workshops should be submitted before December 2, 2011 to the Tutorials and Workshop Chairs at tutorials@ccece2012.org.

Important Dates

Tutorial or workshop proposals must be received by: ..... Friday, December 2, 2011
Full length papers must be received by: ..... Friday, January 7, 2012
Notification of acceptance/rejection will be sent out by: ..... Friday, February 24, 2012
Final papers must be received by: ..... Friday, March 9, 2012
Authors' Registration ends by: ..... Friday, March 9, 2012
Advance Registration ends by: ..... Friday, March 30, 2012

Industrial Exhibits and Sponsorships

For industrial exhibits please contact the Industrial Exhibits Chair at exhibits@ccece2012.org.
For sponsorships please contact the Sponsorships Chairs at sponsorship@ccece2012.org.

Questions or Comments

For any questions or comments, please contact the Conference Chair:
Amir G. Aghdam. Ph: 514 848-2424 Ext. 4137, Fax: 514 848-2802 Email: aghdam@ece.concordia.ca

Appel de communications et propositions

Le Congrès canadien de génie électrique et informatique édition 2012 aura lieu à Montréal (Québec), Canada du 29 avril au 2 mai au Fairmont Le Reine Elizabeth. Le CCGÉI 2012 constitue un forum où les recherches et développements en génie électrique et informatique effectués au Canada et dans le reste du monde sont présentés. **Les conférenciers de séances plénières** incluent **Alessandro Astolfi** de Imperial College London, **Gregor Bochmann** de l'Université d'Ottawa, **Peter Caines** de McGill University, **Vahid Tarokh** de Harvard University et **Ke Wu** de l'École Polytechnique de Montréal.

Nous vous invitons à présenter des communications, en français ou en anglais, pour les symposiums suivants (*Les présidents sont présentés sous le titre*):

- **Circuits, dispositifs et systèmes**
  Dr. Zahangir Kabir
  (Concordia University)
  Dr. Shahriar Mirabbasi
  (University of British Columbia)
- **Commande et robotique**
  Dr. Joshua Marshall
  (Queen's University)
  Dr. Stephen Smith
  (University of Waterloo)
- **Traitement du signal et multimédia**
  Dr. Fabrice Labeau
  (McGill University)
  Dr. Xianbin Wang
  (University of Western Ontario)
- **Électronique de puissance et systèmes énergétiques**
  Dr. Olivier Trescases
  (University of Toronto)
  Dr. Bala Venkatesh
  (Ryerson University)
- **Informatique santé et biomédicale**
  Dr. Tiago H. Falk
  (Institut National de la Recherche Scientifique)
  Dr. Carolyn McGregor
  (University of Ontario Institute of Technology)
- **Ordinateurs, logiciels et applications**
  Dr. Hamid Mcheick
  (Université du Québec à Chicoutimi)
  Dr. Jagath Samarabandu
  (University of Western Ontario)
- **Communications et réseaux**
  Dr. Anader Benyamin-Seeyar
  (Concordia University)
  Dr. Mark Coates
  (McGill University)
  Dr. Shahram Yousefi
  (Queen's University)

N.B.: Les articles sélectionnés pour cette conférence seront proposés pour publication dans l'*IEEE Systems Journal* et le *Journal canadien de génie électrique et informatique*, après un autre cycle de révision de versions étendues. Les personnes qui souhaitent soumettre des communications sur un thème autre que ceux indiqués ci-dessus sont encouragés à le faire dans le cadre d'un symposium « général ». Tous les articles présentés lors de cette conférence apparaîtront dans IEEE Xplore.

Soumission d'une communication régulière

Veuillez soumettre votre (vos) communication(s) originale(s) complète(s) au Comité du programme technique en utilisant le processus de soumission en ligne sur notre site web à http://www.ccece2012.org avant le 7 janvier 2012. Cliquer sur « Soumission d'une communication » et suivre les instructions fournies.

Soumission d'une proposition de séance didactique et d'atelier

Les propositions de séance didactique et d'atelier d'une demi-journée devraient être soumises avant le 2 décembre 2011 au présidents en charge des séances didactiques et d'atelier à tutorials@ccece2012.org.

Dates importantes

Date limite des propositions de séance didactique ou d'atelier : ..... vendredi 2 décembre 2011
Date limite d'envoi de communication complète : ..... vendredi 7 janvier 2012
Date de notification d'acceptation/refus : ..... vendredi 24 février 2012
Date limite pour la soumission finale des articles : ..... vendredi 9 mars 2012
Date limite d'inscription des auteurs : ..... vendredi 9 mars 2012
Date limite d'inscription anticipée : ..... vendredi 30 mars 2012

Expositions industrielles et parrainages

Pour les expositions industrielles, veuillez contacter le président en charge des expositions industrielles à exhibits@ccece2012.org. Pour les parrainages, veuillez contacter les présidents en charge de ces dossiers à sponsorship@ccece2012.org.

Appel pour réviseurs, questions ou commentaires

Pour toutes autres questions ou commentaires, svp contactez le président de la conférence: Amir G. Aghdam. Ph: 514 848-2424 Ext. 4137, Fax: 514 848-2802 Email: aghdam@ece.concordia.ca

Comité organisateur

Président du congrès
Dr. Amir G. Aghdam
Concordia University

Prés. Programme technique
Dr. Gerry Moschopoulos
University of Western Ontario
Dr. Lacra Pavel
University of Toronto
Dr. Scott Yam
Queen's University

Séances didactiques et ateliers
Dr. Jason Gu
Dalhousie University
Dr. Javad Lavaei
Stanford University
Ms. Somayeh Sojoudi
California Institute of Technology

Finances
Dr. Yousef Shayan
Concordia University

Arrangements locaux
Dr. Anader Benyamin-Seeyar
Concordia University
Mr. Jean-Claude Latortue
Université du Québec à Montréal

Publications
Dr. Mojtaba Kahrizi
Concordia University
Dr. Roni Khazaka
McGill University

Publicité
Dr. Ahmad Fakharian
Lulea University of Technology
Dr. Nazih Khaddaj Mallat
École Polytechnique de Montréal
Dr. Farhad Mehdipour
Kyushu University

Inscription
Dr. Anjali Awasthi
Concordia University
Ms. Preeti Raman
ByteMatters Technology Inc.

Exposition Industrielle
Dr. Kyarash Shahriari
CRIQ

Parrainage
Dr. Alain Abran
Dr. Mohamed Cheriet
Dr. François Gagnon
École de technologie supérieure

Traduction
Dr. Christian Pepin
Université du Québec à Trois-Rivières

Activités étudiantes
Dr. Abdelwahab Hamou-Lhadj
Concordia University
Mr. Muhammad Tariqus Salam
École Polytechnique de Montréal

Webmestre
Mr. Seyed Kian Jalaleddini
McGill University

Comité consultatif IEEE Canada
Dr. Sri Krishnan
Ryerson University

Contact:
Amir G. Aghdam
Dept. of Elect. and Comp. Eng., Concordia Univ.
1455 de Maisonneuve Blvd. W., EV005.139
Montreal, QC H3G 1M8 Canada
contact@ccece2012.org

Over 50% have done it.

OVER 50% OF THOSE WHO SHOPPED WITH THE PERSONAL ACTUALLY BOUGHT!

An easy way to save money in minutes

Great odds means there's a good chance that with one call to The Personal you'll be enjoying the benefits of being part of a group, too!

Call or click for your home or auto insurance quote

1-888-476-8737

thepersonal.com/**ieee**

IEEE

IEEE Canada

thePersonal®
Home and Auto Group Insurance

Source: Sales Summary Report, The Personal, December 2010. Certain conditions apply. Auto insurance not available in Manitoba, Saskatchewan, and British Columbia due to government-run plans. ® Registered trademark of The Personal Insurance Company.