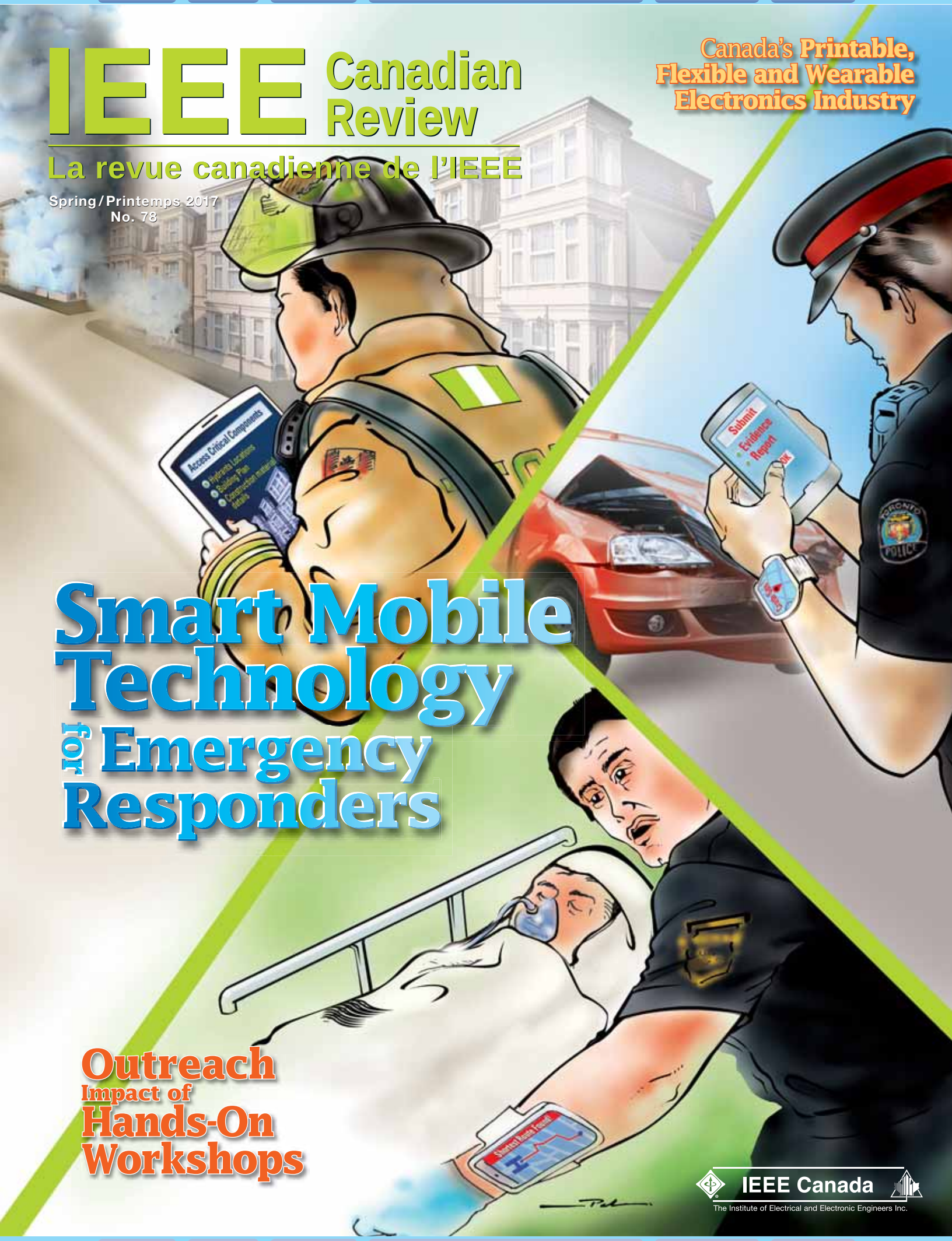
IEEE Canadian Review
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No. 78

Canada's Printable, Flexible and Wearable Electronics Industry

Smart Mobile Technology for Emergency Responders

Outreach Impact of Hands-On Workshops



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President's Message/Message du Président

Witold Kinsner
PhD, PEng, FEIC, FEC



2016-2017
IEEE Canada President and Region 7 Director

Once again, warm greetings and best wishes to all IEEE Canada members, volunteers, and activists, both young and seasoned!

In the 2016 issues of the *IEEE Canadian Review* (*ICR*), I gave an overview of IEEE and described technical and social initiatives to meet current challenges. I also outlined many other activities designed to make our Canadian unit even better.

In this message—my first of 2017—I describe some new IEEE Canada and IEEE activities, and explore some strategic issues.

IEEE is now very complex in terms of its membership and how it addresses different technologies, I have previously noted. The nature of work in our 21st-century world requires much more collaboration amongst professionals in all fields. For example, public policy and regulatory decisions must increasingly be considered by engineers. The physical space in which many of us do our work has changed dramatically; more than one-third of the global workforce is now mobile. Will we in IEEE Canada be merely observers of these challenges, or will we prepare to be active partners?

1. IEEE Canada BoD and Other Activities

An election for the position of 2018-2019 IEEE Canada President Elect will be held this year, as per our schedule of odd-numbered years. The incumbent also serves as IEEE Region 7 Delegate Elect/Director Elect on the IEEE Board of Directors.

The process begins with a call for nominations, followed by selection by the Steering Committee of suitable candidates to be interviewed,

(Continued on page 4)

À nouveau, meilleurs vœux et salutations à tous les membres, bénévoles et militants de l'IEEE Canada, tant jeunes qu'expérimentés!

Dans les numéros de la Revue canadienne de l'IEEE de 2016, j'ai brossé un aperçu de l'IEEE et décrit des initiatives techniques et sociales permettant de relever les défis actuels, de même que des activités conçues pour améliorer notre organisation.

Dans ce premier message de 2017, je décris de nouvelles activités de l'IEEE Canada et de l'IEEE et aborde quelques considérations stratégiques.

L'Institut des ingénieurs électriciens et électroniciens (IEEE) est devenu très complexe dans sa composition et sa façon d'envisager les différentes technologies. La nature du travail exige aujourd'hui beaucoup plus de collaboration entre les professionnels de tous les domaines. Par exemple, les ingénieurs doivent de plus en plus tenir compte des politiques publiques et des décisions réglementaires. L'espace physique dans lequel bon nombre d'entre nous travaillent a changé en profondeur : plus du tiers de la main-d'œuvre mondiale est désormais mobile. L'IEEE Canada demeurera-t-elle observatrice de ces défis ou elle se préparera à devenir un partenaire actif?

1. Le conseil d'administration de l'IEEE Canada et autres activités

D'après notre calendrier les fixant aux années impaires, nous tiendrons cette année des élections pour choisir le président élu de l'IEEE Canada pour 2018-2019. Le titulaire du poste exercera également le rôle de délégué/directeur élu de la Région 7 de l'IEEE au conseil d'administration de l'IEEE.

Le processus électoral prévoit d'abord un appel de candidatures, suivi d'une sélection de candidats par le Comité directeur en fonction des recommanda-

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Smart Mobile Technology for Emergency responders: Opportunities and Challenges

ON THE COVER

Mobile technology is now being applied by fire, police and ambulance services.

Illustration by Pal Singh

President's Message/Message du Président

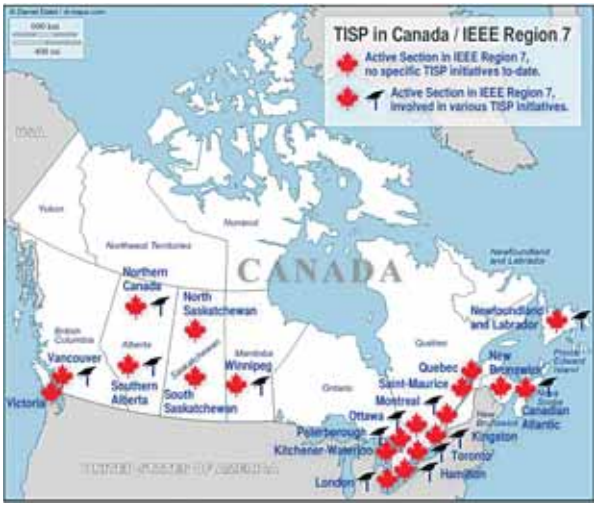
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based on recommendations from the Nominations and Appointments Committee. Several candidates were interviewed by the Steering Committee, according to a well-established procedure. Profiles of candidates were submitted for review by IEEE headquarters, with two candidates advancing. Their biographies, activities and position statements will be posted in June on IEEE's election website. Voting begins mid-August by electronic or paper ballot and ends in early October.

The 30th IEEE Canadian Conference on Electrical and Computer Engineering (CCECE) will be held April 30th to May 3 in Windsor. Barely two years ago Windsor Section held its inaugural meeting; we salute its enthusiastic volunteers for so quickly hosting this very major conference. The annual IEEE Canada Awards Gala will be held on the evening of May 1 as part of the conference. Immediately prior to CCECE, the IEEE Canada Spring Board Meeting takes place in Windsor, April 29-30. Representatives from our 21 Sections, roughly 25 regional committees, the regional leadership team and the IEEE Canadian Foundation will gather to take stock of our progress and look to future goals. Volunteer training and information sessions will be held April 28. Many of our committees hold their own meetings that evening. The organizing of both the CCECE and the Spring Board Meeting requires countless volunteer hours, plus a huge effort from our IEEE Canada Administrator, Kash Husain. My great thanks to all those contributing to these events.

Preparations for the International Humanitarian Technology Conference (IHTC 2017) in Toronto, July 20-22, as well as for the Electrical Power and Energy Conference (EPEC 2017) in Saskatoon, October 20-22, are also underway. There will be more to report in the next issue of the *ICR*. Much appreciation for the efforts so far.

Outreach to pre-university students has been a passion of mine for decades, as is seen in "The Impact of Hands-On Workshops," published in this *ICR* issue. Fortunately for students across this great country, it is also a passion for many of our IEEE Canada volunteers. The Teacher In-Service Program (TISP) is an IEEE initiative strongly embraced by IEEE Canada dating back to early 2009. TISP volunteers in about a dozen centres in Canada organize workshops to teachers, familiarizing them with lesson plans related to science, technology, engineering and mathematics (STEM). In other instances, they directly organize events for students and lead classroom activities. They do outstanding work. The committee's current chair is Dirk Werle from Canadian Atlantic Section; dwerle@ca.inter.net



TISP Canada volunteers hold activities for teachers and students all across the country.
Les bénévoles de PATI-Canada organisent des activités pour les enseignants et leurs élèves partout au pays.

Under the TISP program, I led the delivery of a one-day Teaching Teachers workshop in mid-March. I was ably assisted by students from the University of Manitoba (UofM) McNaughton Centre, the UofM Space Applications and Technology Society (UMSATS) and the UofM Amateur Radio Society (UMARS). I will again be delivering a one-week Research Discovery Week for Indigenous high-school students at the University of Manitoba this summer (May 29 - June 2), under the sponsorship of the Verna Kirkness Science and Engineering Education Program.

My Winnipeg Section IEEE colleagues and I are also developing

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tions du Comité des nominations et désignations. Plusieurs candidats ont déjà été interviewés par le Comité directeur selon une procédure bien établie. Les profils des candidats ont été soumis à l'examen de l'administration centrale de l'IEEE, et deux candidats en sont ressortis. Leurs biographies, rapports d'activités et exposés de fonctions seront affichés en juin sur le site Web des élections de l'IEEE. Le vote commencera à la mi-août de manière électronique ou sur papier et prendra fin au début d'octobre.

La 30e Conférence canadienne de génie électrique et informatique de l'IEEE (CCECE) aura lieu du 30 avril au 3 mai à Windsor. Près de deux années plus tôt, la section de Windsor tenait sa réunion inaugurale. Nous levons notre chapeau à ses bénévoles enthousiastes qui ont organisé si rapidement une conférence de cette envergure. La cérémonie annuelle de remise de prix de l'IEEE Canada aura lieu durant la soirée du 1er mai. Immédiatement avant la CCECE, le conseil d'administration de l'IEEE Canada tiendra sa réunion de printemps à Windsor les 29 et 30 avril. Des représentants de nos 21 sections, près de 25 comités régionaux, l'équipe de direction régionale et la Fondation canadienne de l'IEEE se réuniront pour faire le point sur les progrès accomplis et établir les objectifs futurs. Des séances d'information et de formation des bénévoles auront lieu le 28 avril. Un grand nombre de nos comités tiendront leurs propres rencontres cette soirée-là. L'organisation de la CCECE et de la réunion de printemps du conseil d'administration a exigé un nombre incalculable d'heures de travail bénévole, en plus de solliciter l'intervention de notre administrateur de l'IEEE Canada, Kash Husain. Merci de tout cœur à tous ceux qui ont préparé ces rencontres.

La préparation de la Conférence internationale de technologie humanitaire (IHTC 2017) à Toronto du 20 au 22 juillet, de même que de la Conférence sur l'alimentation électrique et l'énergie (EPEC 2017) à Saskatoon du 20 au 22 octobre va bon train. Nous aurons de plus amples renseignements à communiquer dans le prochain numéro de la Revue. Bravo pour les efforts fournis jusqu'à maintenant!

Comme en fait foi mon article sur les ateliers pratiques publié dans le présent numéro de la Revue, je m'intéresse aux étudiants préuniversitaires depuis des décennies. Heureusement pour les étudiants de notre grand pays, de nombreux bénévoles de l'IEEE Canada s'y intéressent aussi passionnément. Les bénévoles du Programme des enseignants en service (PATI) organisent, dans une douzaine de centres au Canada, des ateliers destinés aux enseignants afin de les familiariser avec des plans de cours se rapportant aux sciences, à la technologie, à l'ingénierie et aux mathématiques (STIM). À d'autres occasions, ils organisent directement des événements pour les élèves et mènent des activités en classe. Leur travail est remarquable. Le président actuel du comité est Dirk Werle, de la section Canada atlantique.

Dans le cadre du programme PATI, j'ai dirigé à la mi-mars un atelier pédagogique d'une journée destiné aux enseignants. Des étudiants du Centre McNaughton, de la Space Applications and Technology Society (UMSATS) et de l'Amateur Radio Society (UMARS) de l'Université du Manitoba m'ont assisté avec brio. J'animerai de nouveau une semaine de découvertes en recherche pour des élèves du secondaire autochtones à l'Université du Manitoba du 29 mai au 2 juin prochains, sous le parrainage du Programme d'éducation en sciences et ingénierie Verna Kirkness.

Mes collègues de la section de l'IEEE de Winnipeg et moi travaillons à

(President's Message cont'd from page 4)

the program for the 2017 Summer Space Camp for senior high-school students at the University of Manitoba, under the sponsorship of Aerospace Manitoba and more than 10 other organizations. The one-week camp will be attended by 40 students. This hands-on oriented program includes workshops and presentations from academia, as well as from both the technology and business perspectives of the aerospace industry.

2. IEEE MGA and BoD

So far during my Presidency, the IEEE Board of Directors (BoD) has met seven times for two days each. Our current R7 Director-Elect, Maike Luiken, has attended the latter four meetings.

I am planning to attend the IEEE Board and MGA meeting series in New Brunswick, NJ, June 21-26, 2017, and Phoenix, AZ, November 15-20, as well as the Sections Congress in Sydney, Australia, August 11-14, 2017, combined with an IEEE Canada Board meeting and a strategic planning session.

2.1 Strategic Planning: An Example

A Board and Management Council strategy session in Kapolei, Hawaii, focused on "Creating the Next Generation of the IEEE: What should IEEE look like in 2025 to appeal to and serve young professionals and other underserved communities globally, and what should IEEE do to get there?" The objectives were: (i) to determine what a membership society like IEEE should look like in the future; (ii) find new ways to appeal to (and better serve) young professionals, including women and diverse global populations; (iii) create long- and short-term plans to achieve the goal; and (iv) engage leaders from across IEEE to co-create the plan and gain their buy-in and alignment.



Helping Young Professionals identify and develop career directions is one of IEEE's strategic goals.

Un des objectifs stratégiques de l'IEEE consiste à aider les jeunes professionnels à orienter et à développer leur carrière.

The deliberations focused on 12 topics selected out of 33 topics proposed by the attendees, including:

1. **Develop IEEE in the African Continent** (enhance the current Africa Ad Hoc Committee by including Young Professional and women IEEE members; develop an effective communication strategy for the Ad Hoc on Africa and for the region).
2. **Member Models** (make member accomplishments within IEEE more visible to colleagues and current/prospective employers—often called credentialing or badging; introduce a new, scaled fee structure; create a new corporate membership model for practitioners and industry).
3. **Women in IEEE: Attract, Engage, Retain** (formalize a vision statement for WIE, and determine actions; review the existing WIE business plan and try to strengthen it; assess opportunities with other mature professional organizations that focus on women in engineering, science and technology, and develop an action plan).
4. **Communication: Humanized, Fast, Tailored, Evolving** (from the present incomplete W5: who-audience, what-content, when-timing/frequency, where-channel, and why-purpose).
5. **New Approach to Volunteering** (deliver a pilot/proof-of-concept for a volunteering ecosystem that will enable and encourage flexible volunteering opportunities among Young Professionals and across IEEE. Include the following elements: design and implement a volunteering reward and recognition

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l'élaboration du programme du camp spatial d'été 2017 pour les élèves du 2e cycle du secondaire à l'Université du Manitoba, sous le parrainage d'Aerospace Manitoba et de plus d'une dizaine d'autres organisations. Le camp d'une semaine accueillera 40 élèves. Ce programme pratique inclut des ateliers et des présentations de chercheurs, de même que de spécialistes de la technologie et de gens d'affaires de l'industrie aérospatiale.

2. Le CAGM et le CA de l'IEEE

Sous ma présidence, le conseil d'administration s'est réuni sept fois à raison de deux jours par réunion. Le directeur élu actuel de la région 7, Maike Luiken, a assisté aux quatre dernières réunions.

Je prévois assister à la série de réunions du CA et du Comité des activités géographiques et pour les membres (CAGM) à New Brunswick (N. J.) du 21 au 26 juin 2017 et à Phoenix (AZ) du 15 au 20 novembre 2017, de même qu'au congrès des sections à Sydney, en Australie, du 11 au 14 août 2017, congrès qui sera combiné avec une réunion du CA de l'IEEE Canada et une séance de planification stratégique.

2.1 Planification stratégique : un exemple

Une séance de planification stratégique du conseil d'administration et de gestion a eu lieu à Kapolei, à Hawaii, pour traiter de la création de la nouvelle génération de l'IEEE : à quoi devrait ressembler l'IEEE en 2025 pour attirer et servir les jeunes professionnels et d'autres communautés laissées pour compte dans le monde, et que devrait faire l'IEEE pour atteindre cet objectif? La séance poursuivait les objectifs suivants : i) déterminer ce qu'une société de membres comme l'IEEE devrait devenir; ii) trouver de nouvelles façons de faire appel aux jeunes professionnels (en répondant mieux à leurs besoins), y compris les femmes et les populations mondiales de nature diverse; iii) concevoir des plans d'action à court et à long termes; iv) mobiliser des leaders au sein de l'IEEE afin de cocréer ces plans et d'obtenir leur appui dans une recherche de résultats.

Les délibérations se sont centrées sur les douze sujets suivants, sélectionnés parmi les trente-trois propositions de l'assistance :

1. **Développer l'IEEE sur le continent africain** (renforcer l'actuel comité ad hoc sur l'Afrique en y intégrant de jeunes professionnels et des femmes, membres de l'IEEE; élaborer une stratégie de communication efficace pour le comité et la région).
2. **Présenter des membres comme modèles** (publiciser les accomplissements des membres de l'IEEE auprès des collègues et des employeurs actuels ou éventuels – par accréditation ou mention; proposer un nouveau barème tarifaire; créer un nouveau modèle d'abonnement collectif à l'intention des praticiens et de l'industrie.)
3. **Attirer, embaucher et retenir les femmes au sein de l'IEEE** (officialiser un énoncé de vision concernant les femmes ingénieures (WIE) et prévoir des mesures; réviser le plan d'affaires actuel de WIE en tâchant de le renforcer; évaluer les occasions se présentant dans d'autres organisations professionnelles matures pour les femmes en génie, en sciences et en technologie, et élaborer des plans d'action.
4. **Des communications humaines, rapides, personnalisées et évolutives** (combler les lacunes des communications actuelles répondant aux questions Qui? auditoire, Quoi? contenu, Quand? moment/fréquence, Où? canaux, Pourquoi? but.)
5. **Une nouvelle approche du bénévolat** (mettre en place un écosystème de bénévolat pilote/probatoire qui favorisera et encouragera, en souplesse, les occasions de bénévolat parmi les jeunes professionnels et au sein de l'IEEE. Concevoir et mettre en œuvre un système de reconnaissance et de récompense; mettre au point un parcours de bénévolat mondial qui permette

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A few words from the Editor-in-Chief / Quelques mots du rédacteur en chef



Bruce Van-Lane, P.Eng.

L'inauguration récente de l'Institut Vecteur, au District de la découverte MaRS, à Toronto, a dominé les manchettes des médias grand public. On peut facilement le comprendre. En trouvant des exemples d'intelligence artificielle aussi près de nous que dans l'application de reconnaissance vocale de nos téléphones intelligents, nous constatons que l'IA fait de plus en plus partie de chaque aspect de notre société.

Une autre application intégrée à nos téléphones intelligents est cette capacité phénoménale d'aider les intervenants d'urgence. Notre article examine les attributs que doivent présenter les applications mobiles pour alimenter les systèmes structurels de renseignements tactiques. Un incendie majeur survenu à Toronto en février dernier a conduit le Service des incendies de Toronto et le Service de police de Toronto à se préparer à adopter une technologie mobile.

L'intégration de circuits dans les vêtements est l'une des tendances de l'industrie canadienne de l'électronique imprimable, souple et portable. Déterminés à motiver tous les groupes de la société canadienne à tirer parti de l'électronique, certaines bénévoles de l'IEEE de Winnipeg ont animé 60 ateliers à ce sujet au cours des six dernières années. Dans un article engageant sur « l'effet des ateliers pratiques », Dario Schor relate les succès et les leçons apprises de ces expériences dans une démarche qui pousse à la réflexion. L'auteur s'est joint à l'équipe de *la Revue canadienne de l'IEEE* à titre de collaborateur à la rédaction pour ce numéro. Ingénieur informatique à Magellan Aerospace, il fera état des derniers développements dans l'industrie aérospatiale dans sa chronique régulière « Lift Off! » Sois le bienvenu, Dario!

Dans notre prochain numéro, nous conclurons notre hommage à Bob Alden, fondateur de cette publication entre plusieurs autres réalisations remarquables liées à l'IEEE. Je remercie tous ceux qui ont partagé leurs souvenirs après la publication de la première partie de notre hommage dans le numéro d'automne 2016. Parmi les souvenirs recueillis depuis le décès de Bob, j'aimerais en mentionner un d'une importance particulière. Il se rapporte à sa vision d'une identité canadienne forte comparativement à ce que l'on désignait officiellement jusqu'en 1995 comme la Région 7 de l'IEEE. Son parcours entre son lieu de naissance à Oxford, en Angleterre, et l'Australie-Méridionale me donne à penser qu'il a immigré au

(Suite au bas de la p. 8)

The recent opening of The Vector Institute in Toronto's MaRS Discovery District was a leading item in mainstream media. It's not hard to see why. With examples of artificial intelligence being as close-at-hand as our smart phones' voice recognition capability, AI is becoming increasingly embedded into every aspect of our society.

Embedded within smart phones is the capability to enormously aid emergency responders. Our cover story examines the desired attributes for mobile applications for Building Tactical Information Systems. A major fire in Toronto this past February is the starting point for a sidebar exploring how Toronto Fires Services and Toronto Police Service are planning for adoption of mobile technology.

Embedding of circuitry into our very clothes is one of the trends we take stock of in our feature on Canada's printable, flexible and wearable electronics industry. And with the goal of embedding an enthusiasm for working with electronics across all groups within Canadian society, some IEEE volunteers in Winnipeg have delivered in excess of 60 workshops in the last six years. "The Impact of Hands-On Workshops" is an engaging, thought-provoking account of their successes and lessons learned. The lead author, Dario Schor, joins the *IEEE Canadian Review* team as Contributing Editor in this issue. A software engineer with Magellan Aerospace, he will be reporting on developments in the space industry through his regular column "Lift Off!" A warm welcome, Dario.

In our next issue we will conclude our tribute to Bob Alden, founder of this publication amongst many other notable IEEE-related achievements. My appreciation to all those who sent remembrances following the first part of the tribute in our fall 2016 issue. Amongst the insights shared with me since his passing, one in particular stands out. It has to do with his vision of a strengthened Canadian identity for what was before 1995 only known officially as IEEE Region 7. Moving at some point from his birthplace of Oxford, England to South Australia, it was suggested to me he immigrated to Canada with an "outsider's" appre-

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Biz-tech Report



by Terrance Malkinson

Bombardier's C Series aircraft program was launched in March 2005 and this year this Canadian aircraft manufacturer is working hard to achieve a breakthrough in a very competitive international marketplace. Rick Adams discusses challenges that the company is facing in his article "Ready, Set, Go!" [*Wings*. 58(1):13-16. January-February, 2017. www.wingsmagazine.com]. Growing innovation, high-technology and high-demand businesses such as aeronautics is important to the entire country—providing skilled jobs and many spin-off opportunities. A 27-page inset article ["Careers in Aviation and Aerospace 2017"] discusses education, training and job prospects in Canada's aviation and aerospace sector. In an editorial [page 4] Matt Nicholls discusses the importance and economic ramifications for maintaining a strong aerospace "footprint" in Canada. In 2015 the aerospace industry contributed more than $28 billion to the Canadian GDP and generated 211,000 jobs in the Canadian economy.

An interesting article in the February 25, 2017 issue of the *National Post* by David Akin "Canada's Innovation Drought" [www.nationalpost.com] brings to our attention the weak innovation performance of Canadian business. The author starts his commentary by re-stating a question originally raised by Peter Nicholson in the November issue of *Canadian Public Policy* [42(S1):S39-S45. www.utpjournals.press/loi/cpp] "Why is Canada filled with 'low-innovation' companies?" Nicholson believes that the biggest hurdle to overcome is inertia. "It is too easy and very profitable for corporate Canada to let American firms take all of the risk when it comes to innovation." For more than one hundred years successive governments have attempted to promote technological innovation and have for the most part failed. In this article the author provides his assessment of Canadian innovation performance, and discusses a number of other topics. He concludes that "habits embedded for over a century have created a business culture in Canada that cannot easily be changed……businesses themselves must decide to become more innovative to prosper, or even to survive."

The future of sustainable construction in Canada is described by Joseph Caouette in his article "Closing in on Carbon" in *Alberta Construction Magazine*. [38(1): 18-26. Spring, 2017]. The author believes that reaching net zero will require a top-to-bottom makeover on how buildings are constructed and operated. Using the example of the construction of the Mohawk College Joyce Centre for Partnership and Innovation in Hamilton, Ontario the author discusses plans to make all Canadian buildings net zero by 2050. This project serves as a living laboratory to support students with their hands-on education on sustainable construction. Other articles on this issue continue on the theme of energy efficient construction, discussing topics such as new building codes and the Leadership in Energy and Environmental Design (LEED) for Healthcare rating system in Canada.

Architectural and Engineering innovations used in the construction of Studio Bell, the new home of the Canadian National Music Centre in Calgary, Alberta are provided by Graham Liversey in the February 2017 issue of *Canadian Architect* [pp. 22-28. www.canadianarchitect.com]. This center for musical exhibition, performance and recording has already received a number of awards for its engineering and design. One of many unique features is complex interstitial spaces that slice throughout the center. Nine towers that transform from rectangular to curvilinear with architectural complexity form the body of the building and are clad in terracotta tile.

In another story of Canadian excellence in architecture the City of Montreal's "Stade De Soccer De Montreal" is profiled by Gilles Saucier in *Sustainable Architecture and Building Magazine* [issue #54 pp. 26-29. Winter 2017. www.sabemagazine.com]. This dramatic neighborhood soccer stadium is not only a state-of-the-art athletics facility but has brought about neighborhood revitalization and ecological restoration. The unique engineering and design of the cross-laminated timber roof is highlighted. This CLT grid structure is the only one of its kind in the world with approximately 90% of the lumber used being locally sourced black spruce. The main room is supported by thirteen separate 69 meter long box beams 500 mm wide. This is an attractive, light, cost-effective, and sustainable engineering design. The project is targeted for LEED Gold.

Researched by Aon Hewitt the December 2016 issue of "*Canadian Business*" provides its annual ranking of Canada's Best Employers". [89(14):27-39. www.canadianbusiness.com]. Seventy-nine Canadian organizations who have successfully created great workplaces that attract and retain top-tier talent made the list. This special report also includes six reader-friendly articles on how these employers motivated their "super workers" and what smart bosses should apply to their organization to achieve success. These include: 1). Put People First, 2). Give Everyone a Career Ladder, 3). Help People Do Some Good. 4). Make Managers Care, 5). Manage Performance Intelligently and, 6). Create Evangelical Employees. Also included in this issue is a profile of a Canadian business success story: The Rocky Mountaineer vacation railway service ["Railway Ties that Bind." Max Fawcett. pp. 41-42]. A feature article by Steve Brereton "The Power List." pp. 45-52] names influential Canadian leaders who manage large and complex organizations with skill, delivering value to stakeholders and influencing events.

The March, 2017 issue of *The Canadian Business Journal* [10(3). www.cbj.ca] contains among other items a meeting report from the annual conference of international marketing leaders held in Banff Alberta. ["The Gathering." Angus Gillespie. pp. 29-47]. The objective of this conference is to give the sold-out audience of more than 1,000 participants the opportunity to share their marketing strategies and establish business networks. Other articles of interest in recent issues of the journal include one by Angus Gillespie ["Canada-UK Trade Relations and What to Expect Post Brexit" [pp. 28-37. February, 2017] where he discusses the decision and how the trade relations between Canada and the UK will continue as strong as they have always been. Surespan Wind Energy Services Ltd. Is profiled [pp. 108-117]. Based in Ayr, Ontario this company has become one of the fastest growing full-service wind energy companies in North America designing, supplying, and constructing high quality wind energy solutions and installation. Finally in the communications arena, two articles that provide insights into effective Blogging are provided: "Blogging Tips, Tactics and Trends: Survey Results" by Melonie Donaro [pp. 52-59 February, 2017] and "How to Generate Blog Ideas That Will Keep Readers Coming Back." By Marsha Friedman. [pp. 65-69. March, 2017]. ■

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*, contributing 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 was an elected Governor of the IEEE Engineering Management Society as well as past editor of *IEEE Engineering Management*. He is the author of more than 550 earned publications, and an accomplished triathlete. **malkinst@telus.net**

How and Why I Volunteered [illegible] IEEE



I came to Canada as an international student in January, 2015 and started a Ph.D. program at the University of Manitoba to continue my research on Biomedical Imaging Systems.

I have always had passion in learning new skills, and as a newcomer to Canada, I had a lot to explore. I attended the IEEE Winnipeg Section meetings and seminars to explore professional communities. I was fortunate that IEEE offered me the position of Chair of the Women in Engineering (WIE) affinity group in January, 2016. I was excited that as the WIE Chair, I had the opportunity to encourage young girls to pursue careers in engineering and science. I have met dedicated volunteers who create a friendly environment—a space where we enjoy the activities of the group, while practicing our leadership skills.

Nasim Abdollahi
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I have an unwavering desire to promote social justice and I am inspired to help others. Through IEEE WIE, not only can I practice my social advocacy skills and improve my leadership abilities, but I am also hoping to contribute in overcoming the tradition of gender disparity. I want to see women and men have the same opportunities using their distinct talents to make a better future.

The involvement with IEEE has provided me with the opportunity to meet many professionals from industry and emerging researchers. This has helped me build my professional network, which I will definitely benefit from in the future. Being an active member of IEEE, I have been able to grow as an individual, but also help others build a brighter future. ■

Community News/Nouvelles de la communauté

U. of Victoria Student Branch Outreach

Collaboration with other engineering clubs broadens workshop offerings



Technical skills are in high demand by employers seeking co-op students. University engineering programs cover a wide range of subjects and focus on theory, leaving little time to teach "hands-on" skills.

The University of Victoria's IEEE Student Branch has bridged that gap with SkillDev, an innovative series of free workshops providing practical, technical skills to interested students in all disciplines.

As of the fall of 2016, there had been 409 participants in a total of 15 workshops over two semesters. "It was fun to use a tool that might actually be part of our future careers," enthused one participant. "Amazing group of seminars," stated another.

To ensure the workshops provided the most up-to-date knowledge and skills, the IEEE Student Branch reached beyond electrical engineering to collaborate with other engineering clubs for workshop content and presentation.

Soldering Fundamentals was presented by the Autonomous Underwater Vehicle interdisciplinary engineering team, (AUVic), with circuit boards provided by a B.C. based company. Embedded systems basics were explained by Jason Long of Engenuics Technologies. Autocad was taught by a structural designer from Tetra Tech and Bearing Fundamentals by the University of Victoria Formula Society of Automotive Engineers. Not ignoring the "soft" skills, a Public Speaking Workshop was hosted by the Engineering Student Society.

The University of Victoria's McNaughton Centre has been key to many of these activities providing space and equipment for development and testing of workshop projects.

IEEE Canada's 16th Milestone approved

On 9 September, 1982 an aircraft crashed in the mountains of British Columbia. A Canadian ground station in Ottawa located the aircraft using the Cospas-Sarsat satellite system. Search and rescue teams were dispatched and all on board were rescued. Since the first incident, many tens of thousands of lives have been saved around the world using this technology.

The above is the citation for IEEE Canada's 16th Milestone, approved by the IEEE Board of Directors in February. Congratulations to Michael Stott and other members of the Milestone Proposal Team from IEEE Ottawa Section. Following the Milestone dedication, the *IEEE Canadian Review* will provide a full report on this humanitarian breakthrough.



Photo: Friends of CRC

Close-up of B.C. mountain crash site

(Quelques mots du rédacteur en chef suite de p. 6)

Canada en percevant de l'extérieur ce que notre pays présentait d'unique.

Comme d'innombrables immigrants l'ont fait avant lui et de nombreux autres depuis, Bob Alden s'est fondu à l'étoffe de la société canadienne, contribuant à enrichir ses ressources matérielles et culturelles. Son legs témoigne des contributions extraordinaires que font ceux et celles que nous accueillons d'autres pays. ■

(A few words from the Editor in Chief cont'd from page 6)

ciation of the uniqueness of what this country had to offer.

As countless newcomers had before him, and many more since, Bob Alden embedded himself into the fabric of Canadian society, helping grow its material and cultural richness. His legacy serves to remind us of the extraordinary contributions made by those we welcome from other countries. ■



Lift Off

by **Dario Schor**

The space industry in the late 1950s transformed the eloquent words of science fiction writers into reality with the launch of artificial satellites and humans into space. Since then, we've witnessed humans stepping on the moon, spacecraft exploring the Solar System and beyond, the development of the Space Shuttle as a re-usable vehicle to reach low-Earth-orbit, and the beginning of human habitats through space stations. More recently, we find ourselves in the era of commercial space with start-ups and private enterprises expanding their ventures to low-Earth-orbit and beyond. The commercialization foments competition and innovation, but also challenges the principles laid out in the 1967 Outer Space Treaty of the United Nations with regards to resource extraction from celestial bodies.

This column will highlight a few of the exciting projects, missions, spin-offs, and findings from current space activity, while also touching on key national and international policies affecting the industry. Furthermore, each issue will feature a Canadian student project, showcasing the up-and-coming talent within our community.

We welcome feedback and suggestions for topics.

Ad astra,

Dario Schor; schor@ieee.org

The modern day "Race to the Moon" is approaching its final stage. Five rovers will be launched Moonward in 2017 as part of the Google Lunar XPRIZE competition. The first of these privately funded missions to demonstrate it can travel 500 metres and transmit high-resolution video from the surface of the Moon will be awarded the US$ 20 million grand prize. The pool of teams has decreased from 32 registered, to 16 that participated in all activities, and now to five that obtained a verified launch contract by December 2016. The five teams remaining are (i) Moon Express, a US-based company aiming for multiple missions to ultimately extract resources from the Moon, (ii) Japanese team Hakuto utilizing a state-of-the-art infrared Time-of-Flight 3D Camera to detect and automatically avoid mission hazards while travelling on the lunar surface, (iii) SpaceIL from Israel, whose novel propulsion system will enable its rover to hop over obstacles, (iv) Team Indus from India using a lightweight 5-kg rover with a unique wheel design not needing suspension to overcome the rough lunar terrain, and (v) the international collaboration of Synergy Moon, attempting to be the first moon-based internet web server. These five organizations share a commercial goal, STEM educational objectives, and aspirations for their own "Apollo moment" on the surface of another celestial body.



Photo: John Ulan

Ex-Alta 1 – Becoming the first orbiting student-designed CubeSat from the University of Alberta (UofA), the spacecraft launched April 18 on a cargo resupply mission to the ISS. The 34 cm x 10 cm x 10 cm satellite is part of the QB50 constellation led by the Von Karman Institute in Belgium. The spacecraft is designed, built, and tested by a group of 60 dedicated students from the faculties of Engineering, Science, Business, and Education. Like other CubeSats from QB50, the spacecraft carries a primary payload to provide multi-point measurements of plasma in low-Earth-orbit using a Langmuir probe designed by the University of Oslo. Ex-Alta 1 carries two additional payloads designed by research teams at the UofA: A digital fluxgate magnetometer and a teledyne radiation dosimeter. The spacecraft is controlled by a custom-built Command and Data Handling (CDH) system designed by students and made available as open hardware and software to help expedite the growth and development of the CubeSat community. The spacecraft was deployed using Nanoracks. The team members share their enthusiasm with the community through outreach events and hope that Ex-Alta 1 will help launch the aerospace industry in Alberta. For details on the launch, please visit www.albertasat.ca.



The satellite will measure magnetic field strength, radiation and plasma levels.

Traditionally, satellite systems are designed with the understanding that once in orbit, there is no room for failure. As such, the designs include many layers of redundancy, autonomous health checks, and are built from expensive components with mission heritage, manufacturing traceability, and undergo thousands of hours of enviromental testing. In addition to the increased costs to launch the missions, it also requires that these satellites be replaced as they approach their end-of-life such that society can continue to utilize their services. Space agencies have produced extensive reports, like the "NASA On-Orbit Satellite Servicing Study," outlining the benefits and challenges of developing the capabilities for on-orbit servicing. These would build on the Shuttle experience where astronauts replaced faulted parts of the Solar Maximum Mission in 1984 and later repaired the Hubble Telescope lens in the 1990s. In early 2017, Space Systems Loral (SSL) was selected by DARPA to develop the Robotic Servicing of Geosynchronous Satellites (RSGS). This technology will include the ability to repair, upgrade, relocate, and refuel both commercial and military spacecrafts in orbit. More specifically, SSL plans to use robotic technology similar to the Canadarm or Dextre to correct the most common mechanical anomalies in deployments, assist in orbital maneuvers, refuel spacecrafts, and upgrade payloads. This could dramatically change the slogan on space merchandise that currently reads "failure is not an option." ■

For **Dario Schor**'s biography please see page 27.

Smart Mobile Technology for Emergency responders: Opportunities and Challenges



Toronto, February 14, 2017, Yonge and St. Clair

The Canadian public safety sector is at the verge of a technological evolution where smart mobile devices become an essential part of everyday operations of emergency responders. These devices (i.e., smartphones and tablets) will give emergency responders the ability to collect, share, and access different types of data that can ultimately enhance their operational efficiency and effectiveness. However, realizing this vision requires considering a multiplicity of technological, operational, and economical attributes when designing mobile applications for these devices. This article unveils ten key attributes that should be taken into consideration. These attributes are then projected onto a software solution that gives emergency responders necessary and sufficient building information while en route to an emergency scene.

By **Ala Abu Alkheir** and **Hussein T. Mouftah**
School of Electrical Engineering and Computer Science, U. of Ottawa



I. Smart Mobile Devices

Smartphones and tablets are mobile electronic devices that run a mobile operating system, e.g., Android or iOS, which have advanced computing and communicating capabilities. Modern smart mobile devices are multi-use devices that support portable media players, have low-end compact digital cameras, and Global Positioning System (GPS) navigation units. They also include high-resolution touch-screens and web browsers that can display standard and mobile-optimized web pages. These devices can be connected to a number of wireless communication technologies, e.g., 3G, 4G, Wi-Fi, and Bluetooth.

The number of smart mobile devices in the world has been steadily growing over the past decade [1]. Currently, there are more than 2.6 billion smartphone subscriptions in the world, representing more than 35% of all mobile subscriptions. However, this ratio is much higher in developed countries.

These devices allow police officers to see incoming 9-1-1 calls, access the city's databases, and access a number of sources of information

For instance, by the end of 2014, 66% of Canadians 18 years of age and older owned a smartphone, which represents more than 82% of all mobile subscriptions in the country [2]. Furthermore, by the same time, 49% of Canadians 18 years of age and older owned a tablet, compared to 39% in 2013 [2]. A primary reason behind the ever-increasing number of smart mobile devices is mobile applications. Smart mobile devices often come with a number of pre-installed applications, e.g. web browsers and email clients. However, most mobile applications are available through distribution platforms called application stores, e.g., Google Play, which are operated by the owner of the mobile operating system. Mobile applications are available for free, fermium, or a premium. Combined, App Store and Google Play have more than 2 million applications that were downloaded more than 125 billion times [3]. On average, a

How mobile is transforming emergency services in Toronto

By **Vawn Himmelsbach**

Valentine's Day was a heartbreaker this year for Toronto historians. The city's venerable Badminton and Racquet Club went up in flames — a six-alarm fire that required the assistance of 120 firefighters, forced the evacuation of thousands of office workers and residents, and crippled public transportation in a densely-populated area of the city.

While the building was destroyed, there were no serious injuries. But the outcome could have been different if fewer resources had been available.

Like emergency services across the country and around the world, Toronto Fire Services and Toronto Police Service are looking at how technology can help to improve overall efficiencies and response times during emergency situations. While technology isn't a panacea, it could help.

But implementation is not easy. "Operational changes can be slow in a large organization," says Frank Pappone, Division Chief with Toronto Fire Services (TFS), "but new technologies are definitely coming." Firetrucks, for example, are already equipped with mobile data terminals, but TFS is in the process of rolling out 150 ruggedized, Windows-based tablets that will untether crew from vehicles.

"With the direction we're seeing fire services going — particularly in Toronto where we're looking at transforming the traditional role of the firefighter, getting them more engaged in the community — we have to provide them with the toolsets to engage in a level that traditionally they haven't done," says Pappone. "We want to be able to leverage our biggest resource, which is our staff."

TFS is replicating its current system in a tablet format, but towards the second half of this year it will be looking at enhancing the functionality of front-line staff through mobile technology, such as providing data on buildings.

"When you're looking at fire emergency response, our target travel time is four minutes — we've got four minutes to digest information, at least for the first truck," says Pappone. "We do have links in the backend with paramedic services; we don't have that yet with police and 911, but we hope to make some progress this year." That means, while some technology is interconnected with paramedic services, we could see more integration between all emergency services in the future.

First, though, that requires digital data. Currently, firefighters collect data with pen and paper, and then manually input that into a records management system. The challenge is not only collecting this information, but keeping it current. TFS has already started mapping vulnerable occupancies, such as vacant buildings where there could be squatters, and multi-unit residential buildings. This information will help to classify risk and determine if firefighters should take a defensive or offensive approach during a fire.

But having access to building information is only half of the equation. Firefighters need to know where all the critical components are, such as where hydrants are located and where the first line will be laid. And it's one thing to understand the building; it's another to understand building construction and how they burn. Having that information at their fingertips could be transformative.

"It really comes down to gathering information and distributing it when required

(continued on Page 15)



Photo: Toronto Police Service

Toronto Police Service uses technology to be where needed most. Officers equipped with mobile technology can be more engaged with the public.

smartphone user spends more than 29 hours per month on the top five mobile applications categories as shown in Table 1.

Realizing the importance and usefulness of smart mobile devices, a number of cities are taking steps towards equipping their emergency responders with these capable devices. For instance, New York Police Department (NYPD) has equipped all its officers (36,000 officers) with smartphones and equipped 2,000 police vehicles with tablets [4]. These devices allow police officers to see incoming 9-1-1 calls, access the city's databases, and access a number of sources of information, like the Domain Awareness System (DAS), which is a mobile application that allows police officers to access surveillance cameras across the city. Canadian cities are following suit. In 2016, Toronto police service has released a roadmap for modernizing community safety. One of the major enablers of this modernization is smart mobile technology [5]. Similarly, Ottawa police are equipping their officers with smart mobile devices as part of its technology roadmap released in May 2016 [6].

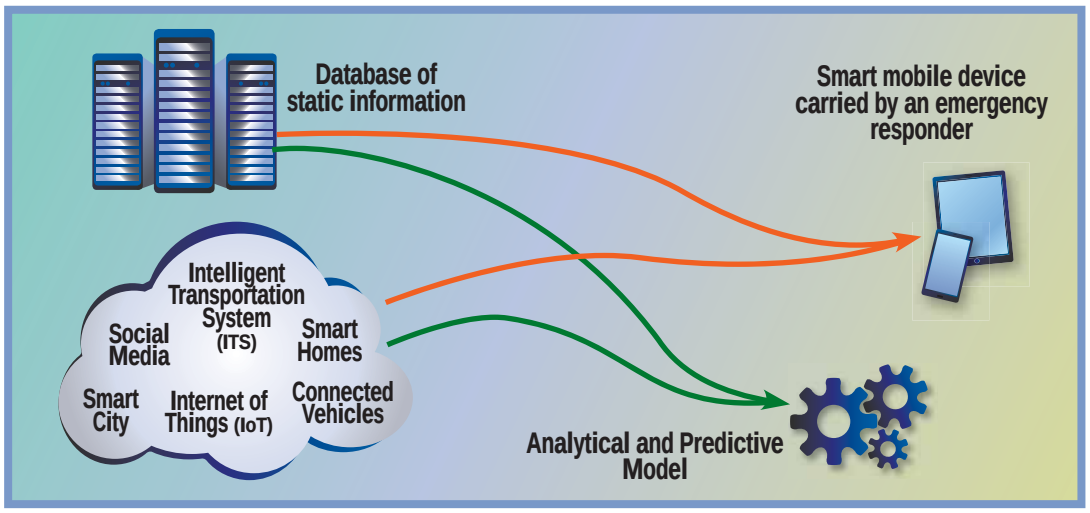


Figure 1: Different types of information that can be used by emergency responders.

MOBILE APPLICATION CATEGORY	AVERAGE HOURS SPENT PER MONTH
Search Engines, Portals and Social	10hr and 56 min
Entertainment	10hr and 34 min
Communication	3hr and 48 min
Productivity and Tools	2hr and 16 min
Commerce and Shopping	1hr and 33 min

Table 1: Average time users spend on the top five mobile applications

This heightened adoption of smart mobile technology has led to a growing number of mobile applications built specifically for emergency responders. These include emergency reporting applications, team management and tracking applications, volunteer finder applications, and supplementary information applications (e.g., hazmat). These applications range from cause-driven applications, e.g., PulsePoint mobile application for Cardiopulmonary Resuscitation (CPR)-trained volunteers, to for-profit applications, e.g., BeOn secure group communication mobile application. The vast majority of these applications were developed with minimal or no coordination between the developing firms and the emergency responders community. This has led to negligible adoption. In April 2013, the Association of Public Safety Communications Officials (APCO) launched an online Application Community (AppComm) to collect and promote mobile applications built for public safety in general and emergency responders in particular [7]. Currently, this website includes more than 200 mobile applications. In addition, AppComm provides design guides and best practices for mobile developers based on the works of the National Institute of Standards and Technology (NIST) [8] [9] [10] and the Department of Homeland Security (DHS) [11].

This article reviews the technological, operational, and economical attributes that should be considered during the design process of mobile applications for emergency responders. In part, these attributes were solicited from the works of NIST, APCO, and DHS. They are also based on our work on the operational requirements of a Building Tactical Information System (BTIS) software solution that gives emergency responders necessary and sufficient building information while en route to an emergency scene [12]. The remainder of this article is organized as follows. Section II gives a summary of the different types of information that can be used by emergency responders. Section III introduces the ten attributes that should be considered during the design process of mobile applications. In section IV, these attributes are projected onto the aforementioned BTIS. Finally, conclusions are drawn in Section V.

II. Types of Information

The ultimate objective of any mobile application is giving emergency responders necessary information at the right time and the right location. In general, emergency responders are interested in three types of information: static information, dynamic information, and inferred or calculated information [13]. These three types of information, shown in Figure 1, are discussed subsequently.

II.1 STATIC INFORMATION

This information does not change with time, or changes at a very slow pace. For instance, it includes a building's address, entrance, floorplan, and location of fire panel. It also includes a person's name, address, occupation, and age. Currently, emergency responders access some of this information electronically using vehicle-mounted Mobile Data Terminals (MDTs) or verbally by calling dispatch. Existing records are often limited to criminal records, civic addresses, and vehicle registration. In general, emergency responders do not have (technological) means or procedures to collect static information in electronic format.

II.2 DYNAMIC INFORMATION

This type of information changes with time on a frequent basis. For example, the readings of a fire alarm system or an access control system. It also include the whereabouts of emergency responders (e.g. inside a building). Currently, emergency responders have very limited access to dynamic information. For instance, they can access the readings of a fire panel or the stream of a surveillance camera only on site, but not en route. They can track the locations of each other outdoors but not indoors. This limited access is due to two main reasons. First, limited availability of dynamic information, e.g. vast majority of buildings do not have intelligent monitoring and control systems.

Second, there is a lack of unified information sharing protocols between different sources of dynamic information and the emergency responders [14].

While static information is currently the dominant type of information available to emergency responders, it is expected that dynamic information will become equally dominant—if not the dominant—as the Smart Grid, Smart City, Internet of Things (IoT), and Intelligent Transportation Systems (ITS) become realities [15].

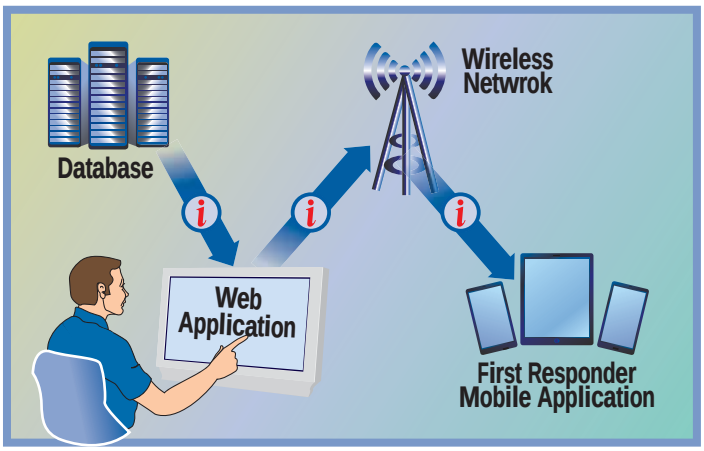


Figure 2: Building Tactical Information System (BTIS)

II.3 INFERRED OR CALCULATED INFORMATION

Unlike the previous two types, this type comes out of analytical and predictive models. These models digest static and dynamic information and give emergency responders accurate analysis and predictions of the ongoing emergency. For instance, a model might use some social media feeds about a multivehicle accident along with traffic information in that particular part of a city to give law-enforcement personnel the best course of action in terms of road closures and traffic rerouting.

Limited instances of this type of information are available these days. For instance, emergency responders can use data analytics to digest social media feeds related to a certain emergency without reading every post. However, it is predicted that the increase in the volumes of static and dynamic information that emergency responders have access to will stimulate interest in inferred or calculated information [16].

III. Desired Attributes of Mobile Applications

The emergency responders market is fundamentally different from the consumers market for many reasons. First, emergency responders work in teams with a strong sense of hierarchy and accountability. Second, emergency responders deal with a lot of private and sensitive information. Third, emergency responders follow very specific standard operational procedures and response protocols. Fourth, emergency responders have limited financial resources. When they invest in a new technology, they are very conscious of the resulting Return on Investment (ROI). These differences are naturally reflected in terms of attributes for mobile applications. In the following, we highlight the main attributes.

III.1 ROI

A mobile application has to address a current need, solve a problem, or enhance the performance of emergency responders with a measurable and significant ROI.

III.2 OPERATIONAL COMPATIBILITY

A mobile application has to blend with, or cause minimal change to, existing operational procedures and protocols. For instance, emergency responders often work in groups with close collaboration between field officers, dispatch, and the main office. Accordingly, the mobile application has to allow for seamless exchange of information between these three groups to guarantee uniformity of information sharing.

III.3 CYBERSECURITY

This is probably one of the most critical attributes. The sensitivity of the information that emergency responders use make it an attractive target for cyberattacks. Hence, mobile applications have to be secure by design. This includes user authentication, data encryption, and secure storage.

For instance, a model might use some social media feeds about a multivehicle accident along with traffic information in that particular part of a city to give law-enforcement personnel the best course of action in terms of road closures and traffic rerouting.

III.4 ACCOUNTABILITY

The information provided by a mobile application is likely to guide the decision-making process of emergency responders. Hence, an access log has to be maintained for each user along with time and location. In case of accessing information over the Internet, the log has to include whether information was successfully received or not.

III.5 PLATFORM AND NETWORK NEUTRAL

As the public safety sector is embracing smart mobile technology, it is consciously aligning itself (to a large degree) with the consumers market to leverage economies of scale. This was most apparent when Long Term Evolution (LTE) technology was used to build the upcoming Public Safety Broadband Network(PSBN) [17]. Accordingly, any mobile application is expected to be agnostic to the wireless technology (LTE, 3G, Wi-Fi, etc.), device hardware, and operating system.

III.6 SCALABILITY

Every emergency is unique, and the number of responders needed at an emergency scene is unpredictable. Some major incidents draw responders from different jurisdictions. Hence, a mobile application should be able to guarantee a constant level of service regardless of the number of served responders.

III.7 UNIFORMITY OF PRESENTATION

Operational integrity of emergency responders requires that all members of a response team have access to the same amount of information using the same presentation. The reason behind this is the dynamic and unpredictable nature of emergency response. Different responders might do different things in different situations. Hence, guaranteeing delivery of the right information to the right person requires using the same presentation to all team members.

III.8 BILINGUALISM

The mobile application should account for situations where emergency responders use more than one language. This can be encountered, for instance, near the borders of Quebec. In this case, the mobile application needs to support all used languages.

III.9 INTUITIVE/USER FRIENDLY

This is a very important design challenge for mobile applications. Emergency responders come from different backgrounds, with different levels of education, and different levels of comfort with mobile technology. Furthermore, emergency management tends to be a fast-paced profession where responders have very limited time to use a mobile application. Accordingly, the mobile application has to be intuitively designed. Users need to find information in the most likely places and with the least number of steps.

Table 2: Key attributes of a mobile application as applied to BTIS

DESIRED ATTRIBUTE	HOW BTIS ACHIEVES IT
ROI	• The solution results in a measurable reduction in response time by cutting about five minutes of incident assessment and response planning times. • The solution can be used for every building emergency incident, i.e., meet a daily need.
Operational Compatibility	• The solution preserves the same command hierarchy that emergency responders currently use. • The solution requires minimal effort from the dispatcher while giving him full information about the response team (who is available, who received the information and who did not, who is online and who is offline, etc.).
Cybersecurity	• The solution does not store building information locally on any device. • The solution uses encrypted communication to send information to the response team. • The database is hosted in a Tier 3 or Tier 4 datacenter. • The solution does not send information to off-duty responders (they are marked as offline).
Accountability	• The solution uses acknowledged communication to confirm reception of information. • The database is populated and maintained by the emergency response department. • Formal training is conducted prior to employing the solution.
Platform and Network Neutral	• The software is platform agnostic. It runs on any mobile device and any desktop operating system with a modern internet browser. • The software works on any public or private wireless network.
Scalability	• The solution is not affected by the number of members on the response team.
Uniformity of Presentation	• All members of the response team have the same information presentation on their devices.
Bilingualism	• The solution supports English and French.
Intuitive/User Friendly	• The solution has an intuitive user interface for both responders and dispatchers.
Battery and Data Efficiency	• The solution does not store or process information locally. • Compressed information is sent to the response team to reduce data traffic.

III.10 BATTERY AND DATA EFFICIENCY

The mobile application has to be as efficient in power and data as possible. Emergency responders sometimes operate for prolonged periods of time without access to power chargers. Hence, the application needs to be as conservative in its power consumption as it possibly can. On the other hand, emergency responders operate in all types of environments, some of which might have bad wireless coverage. In fact, even with good coverage, emergency responders will ultimately use the PSBN that will have a 20MHz bandwidth [17]. Hence, efficient use of wireless resources will always be a necessity.

IV. Case study: Building Tactical Information System (BTIS)

Let us now apply these attributes to a mobile application that gives emergency responders access to building information while en route to an emergency scene. This application is part of a software solution referred to as a Building Tactical Information System (BTIS) [18]. This solution is illustrated in Figure 2.

Upon dispatching a response team to an emergency scene, the dispatcher pulls available building information from the database and pushes it to the response team through a wireless link. Table 2 above summarizes how BTIS meets the above mentioned attributes.

V. Conclusions

The public safety community is facing unique challenges as they embrace smart mobile technology. A growing number of mobile applications and software solutions are being built for this sector without proper consideration of technological, operational, and economical requirements. This article has discussed the potentials of smart mobile technology and highlighted ten key attributes that have to be considered in the design process. These attributes are then applied to BTIS. ■

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How mobile is transforming...

continued from Page 11)

in a format that's digestible," says Pappone. That means all forms of information, including audio and video. Thanks to Hollywood movies, the public already believes emergency response personnel can do this stuff, he says.

"People think they can send video clips and images to 911, and that's certainly not the case," he says. There's also a danger of overwhelming the system; a single traffic accident on a major highway in Toronto can result in 200 calls to 911. "The technology only gets you part way; we need to have staff in place and filtering mechanisms. Artificial intelligence is going to have to kick in."

The Toronto Police Service is also modernizing its IT infrastructure, rolling out mobile technology that allows them to access data, collect evidence and file reports on smart phones and tablets. TPS is in the pilot phase of moving to mobile, which it hopes to fully roll out in the next two to three years.

In a report released in January, the TPS's Transformational Task Force says vehicles are a physical barrier that create a sense of isolation from residents. It also says in some cases officers file paperwork and respond to emails at divisional stations, preventing them from patrolling communities. Both issues could be resolved through the use of mobile technology.

"In the next three years, we're going to be undergoing a modernization process, and among those goals is leveraging technology to ensure we're being efficient and effective in our policing efforts," says Sergeant John Apostolidis, a member of the TPS's task force implementation team." This is where that mobile platform will further enable us."

Of course, mobile technology is only as good as the content that's on it. Some police forces are experimenting with mobile applications; the Prince Albert Police Service in Saskatchewan, for example, is piloting a Building Tactical Information System (BTIS) developed by Ottawa-based firm APX, which can provide officers with information on buildings they enter in response to emergency calls, equipping them with everything from floor plans to satellite photos.

The Toronto Emergency Safe School System (TESS) and Toronto Operational Response Information System (TORIS) allow TPS to access information such as floor plans, emergency contacts, fire plans and evacuation strategies in buildings ranging from schools to small businesses to big towers in the downtown core. This information allows TPS to appropriately develop an emergency response if needed.

Once officers are equipped with mobile technology, they'll have access to this type of information at their fingertips. It will also allow for "proactive action," where they can access data for situational awareness and crime prevention. And they can collect evidence and statements (including audio and video) directly from their mobile device.

"There's a completely different reaction from the public when you're outside of a vehicle," says Apostolidis. "I rode a bicycle quite a bit; having that direct contact certainly made my role more approachable. We're extending that with now being able to be reached through a mobile device."

As with Toronto Fire Services, it's all about providing the right information, to the right person, at the right time. "We're looking at how we can garner efficiencies," says Pappone, "so it's not only giving them the information they need to respond but also providing full sets of data to create greater efficiencies overall." ■

Vawn Himmelsbach is a freelance writer who has written about business and technology for close to 20 years.

Upcoming IEEE Mobile Communications Events

PIMRC'17and 5G Summit in Montreal in October

Personal, Indoor & Mobile Radio Communications (PIMRC '17), will be held October 8 -13. One of IEEE Communication Society's flagship conferences, it is widely regarded as a premier conference in the field of wireless research. The conference has a long history of bringing together academia, industry and regulatory bodies, and PIMRC 2017 will be no exception.

Covering the latest research and innovation in wireless communications technologies, the comprehensive technical and industry program includes core wireless PHY, MAC, and networking, and also encompasses microwave components and circuits, antennas and propagation aspects, DSP, VLSI, circuits and systems design, power electronics, machine learning and artificial intelligence. For more information please see the website: http://pimrc2017.ieee-pimrc.org/

PIMRC 2017 IMPORTANT DATES:

- 5 May 2017—Call For Special-Session Proposals

- 5 May 2017—Call For Workshop Proposals

- 19 May 2017—Regular Paper Submission

The 5G Summit is expected to be collocated with PIMRC 2017. With the support of IEEE Montreal Section's award-winning ComSoc Chapter, the Summit will be one of 18 held this year. The Summit series was launched in 2015, with the second hosted by Toronto Section's ComSoc Chapter in November of that year. Please consult the web site for further information: http://www.5gsummit.org/montreal/

About the Authors



Ala Abu Alkheir is a postdoctoral fellow at the School of Electrical Engineering and Computer Science at the University of Ottawa since 2013. He earned a PhD from Queen's University in 2013. In 2016, he worked with Advance Property eXposure (APX) Inc. on developing operational requirements for their software solutions. Ala's research expertise spans the areas of smart mobile technology for first responders, spectrum sharing networks, wireless sensor networks, connected and autonomous vehicles, and 5G systems. He is currently working on using Bluetooth technology to build location-based services for emergency responders.



Hussein Mouftah is a Distinguished University Professor and Tier 1 Canada Research Chair at the School of Electrical Engineering and Computer Science at the University of Ottawa. Dr. Mouftah is developing next-generation technologies that will serve as a foundation for smart cities. He has made significant contributions to the understanding and knowledge of telecommunication networks, including ad hoc and sensor networks related to the Internet of Things (IoT).Dr. Mouftah has authored or co-authored 11 books, 145 industrial reports and more than 1,500 technical papers; to date, he holds 14 patents and six invention disclosures. He is a Fellow of the IEEE, the Canadian Academy of Engineering, the Engineering Institute of Canada and the Academy of Science of the Royal Society of Canada.

IEEE Canada IHTC 2017 — International Humanitarian Tech. Conference

TORONTO, CANADA – JULY 20-22, 2017 WWW.IHTC2017.IEEE.CA



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Design projects seeking to solve Humanitarian issues using Technology done from July '15 to June '17 are welcomed. Judging to be based on innovation, feasibility, relevance to real-world problems and cost-effectiveness.

The theme of IHTC 2017 is "Innovate and Collaborate for Sustainable Development." IHTC 2017 is a unique conference that will focus on humanitarian applications of technologies, aligning with Sustainable Development Goals of the United Nations: Mainly, sustainable development of communities, health, disaster mitigation and management; and engineering education with an emphasis on humanitarian issues. The conference will feature outstanding keynote speakers, workshops, a student design competition and peer-reviewed papers.

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Proposals are invited for half-day tutorials, and workshops on new and emerging topics within the scope of the conference.

Please describe the content, importance and timeliness, the speaker(s), brief CVs, and where appropriate, topics each will cover. For further info, contact: **xavier@ieee.org**

SUBMISSIONS

All materials to be uploaded by registering with: http://edas.info

Please use PDF format for both papers/paper abstracts, as well as proposals for tutorials, workshops and panels. Detailed information on paper format and submission procedure can be found on the conference website.

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The target audience for the conference includes researchers, practitioners and students in the fields of sustainability, human development, education, disaster relief, STEM fields and management sciences, as well as interested professionals and anyone wanting to contribute their talents in the humanitarian and sustainable development fields.

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http://www.ihtc2017.ieee.ca/patronage-exhibition

AREAS OF INTEREST

The technical program committee is organizing sessions in the following track areas.

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1. Poverty alleviation, achieving food security and improved nutrition and promotion of sustainable agriculture
2. Effective management of refugees, (re)settlements and integration
3. Ensuring healthy lives and promoting well-being for all, at all ages
4. Quality education and promotion of lifelong learning opportunities for all
5. Sustainable management of water and sanitation for all
6. Affordable, reliable, sustainable and modern energy for all
7. Making cities and human settlements safe, resilient and sustainable
8. Disaster mitigation, management, relief, and recovery
9. Combating climate change and its impacts
10. Social impacts of technology
11. Data and personal security humanitarian technology
12. Humanitarian and educational technologies
13. Community engagement

IMPORTANT DATES

Authors notified about acceptance and modifications	**May 15, 2017**
Submission of camera-ready papers	**May 31, 2017**

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For detailed up-to-date information, visit the Conference web site:
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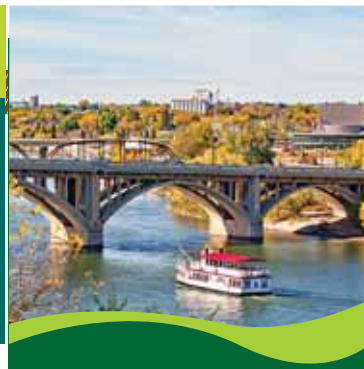
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Topics: **The EPEC 2017 welcomes submission of papers related to the conference theme including, but not limited to, the following topics:**

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2. Smart Grid Communication Systems
3. Power System Reliability
4. Energy Storage
5. Electrical Vehicles
6. Power Electronics, HVDC and FACTS
7. Micro-grids
8. Power System Protection
9. Data Analytics and Computational Methods in Power Systems
10. Cyber Security
11. Power Quality
12. Power System Dynamics and Stability
13. Power System Control
14. Energy Conversion and Efficiency
15. Asset Management and Maintenance
16. Advanced Technology Developments
17. Renewable Energy Systems
18. Electricity Markets

Paper Submission: The format of the paper should follow the IEEE conference paper style. EPEC 2017 will only accept the electronic submission of a full paper in English. Detailed information about the paper format and submission procedure is available at epec2017.ieee.ca. The EDAS link for paper submission is edas.info/N23711.

EPEC 2017 proceedings will be submitted to IEEE *Xplore*, EI Compendex and ISI Proceedings. Authors are invited to submit extended versions of their presented conference papers for consideration in the EPEC 2017 Special Issue of the *IEEE Canadian Journal of Electrical and Computer Engineering* (*CJECE*) within four weeks of the conference final day. *CJECE* is indexed on IEEE *Xplore* and accepts submissions via the ScholarOne Manuscript portal. Please see http://journal.ieee.ca/ for more information.

Important Dates:

Submission of full papers in PDF	**May 1, 2017**
Submission of workshops panel session proposals	**May 1, 2017**
Submission of tutorial proposals	**May 1, 2017**
Notification of workshop/panel/tutorial acceptance	**June 30, 2017**
Notification of paper acceptance	**June 30, 2017**
Submission of final camera-ready papers	**July 31, 2017**

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The Impact of Hands-On Workshops

Dario Schor (MIEEE)
Magellan Aerospace

Troy Denton (MIEEE)
JCA Electronics

Witold Kinsner (LFIEEE)
University of Manitoba

Emma and her grandfather, Jacob, walked into a café on a fall Saturday morning and ordered pancakes. While they waited, she pulled out her laptop and a box containing parts for her project for Halloween night. Unlike in previous years, she was more concerned with developing an M&M© sorting machine to "save the red ones for last" than which costume she was going to wear. So far, her prototype consisted of a microcontroller reading a luminosity sensor to determine the color of the candy. She had attached an RGB LED and programmed it to display the same color from the sensor to confirm it was functioning correctly.

Jacob, a retired accountant, had recently attended an IEEE workshop at the public library to learn about electronics in an effort to reconnect with Emma. Although her project went beyond the introductory knowledge of microcontrollers and sensors, it was enough for them to converse, learn, and experiment with embedded systems together.

Both were deeply engaged in the conversation when the waiter arrived with the chocolate chip pancakes. As he placed the food on the table, he looked at the small development board connected to a breadboard through a mess of colorful jumper wires and asked Emma, "What are you building?"

Let's pause here for a moment and consider this scenario. Can you spot the fictional element?



Photo: David Lipnowski

Degrees Restaurant, U. of Manitoba (Feb. 4, 2017).

The made-up component is the welcoming environment of a local coffee shop for people working on electronics. This public space is often associated with chatting, reading, or editing an essay on a laptop. The rest of the story is based on real events from an IEEE workshop held at the Winnipeg Public Library.

Opening a project box with small circuit boards connected through colorful wires can be a cause for concern in today's hyper vigilant society. For this to change, STEM education needs to reach audiences beyond the classroom to not just teach new concepts, but also remove fears, demystify what engineers and scientists do, and, ultimately, encourage a sense of experiential life-long learning.

This article shares the experience from a group of dedicated IEEE volunteers from the Winnipeg Section who have delivered over 60 workshops in embedded systems and other topics. These initiatives have significant impact in the community engaging high school students and teachers in STEM subjects, challenging university students to experiment outside the classroom environment, helping hobbyists work on their home automation projects, providing professional development activities for practitioners, and even bringing a grandfather closer to his grandchildren over a discussion on Arduinos.

How it all began

Historically, the IEEE Winnipeg Section had organized many embedded systems workshops with microprocessors going back to the 1980s when Prof. Witold Kinsner ran events at the first Microelectronics Centre in Western Canada. Later, during the 2000s, the emphasis was on Matlab for use in university labs and web applications for the trending World Wide Web phenomenon. For the most part, these events were usually ran as a seminar where a presenter would go through slides and live demonstrations, but the onus was on audience members to follow along. Many ideas were entertained to incorporate small development boards like those used in labs, but these did not materialize due to a combination of financial and logistical reasons. The lack of workshops did not prevent ambitious students like Mark Roy from experimenting as he built an LED Desktop Clock [2], but there was an untapped opportunity to engage more students in experiential learning opportunities.

In the Winter of 2011, a group of University of Manitoba (UofM) students were working on assignments in the IEEE McNaughton Centre and stumbled upon the Texas Instruments MSP430 LaunchPad—a small development board that included software and cables to get started for only $4.30 [3]. They began reading about the board, sharing ideas for projects, and started filling out a form to order them. The buzz in the room was contagious and more people gathered around to learn about the potential from this exciting product. Even with all the excitement, there were some engineering students hesitant to get involved, as their experience with electronics was limited to the safe confines of the university labs. This combination of excitement and anxiety lead to the impromptu decision to organize a workshop.

The buzz in the room was contagious and more people gathered around to learn about the potential from this exciting product

Within a span of four hours, a group of IEEE student members put in an order for more than $500 for development boards, breadboards, LEDs, resistors, and other components from various retailers around the world. Surprisingly, the breadboards became the most expensive component for the workshop when compared to the inexpensive development boards. In retrospect, the team should have called a meeting with the Student Branch executive and approved the budget expenses, however, as Grace Hopper wisely stated, sometimes "it's easier to ask forgiveness than it is to get permission." Before wrapping up the activities for the day, they talked to the branch counsellor, Dr. Kinsner, who offered lots of advice on how to manage the logistics, but more importantly, emphasized many of the pedagogical elements to consider during the workshop. In particular, he emphasized the importance of not just doing, but understanding the principles behind it by linking to the theory taught in the classroom and challenging the audience with questions to entice them to build on the examples and try out things by themselves.

By the end of that day, the UofM IEEE Student Branch was committed to its first hands-on embedded systems workshop. Since some of the parts were purchased from online overseas retailers, the dates for the workshop were not set until all the packages arrived. By then, the student branch executive had helped with many logistical elements

and a group of six instructors was formed: Dario Schor, Troy Denton, Frank Serafin, Matthew Sebastian, Matthew Woelk, and Benjamin Bergman—a combination of undergraduate and graduate students with previous embedded systems experience through courses, student group involvement, and their own projects. The team met a few times to try out the boards, developed a few examples, and noted common problems that participants might experience. In parallel, they secured funding from a few different sources including the IEEE Winnipeg Section, UofM Student Union, and the UofM Dept. of Electrical and Computer Engineering to cover the cost of food and advertising.

The "Hands-On Embedded Systems" workshop was scheduled for Sunday, March 27, 2011 from 10 a.m. to 3 p.m. in a classroom at the UofM. The cost of $20 per student included the hardware to take home, breakfast, snacks, and lunch. The 25 spots available filled up in less than 24 hours and a waiting list was created. The group consisted of electrical engineering, computer engineering, mechanical engineering, physics, and computer science students ranging from first year through masters students.

On the day of the workshop, the participants arrived, registered, and picked up their components. All participants were instructed to bring their own laptops or use one of the desktop computers from the student group. The first hour was dedicated to installing the development environment, soldering header pins onto the MSP430 boards, and eating some snacks. Already the activities were behind schedule. There were many different versions of Windows, MacOSX, and Linux operating systems to deal with, thus requiring longer to install the development tools. Furthermore, it was surprising to see how many students were soldering components for the first time. This is something that was not taken lightly, so the instructors spent some time going over safety procedures, showing what a good solder joint looks like, and guiding students through the process.

The team grew as we incorporated some attendees from the first event and other students who had lots of good ideas to contribute

The instructors took turns delivering content and helping students one-on-one. They started with a basic blinking LED example and moved through more complex material. The goal was to build a system that would connect all the boards from every participant together in a circle, such that they would receive an interrupt, blink an LED, and send a signal to trigger an interrupt for their neighbour's board—much like watching people do a wave at a sporting event. This proved to be too ambitious and wrongly assumed everyone would complete all the exercises by the same time. The scheduled 3 p.m. end-time would come and go. The group was so immersed in the experience that they stayed an extra 2-3 hours working. The evening ended with a large pizza order for all of those that were still around for dinner.

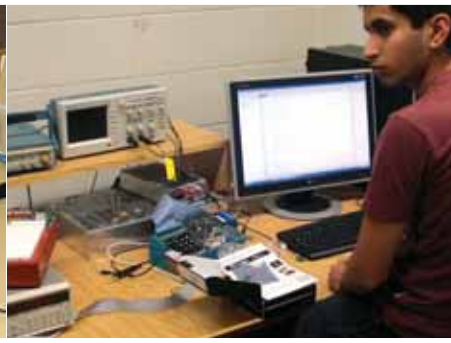
After the event, a survey was emailed to all participants and the results were very positive. There were some constructive comments to (i) reduce the amount of time associated with setting up the development environment, (ii) separating activities for audiences based on experience, (iii) adjusting the amount of content delivered to make the goals more achievable in the allotted time, (iv) improving the slides and making them available to students along with sample code to avoid re-typing unnecessary code, and (v) opening the event to non-UofM students. Overall the message was clear: the experiential learning objectives were met; and, most importantly, there was a yearning for more.









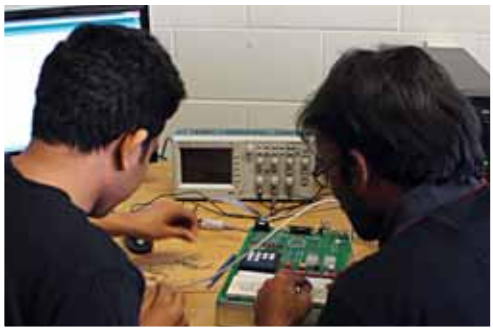


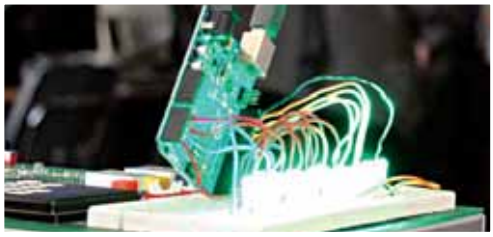
The Workshop Fever that Followed

The first workshop was not even finished and the group of attendees and instructors already began talking about the next phase. Wisely, the decision was to take time over the summer months to plan activities, develop material, and secure funding to improve the overall experience in future offerings. The team grew as we incorporated some attendees from the first event and other students who had lots of good ideas to contribute. Furthermore, there was an increased camaraderie and collaboration with other student groups including Society of Automotive Engineers (SAE), UofM Amateur Radio Society (UMARS), and UofM Space Applications and Technology Society (UMSATS), who requested specific topics to be covered to help in their respective projects.

From 2011 through 2016, there were more than 60 offerings of workshops using different development platforms including MSP430 [3], Arduino [4], and Raspberry Pi [5], and hosted by different venues around the city including the UofM, Red River College, the Winnipeg Public Library, and many high schools. In addition, there have been many collaborations with other organizations including WISE Kid-Netic Energy, UMARS, and UMSATS. Most workshops are now split into different sessions for beginner, intermediate, and advanced audiences with different prerequisite knowledge depending on the activities to be completed. The setup time has been reduced by pre-installing all the necessary tools in a computer lab where the workshop is being hosted and providing links to instructions to those wishing to install compilers on their personal computers.













WISE Kid-Netic Energy Workshops

*By **Nusraat Masood***

WISE Kid-Netic Energy is an outreach program established in 1990 at the University of Manitoba and a member of Actua. We serve all of Manitoba, including First Nations reserves, northern communities, southern communities and the city of Winnipeg. Annually we engage between 25,000 to 35,000 youth depending on funding levels. We are a not-for-profit. Whether it is summer camps, workshops, girls clubs or special events, all of our activities support STEM (Science Technology Engineering Math) learning through fun, messy, experiential activities. WISE stands for Women in Science & Engineering.

We engage all youth but have specific initiatives to target underrepresented groups like girls, Indigenous youth and youth facing socio-economic challenges. We hire undergraduate students pursuing degrees in STEM to deliver our outreach. This year we are offering over 20 workshops for in-classroom exploration. We follow the Manitoba science curriculum and are an excellent resource for teachers. In fact this year we received a STAM (Science Teachers' Association of Manitoba) award.

We have a workshop for grades 4-8 wanting a great first exposure to coding. The workshops is called "Codemakers" which is a nod to our funder Google.

We bring tablets and Dash robots and go through simple coding concepts like if/else and loops. Another great workshop for grade 9 is our "Solder Shop" where students solder electrical components on a printed circuit board to build a blinking LED device. For all of our workshops we bring in trained staff, materials and clean up afterwards.

If you're looking for extra-curricular activities for your girls we have some great options. This year we are running our "All Girls Robot Fight Club." It's an eight-week, 4-hour long training prep series for the Manitoba Robot Games LEGO Mindstorms competition. All participants use our LEGO Mindstorms to prepare and compete. We have a Computer Science student, Valorie Plataro, an UMSATS member and ECE student Jenica Woitowicz training the girls this year. This summer we will also be offering an all-girls intro to coding camp. The dates are July 18-20 and August 1-3. The girls will be exposed to learning apparatus like littleBits, Arduino, Dash, LEGO Mindstorms and Snap Circuits.



If you would like to learn more please see our website: wisekidneticenergy.ca

Nusraat Masood is the Program Administrator for WISE Kid-Netic Energy. She has a Bachelor's and Master's degree from the Faculty of Engineering at the University of Manitoba (UofM) in Electrical and Computer Engineering. For her Masters she designed and fabricated a lab-on-a-chip device that non-invasively manipulated dielectric beads using dielectrophoresis. After her graduate degree she worked at a start-up in Kanata, Ontario. For the past five years she has led the STEM outreach not-for-profit WISE Kid-Netic Energy program for the Faculty of Engineering at UofM. She recently spoke about how all youth are capable of pursuing STEM careers in a TEDx talk. Ms. Masood is the interim Director of UofM's Internationally-Educated Engineers Qualification program.

The Beginner workshops introduce basic concepts and are designed under the assumption that the participants have never built a circuit or programmed before. These workshops have been adapted for grade 7 classes, through university students, and beyond. For the most part, they start with a high-level description of development tools and then jump right into an example to make an LED blink. There is an unwritten goal for every student to complete the first activity and see the LED blink within the first half hour of the workshop to prove to them that they can do this. The half-hour goal is even more important for high school visits and younger audiences where many participants have preconceived notions of electronics and their strengths that have to be overcome with a positive experience before presenting them with challenging new material. For example, at a workshop held at the UofM with International Baccalaureate grade 10 students from across the province, there was a young lady that spent part of the time on her cellphone (thinking the instructors did not notice) and openly stated that electronics was way outside her interest in biology. However, she was the first to complete the hands-on example, giving her the confidence to get up from her seat to help others, alter her perception of engineering, and leave with a new perspective on her own capabilities.

Over the years, the workshops became more popular, the students involved in the activities transitioned to Young Professionals, and there was a natural opportunity to expand the activities beyond the University of Manitoba

After completing the first example, the breadboards, passive components, and other peripherals are integrated into subsequent activities. Depending on the length of the workshop, students will be provided with more complex examples that include sending messages in Morse code using an LED, reading an analog sensor, converting readings to engineering units, and printing messages to standard output. Most of the time, the final example introduces students to a rudimentary closed-loop control system where an LED represents a heater that is turned on/off depending on the readings from a thermistor. This requires students to integrate all the elements discussed into a single example that is something they can intuitively understand from their thermostats at home.

Shaftesbury High School Workshop

*By **Robert Striemer***

In 2010, the Shaftesbury High Altitude Robotics Project (SHARP) launched its first high altitude balloon (HAB) from the Erickson aerodrome in western Manitoba. The balloon reached an altitude of 107,000 feet and travelled more than 200 km before making a parachute landing just 18 kilometres from Shaftesbury High School in Winnipeg. The excitement created by this flight led to five more flights and collaboration with a growing number of schools. In April of 2016 six schools launched HABs from the playing field behind Carman Collegiate. Yearly HAB flights are now coordinated by the Manitoba Association of Physics Teachers (MAPT).

Students design and build payloads that have reached altitudes of more than 36 km. To date, fourteen payloads have flown to the stratosphere and all have been recovered. It does help that southern Manitoba is relatively flat and treeless. HAB payloads carry science and engineering experiments as well as video cameras.

Students use their electrical skills to build a payload power distribution system. Arduino microcontrollers are a very common component of HAB payloads. MAPT organized an Arduino workshop for school teams (students and teachers) in March. The University of Manitoba's department of Electrical and Computer Engineering and IEEE ran the workshop. Arduinos are used to log sensor data and control circuits such as the payload release circuit. The Arduino in the payload release circuit receives input from a GPS receiver. At a programmed altitude, the Arduino sends current to a thermal knife which cuts the line between the payload and the balloon. The payload containing experiments and cameras returns to Earth by parachute. Students analyze their data and make presentations and may enter their project in science fair competitions. Amateur radio beacons inside the payloads are used for real-time tracking. Many students take amateur radio certification courses learning about electronics, transmitters, receivers and antennas. Some students use their own ham radios to help coordinate the flights.

Shaftesbury High School hosted the first Manitoba Schools HAB Symposium in October of 2016. The symposium, sponsored by MAPT, allowed students to demonstrate their work. Their projects were discussed and information was shared in the Proceedings. Collaboration between schools has helped teams improve in all areas from flight theory, launch and tracking operations to experiment and payload design. This year about a dozen Manitoba schools are working on HAB projects. Spring floods permitting, most HABs will take to the air together sometime before the end of June 2017.

Robert Striemer has been a public high school physics and science teacher for the past 33 years. Receiving his B.Sc. degree and Certificate in Education from the University of Manitoba, his classroom skills and dedication to students were recognized by a Prime Minister's Award for Teaching Excellence in 2012. He is a member of the Radio Amateurs of Canada, the Manitoba Repeater Society and the Winnipeg Amateur Radio Club in which he serves as Chief Instructor, delivering amateur radio certification courses to the community including school teachers and their students.



Glowing softly in the early morning light, a high-altitude balloon and payload are readied for lift-off roughly 250 km upwind of Shaftesbury High School.

The intermediate and advanced workshops assume that the participants have experimented with a development board before and are at least familiar with the environment. On average, about 75% of participants sign up for all three workshops, so the instructors tend to know the level of knowledge and what is expected. For those that sign up to multiple workshops, one assumes they have tinkered with the boards in the weeks in-between sessions. These workshops introduce more peripherals like different types of sensors, seven-segment displays, serial interfaces, and even the use of interrupt signals. One of the goals is to help people become more independent as they progress through different workshops. This is accomplished by providing the participants the theory behind the components and terminology they may encounter when reading about the subject. In addition, some time will be dedicated to putting datasheets on the screen and highlighting key information like operating conditions, maximum ratings, and how to interface the device to a microcontroller. Essentially providing enough knowledge to interface with simple components. Finally, the more advanced workshops have small interrelated examples that lead to a project to be completed during the session. A more grandiose end-goal keeps the interest from participants throughout the session and challenges them to think of how all the parts will fit together. Some of the most ambitious hands-on projects are described in the next section.

Regardless of the audience, there is a significant amount of effort associated with developing materials in advance of the workshop. Most of the instructors are used to working with state-of-the-art commercial software available through the university or place of employment. Initially, these were used to develop the material for the workshop, but many participants asked for open-source equivalents that they could try at home. Thus, there has been a trend to move towards open-source tools for all the materials unless specifically advertised as part of the workshop goals, like the case of the printed circuit board (PCB) workshop where students designed an Arduino shield using Altium Designer. The slides are developed in Google Slides and a link to view the files is shared with all participants at the beginning of the workshop. The advantage of this system is that it allows one instructor to continue presenting material while another person annotates the slides as needed based on feedback from participants. In the first few events, the code examples were distributed through the websites for student groups, however, more recently there was a transition to GitHub repositories to track changes during development and subconsciously promote good habits for configuration management. Finally, the diagrams and schematics have been developed in Fritzing to allow students to jump back and forth between schematics, vector graphics of the breadboard layouts, and even PCBs if desired. The vector graphics include everything from the development board, breadboard, passive components, sensors, and jumper cables. Thus, it is easy to make a high quality image that has improved legibility over an annotated photograph. Finally, handouts were developed on rare occasions for advanced workshops where text descriptions were easier to follow than bullets on a slide.

There have been many approaches used for handling workshop components and costs. Nominally, at the UofM and RRC, students register online in advance of the workshop and select whether they want to purchase any parts at cost through the student branch. This is often preferred as the bulk orders are often eligible for educational discounts. At the end of the workshop, the students get to take home all the components to continue experimenting. Any funding obtained by the student branches is only used to cover the cost of refreshments or equipment that will be kept by the branch for future activities. This is very different for high school workshops where either the school purchases parts for a physics or computer science class or the instructor signs out a set of development boards used for outreach activities by the UofM Faculty of Engineering. In contrast, the library purchased components as part of a Makerspace initiative and makes them available for short term loans.

Over the years, the workshops became more popular, the students involved in the activities transitioned to Young Professionals, and there was a natural opportunity to expand the activities beyond the University of Manitoba. These included joint workshops with the Red River College student branch, followed by high school visits coordinated by WISE Kid-Netic Energy, workshops for teachers through the IEEE Teacher In-Service Program (TISP), and other initiatives. The activities were customized for different audiences and delivered by a growing number of instructors working with anywhere from 15-25 participants per session.

Examples of Workshops

Outside the introductory workshops already described, there are many special events that show the potential for these events within the community. The following are six examples that give an overview of the range of activities in Winnipeg.

GPS Receivers at Shaftesbury High School



In the Spring of 2012, a physics teacher from Shaftesbury High School, Mr. Robert Striemer, asked if the group could run a custom workshop to help his high school students interface a GPS to an Arduino for a high altitude weather balloon experiment. The teacher had already attended the Arduino workshop series, but wanted some assistance with new concepts like installing libraries, communicating with an asynchronous serial device, parsing data, and validating readings. Two UofM IEEE Student Branch members volunteered to run the activity and prepared some slides talking about GPS receivers, how they work, how the data is formatted, and serial interfaces. The initial tests were conducted in the classroom confirming the unit was reporting the correct coordinates. Afterwards, Robert presented a unique challenge to make the on-board LED blink whenever we entered the endzone of the school's football field. This required extracting the latitude and longitude coordinates from Google Maps and writing some simple logic to turn on the LED at the correct time. Testing the circuit was a memorable experience as shown in the picture. The rain did not deter students from walking with their Arduinos under an umbrella to see whether the lights would blink.

Culinary Arts and Embedded Systems at RRC

In March 2014, Red River College and IEEE Young Professionals organized a workshop to learn to interface with motors and sensors for a manufacturing environment. To make this more realistic, the instructors developed a test system that added motors to a cookie extruder

purchased online and linked that to a conveyor belt that could carry a baking sheet. During the workshop, the participants first interacted with individual components at their desks, developed the software, and after a quick peer review from the instructors, plugged in their programmed Arduinos to the full system. As cookies were being extruded, they were placed in a toaster oven, and served to the participants. Aside from the culinary challenges, the workshop successfully covered many topics related to interfacing, control systems, and testing that could be transferred into other applications in the future.

MANITOBA SPACE ADVENTURE CAMP

By ***Witold Kinsner***



A cutaway model of a rocket motor showing the solid propellant and the nozzle is explained by Space Camp volunteer Diane Kotelko, Lead Systems Engineer at Magellan Aerospace.

While outer space was reserved for very few in the past, many more students today can find challenging opportunities in space-related jobs, education, and research. In order to provide a place to explore such opportunities, a unique affordable one-week summer space camp (SCM) has been developed at the University of Manitoba (UofM) for high-school students from Manitoba and elsewhere, as one element in our multi-faceted space-related education program. The purpose of the SCM is to encourage young men and women from high schools to engage in science, engineering and technology through experiential learning such as hands-on workshops, short tutorials, and related outdoor activities. Parents and friends are also invited to participate in some of the activities.

Typical activities include: rocket building and launching; self-propelled robot building and testing; amateur radio operations and use for tracking of payloads; satellite ground station operation; fox hunting (transmitter locating); zero-G experiments; CubeSat design experience; Canadian Satellite Design Challenge (T-Sat) at the UofM; unmanned vehicles at UofM; simulation of orbital mechanics; demonstration of six high-technology labs at the Faculty of Engineering; space law; astronomy; industrial aerospace accomplishments (Magellan Aerospace); and small space business. The students have access to multi-million dollar space-related software for simulation and exploration.

The space camp is designed to satisfy several long-term objectives, including: (a) to understand the scientific method, (b) to understand the engineering design process, and how ideas can be implemented—not just with much money, but in a smart way; (c) to understand how the very-high level of science and engineering developed for space can be applied to our planet; (d) to learn how to work in teams; (e) to understand the relationship between our planet and space; and (f) how to be good stewards of this planet.

The SCM has been supported by over 20 organizations, including the strong Manitoba aerospace industry, the amateur radio community, and several schools.

To know more about the SCM, contact Witold Kinsner: w.kinsner@ieee.org



Introduction to Internet-of-Things Projects at RRC

Another workshop at Red River College focused on developing an Internet-of-Things application to turn on/off a device remotely. The workshop was broken down into three parts (i) learning to interface with devices on a Raspberry Pi, (ii) installing an Apache web server on the Raspbian operating system, and (iii) developing a web interface that would link a website to Python scripts to interact with peripherals. The objective from the workshop was to enable students to load the web interfaces on their phone and turn on/off devices remotely. In addition to embedded applications, this introduced many topics related to interacting between a server and low-level interfaces. More importantly, it engaged many discussions on network security and understanding the vulnerabilities of such systems.

Advanced Concepts with Arduino Shields at UofM



One of the challenge for most workshops is agreeing on a project to build and selecting parts that would provide the best educational experience. In 2013, the UofM IEEE Student Branch could not make up their mind, so they purchased ten pairs of different Arduino shields with different interfaces including MP3 audio, SD Memory Card storage, motor controllers, capacitive touch interfaces, displays, and different types of sensors. The workshop led by Dr. Ahmad Byagowi, presented the theory behind all the components, and then opened up the floor for students to take turns experimenting with different shields using examples provided by the manufacturer. The instructors walked around and helped people get the examples running, provided ideas on how they could be used in projects, and then encouraged people to try more devices. The free-for-all approach was challenging and stimulating for both students and instructors discussing the potential for the various devices.

Workshops for the Masses

In 2015, the Winnipeg Public Library started a series of Adult Programming classes following the Makerspace trends seen in other venues across North America and contacted IEEE to participate and develop the material. The staff at the Millennium Library managed the logistics, registration, and purchased the parts, while IEEE Young Professional members were responsible for preparing and delivering content to a wide audience that ranged from high school students to retired seniors. The demand for the sessions was very high and all the workshops were sold out with waiting lists of people trying to attend. Thus, in an effort to offer more options, the library staff took on the responsibility of delivering content for the introductory level workshops reusing existing material, while IEEE members continue to develop and run more advanced workshops on embedded systems, 3D printing, and other technologies.

Multiplying Factors through Teacher Workshops

In April 2015, Dr. Witold Kinsner and Ms. Andrea Misner organized a full-day workshop for 26 high school physics teachers through the IEEE Teacher In-Service Program (TISP). The event combined hands-on activities building a solar robotic car intertwined with examples of activities to run in the classroom, safety elements, and pedagogical discussions for teaching electronics to young audiences. The activities were run by university professors, graduate students, and industry professionals who were able to share their passion and experiences teaching and learning about embedded systems. The workshop was a great success and a second iteration was scheduled for March 13, 2017. We can estimate hundreds of students benefited.

The Impact of the Workshops

By the time this issue of the *IEEE Canadian Review* is printed, it will have been six years since the first workshop. In that time, there have been 60+ workshops, 1000+ participants and 40+ volunteer instructors. In order to understand the impact, one must look beyond the numbers and evaluate the benefits to different stakeholders. At a high level, these can be summarized as follows.

The workshops are an outreach tool that makes electrical and computer engineering more tangible through hands-on activities for pre-university students

The workshops are an outreach tool that makes electrical and computer engineering more tangible through hands-on activities for pre-university students. For most students, this is their first and possibly only exposure to the subject in high school. Thus, it is important for them to have a positive memory that involves some success completing the first examples, a high-level appreciation for the field, magnitude of applications in everyday life, and research potential. Some students become very engaged and are excited to learn about more advanced workshops that will challenge their understanding of the subject in a university environment. As an example, while in Grade 11, Erik Johnson attended the 2011 Manitoba Space Camp, was encouraged to participate in some of the university workshops, later enrolled in the Dept. of Electrical and Computer Engineering at the UofM, joined IEEE, delivered workshops himself, and will soon be transitioning to the Young Professionals member grade.

As mentioned in the examples of workshops, the activities through the IEEE Teacher In-Service Program (TISP) serve as professional development for teachers and help reach a wider audience. The teachers and librarians can then incorporate elements of the workshops

THE RESEARCH DISCOVERY SPRING CAMP

By ***Witold Kinsner***



A Verna Kirkness Discovery Week participant concentrates on soldering a circuit-board connection.

The University of Manitoba (UofM) has developed a very good Engineering Access Program (ENGAP) for Indigenous high-school students to facilitate their transition to the Faculty of Engineering. The program is also very helpful to the students already in Engineering. In order to motivate students even more, we have also developed an annual one-week Research Discovery Spring Camp (RDisc) for Indigenous high-school students. It is administered through the ENGAP in the Faculty of Engineering under the umbrella of the Verna J. Kirkness Science and Engineering Education Program (VKP) (http://www.vernajkirkness.org/). Grade 11 students from across Canada representing First Nations, Métis and Inuit are selected to come to our campus. We started the program with fewer than 20 in 2013, expanding to more than 80 students last year.

The program at the RDisc is very diverse, with emphasis on hands-on experience. Workshops include (i) exposure to research, (ii) building and testing of small smart robots (each student takes one home), (iii) Building of a small circuit and its analysis, (iv) computational workshop on Arduino, and (v) many demonstrations. Many seminars are interspersed among the workshops.

Another form to reach Indigenous students in Manitoba was the two-day Peguis First Nation Science, Technology and Engineering Symposium offered at the University of Manitoba in the past. We provided many presentations on research at the UofM, including major workshops on robotics.



Dr. Verna Kirkness graduated from the UofM in 1980 with a Master's in Education after she completed her BA and BEd at the U of M as well. She is a member of the Fisher River Cree Nation, and a member of the Order of Manitoba and Order of Canada. She is a national leader in education in Canada who has inspired countless students and educators in both Indigenous and non-Indigenous communities. In her book (left) Kirkness has written about the history of Aboriginal education in Canada and her valuable efforts in supporting Aboriginal education's development. Her book is published by the University of Manitoba Press: uofmpress.ca.

To know more about the RDisc, contact Witold Kinsner: w.kinsner@ieee.org

in their own classrooms, science fair projects, lunchtime clubs, and other activities that enhance the STEM curriculum. The best teachers plant the seed of embedded systems for students and use the network of IEEE volunteers to help address questions beyond their expertise in the subject. Such was the case when Mr. Striemer introduced Arduinos for his students after attending a few workshops at the UofM, and later contacted IEEE to address the specific need of interfacing a GPS to an Arduino.

As high school students become more engaged in electronics and want to attend workshops outside of school, it is not uncommon for their parents to drop them off, check out the place, meet the instructors, and ask questions. The most common questions have to do with purchasing components locally, recommendations for educational kits, and safety concerns. If parents are looking for mentorship opportunities, the tendency is to refer the students to a group of professors at the university who coordinate activities, meet with the students, and suggest projects. As they say, it truly takes a village to raise a child.

The workshops at the Winnipeg Public Library attract many hobbyists that can be often categorized as those wanting to learn something new about embedded systems versus those seeking advice on specific projects. The first group is eager to learn and maximize their time playing with hardware during the workshop. Their questions focus on hypotheticals for projects, capabilities of the system, and comparisons to other popular development boards like Arduinos and Raspberry Pis. In contrast, the second group of hobbyists comes prepared with questions that can dominate the workshop by asking about their specific project. These questions can involve anything from help to solve an interface issue to more advanced design decisions. In these cases, it is up to the instructors to defer those questions for after the workshop and use their judgment when answering questions without a full understanding of the system.

The events held at the university attract post-secondary students and practitioners. In general, the assumption is that the audience has some limited background in programming, electronics, and mathematics so instructors adjust by providing more theory and concepts rather than low level examples. The feedback from students is that the workshops complement the classroom education through hands-on activities, learning to use new tools, and information on how to set up development environments. The advanced sessions often attract practitioners with varying levels of experience. The junior engineers often use the activities as part of their Engineer-In-Training education requirements, while some of the more senior engineers are often interested in getting a quick tutorial of new tools that they read about in magazines. In any case, the advanced workshops are often eligible for credit with Engineers Geoscientists Manitoba (EGM) as long as the instructors send an outline of the activities covered to the association in advance of the workshop.

The volunteer instructors use the workshops to share their knowledge, prepare material, and practice their communication skills. In addition, those involved with organizing the event get lots of experience in management through planning, tracking budgets, funding proposals, advertising, and more. These activities help prepare instructors for many responsibilities they will face in industry, while also giving them an excuse to purchase new components, test development tools, and build prototypes for different machines. From the Section perspective, the workshops keep student members engaged as they transition to Young Professionals and allow the instructors to develop leadership skills for taking on new positions within IEEE.

Beyond the specific benefits for different stakeholders, there are many heartwarming personal stories from the workshops that include the bonding between a grandfather and his grandchildren over Arduinos, watching parents and children learning together, and witnessing many "eureka" moments.

Ultimately, one hopes that the activities will have an impact beyond the workshops. The appreciation and exposure to the field will play a role beyond the classroom, help demystify what engineers and scientists do, and encourage a sense



Photo: David Lipnowski

of experiential life-long learning. And, hopefully not too far into the future, the widespread understanding of computing will enables us to walk into our local coffee shop and think of someone writing an essay on their laptop as being ubiquitous with working on an embedded systems project. ■

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Special Thanks: Degrees Restaurant at the University of Manitoba for allowing us to convert the restaurant into our lab away from home for an afternoon.

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About the Authors



Dario Schor completed his B.Sc. and M.Sc. in Computer Engineering at the University of Manitoba in 2008 and 2013 respectively. Shortly thereafter, he attended the nine-week Space Studies Program from the International Space University in Strasbourg, France. Currently, he works as a Software Engineer for Magellan Aerospace on flight software, ground tools, and testing for the RADARSAT Constellation Mission and as a Seasonal Instructor for the UofM Computer Science Department. He has served many positions within IEEE Winnipeg since 2009 and is also an active contributor to other organizations. Dario has delivered many workshops on embedded systems, programming, amateur radio, and space systems to a wide range of audiences. He can be reached by email at schor@ieee.org.



Troy Denton is a Software Engineer (EIT) at JCA Electronics in Winnipeg, Manitoba, where he works on OEM Solutions for the Agriculture Industry. He obtained his B.Sc. in Electrical & Computer Engineering from the University of Manitoba in 2012. Troy has been an active volunteer with IEEE since his undergraduate days, serving various executive positions with the Young Professionals group. Troy regularly facilitates workshops on electronics, linux, and embedded systems with Winnipeg Public Libraries, multiple post-secondary institutions around Winnipeg, and at SkullSpace (Winnipeg's local hackerspace). Troy presently serves as a Director at SkullSpace (http://skull.space)—you can find him on IRC in #skullspace (irc.freenode.net)



Witold Kinsner is Professor in the Department of Electrical and Computer Engineering, University of Manitoba. He obtained his Ph.D. degree in Electrical and Computer Engineering from McMaster University in 1974, becoming Assistant Professor there and then at McGill University. He is a co-founder of the first Microelectronics Centre in Canada, and was its Director of Research from 1979 to 1987. Dr. Kinsner has authored or co-authored more than 700 publications in cognitive systems, computational intelligence, robust real-time computing engines, and computer memories. He is a Fellow of the Engineering Institute of Canada (FEIC), a Fellow of Engineers Canada (FEC), Life Senior Member of IEEE and a member of Engineers Geoscientists Manitoba. For more than 40 years he has been very active throughout IEEE—Region 7 (IEEE Canada), Council, Section, Chapter, and Student Branch. His roots in educational outreach date back to the establishment of the first IEEE McNaughton Learning Resource Centre at the University of Manitoba in 1979, in which he was instrumental. Dr. Kinsner is serving as IEEE Canada President and IEEE R7 Director 2016-2017; he can be reached by e-mail at w.kinsner@ieee.org.

IEEE Canadian Foundation Dr. Raymond D. Findlay Scholarship



Raymond D. Findlay is well known across IEEE, having served at its highest levels including IEEE President in 2002. Dr. Findlay was instrumental in the formation of IEEE Canada and served as its first President in 1995. He is currently Director Emeritus. The IEEE Canadian Foundation Dr. Raymond D. Findlay Scholarship honours his more than 40 years of dedication to member services, student activities and leadership in electrical engineering.

As Student Activities Committee Chair for Region 7 in the early 80s, Dr. Findlay was a pioneer in teaching soft skills: problem solving, leadership and team building. Unique at the time, his workshops—presented across North America—were the forerunner of the current leadership program. To further encourage student membership, as VP of the Regional Activities Board from '96-'97, he promoted dues levels attractive to undergraduates and programs that encouraged retention.

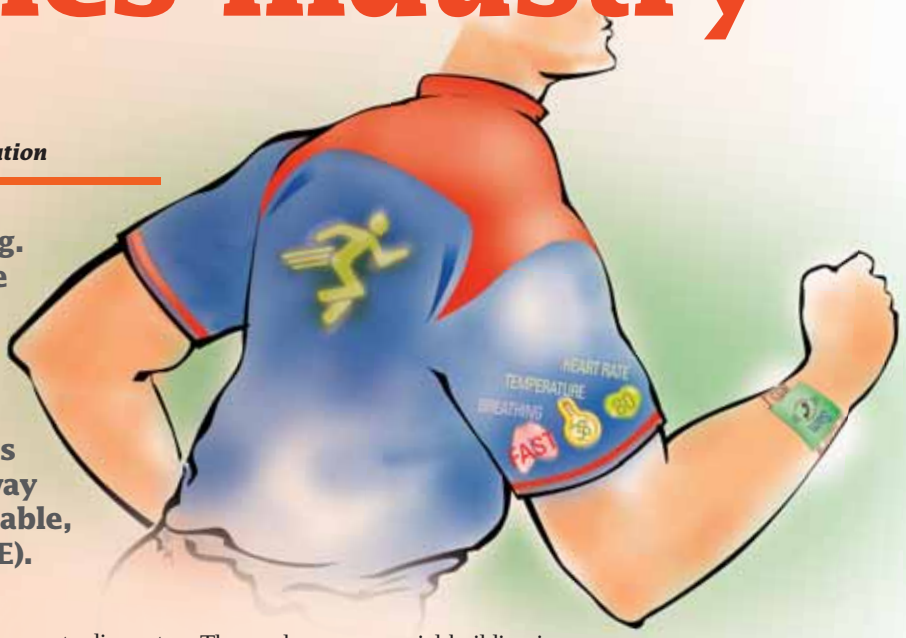
Logan Markewich, the scholarship's inaugural winner, is Vice Chair, U of Saskatchewan IEEE student branch. A strong leader, Logan has been active in recruiting new members and maintaining branch organization. He organized many events as Social Director, and can always be counted on to lend a helping hand and generate enthusiasm.



Logan has enjoyed sharing ideas with other student branch leaders and has been inspired by the spirit of innovation and excellence fostered by IEEE. He plans on involvement in IEEE Young Professionals as he pursues a career in embedded systems.

Building the eco-system of Canada's printable, flexible and wearable electronics industry

By **Peter Kallai** President & CEO
Canadian Printable Electronics Industry Association



Flexible displays and lighting. Smart packaging. Wearable technology. Intelligent buildings capable of low-cost energy harvesting with organic photovoltaics. These are only a few examples of the applications taking hold today that in some way require or can benefit from printable, flexible and wearable electronics (PE).

What is PE?

Printable Electronics transfer conductive inks onto a substrate at high enough density to form a complete electronic circuit, but thin enough to have negligible impact on the substrate thickness. The substrate can be rigid, flexible or even stretchable, for instance: paper, plastic, fabric or glass. Inks can be made from materials such as graphite, silver or copper.

These inks can be applied through traditional printing processes such as flexo, screen, inkjet, gravure, and offset, as well as through coatings. This can be done through fast and inexpensive automated processes, such as those used in the commercial printing industry for newspapers and magazines. These electronic components can also be embedded through additive manufacturing processes, such as 3D printing or in-mould electronics. A related field involves conductive yarns that can be used to create smart garments.

PE can be used to create discreet components such as displays, conductors, transistors, sensors, light emitting diodes, photovoltaic energy capture cells, memory, logic processing, system clocks, antennas, batteries, and low-voltage electronic interconnects. These can be integrated into simple systems that, for example, can record, store, and then transmit temperature information. Fully functional electronic systems can be created in this way, or discreet components and sub-systems can be produced to function as part of a hybrid solution with conventional silicon-based integrated circuits or components.

Creating more intelligent buildings and connected homes

PE can redefine and enhance many of the conventional systems that are allowing intelligent homes and connected buildings to achieve new levels of energy efficiency, automation and occupant comfort.

The modern commercial building is morphing into an intelligent building at a rapid pace. Sensors, analytics, and controls using conventional electronics are already mainstream to improve efficiency, services, occupant comfort and safety. PE's advantages over conventional electronics in terms of form factor, flexibility and cost are driving research and commercial development into new applications for lighting, HVAC, fire, access and safety systems (see *The Office Remade* on page following). The same technology drive is happening in the connected home.

Both ends of the real estate market are looking at PE-related areas such as organic LED lighting and organic photovoltaics for low-cost energy harvesting (see sidebars on page 30).

Smarter parts for transportation and industrial applications

PE is ideal for additive manufacturing processes like 3D printing and in-mould electronics, to embed functionality inside a part or assembly. This reduces the bulk and expense of external hard wiring to connect electronic systems and assemblies.

By the same token, intelligence can be added to a part with low-cost printed electronic tags, labels and serialized sensor matrices. These are digital fingerprints that can be used to identify and authenticate a part.

But the practical uses go beyond these passive applications. With PE tags and sensors, parts and assemblies can collect and transmit data on their use and usage conditions, heat, humidity, stress and so forth. All this data can be collected and stored in the cloud, for remote monitoring and predictive analytics to carry out preventative maintenance and repair.



Wearables, including smart garments for health and wellness

Wearable technology has gone mainstream in a few short years. Many of us are taking advantage of devices worn on our person to enhance our athletic performance, monitor health and fitness indicators such as heart rate and breathing, and ensure the well-being and safety of the elderly. Wearable devices already on the market include bracelets, watches and necklaces, as well as athletic wear such as sports bras and shirts. We even have smart temperature stickers that monitor a child's vital signs during sleep.

The discrete form factors, flexibility and cost advantages of PE versus conventional electronics are crucial to make these devices and applications more practical and affordable. Another rapidly growing application area is smart garments and textiles.

Take, for example, Vagalume — a kind of electroluminescent technology that's incorporated into athletic apparel for greater visibility and safety at night. Unlike other electroluminescents, it is paper-thin, flexible, fully

The office remade

The conventional intelligent office

A typical office space has both ambient lighting and task lighting that can be adjusted to meet specific needs. The office also includes a light sensor that reduces the intensity of artificial light in response to natural light, an occupancy sensor that shuts the lights off when no one is present, and a thermostat.

In addition, there is a smoke/fire detector and an alarm annunciator to provide indication of a fire. Traditionally, each of these is a discrete component, hard-wired to a controller that provides localized control, as well as to a building-wide system for global control (for example, to set minimum and maximum allowable temperatures, to turn off the lights at night, and for the safety and security system).

All this requires a relatively large amount of labour to install, wire and commission all the separate components.

That office remade with PE

Ambient lighting is replaced with a thin sheet of light (using either organic LEDs or an array of inorganic LEDs). The substrate containing the light-emitting layer also includes a daylight sensor, a printed occupancy sensor, and a printed temperature sensor.

Local controls for providing daylight harvesting and occupancy control are printed on the substrate. This simplifies installation and wiring, and greatly reduces the local control burden on the central control system.

The modern commercial building is morphing into an intelligent building at a rapid pace. Sensors, analytics, and controls using conventional electronics are already mainstream to improve efficiency, services, occupant comfort and safety.

Printed temperature sensors are tied into the heating, ventilation and cooling system and can also provide information to the safety system. The lighting is tied into the safety system and is programmed to change colour and provide directional exit information in case of fire.



Because functional electronics for these applications are printed, installation is simplified and costs are reduced. A further advantage is that the printed components are much thinner than conventional components. This allows for more usable space to be created within the building.

How close to market is an integrated system such as this today? Flexible sheet lighting technology is already on the market. The sensors and other discreet PE components are in various phases of development with one-to-five-year time horizons. ■

More than 250 organizations in Canada are involved in the printable electronics supply chain. Below are some examples.

END USERS	SMART PACKAGING	LIGHTING	WEARABLES	MANU-FACTURING	SWITCHES	SENSORS	R&D	EQUIPMENT	INKS, PASTES	SUB-STRATES	TESTING, QUALI-FICATION
Molson Coors Unilever Bank of Canada	Jones Netpak TUKU	Myant Cooledge	Myant OM Signal	CGI Memtronik ICI Canadian Bank Note	Memtronik CGI ClickTouch	Myant Memtronik Tangio	3M, NRC, INO CRC, UWaterloo UBC, UCalgary UQAM, McGill ULaval	NovaCentrix Fujifilm, Xenon MGI Ceradrop Optomec Nano Dimensions	Du Pont NovaCentrix Xerox	Du Pont 3M Corning	CSA NRC

machine washable, and emits its own light using flexible electronic components.

Vagalume, which means "firefly" in Portuguese, is the creation of CPEIA Member company Myant & Co. Myant made waves last year at the Canadian Printable Electronics Symposium (CPES) when it took home the Product Innovation Award.

Other innovators have brought to market smart garments for health and wellness that use embedded biometric sensors wirelessly connected to a software platform. The benefit for users is that they can track and enhance their athletic performance. CPEIA Member OMSignal is one such company. It's known for the OMbra sports bra, as well as Ralph Lauren's PoloTech collection—smart shirts that can track vitals like heart rate and breathing.

The opportunity for Canada

Global revenues for products using PE in 2016 is estimated at US$ 26.9 billion, an annual increase of 31.8 per cent since 2010. Consulting firm Smithers Apex expects the market to grow to an estimated US$ 43 billion by 2020.

A separate forecast from market research firm IDTechEx predicts a US$ 70-billion market by 2024, for applications ranging from organic LEDs (OLEDs) to conductive inks for a variety of applications.

Canada's PE sector has the expertise, innovation and opportunity to revolutionize the electronics industry, for substantial socio-economic benefits across Canada and abroad. More than 250 domestic organizations that we know of are active in the space. Researchers at academic and government labs across the country are busy with the fundamental and applied research that supports innovation by industry in a number of key areas.

And yet, significant challenges remain to get PE technology to market.

The scale-up challenges of an emerging market

Last November, we convened in Toronto our first Sector Leadership Council to take the pulse of this industry in Canada through the eyes of our diverse membership—startups, young SMEs, established mid-sized companies and multinationals with Canadian operations, as well as government organizations that support innovation and commercialization.

According to our members, significant challenges remain in scaling up the sector in Canada. This is still an emerging industry, fragmented and dominated by a roster of startups and earlier stage companies in need of help to bring compelling products to market. There are currently no geographically concentrated technology clusters, government-funded centres of excellence for industry or dedicated incubators/accelerators.

The core group of larger Canadian and global companies that can help early-stage companies overcome their R&D and scalability hurdles face their own challenges to remain competitive. They are working to understand how they can incorporate the advanced features supported by PE into their products.

The Council identified four key challenges for the growth and development of this emerging sector in Canada that impact in various ways upon startups, young SMEs, established mid-sized companies and multinationals with Canadian operations:

The Market Challenge: Defining applications and products with large and profitable markets in partnership with world-class end users. Critical in this is accessing such end users globally and getting them to work with Canadian companies.

The New Product Development Challenge: Prototype development towards commercialization with lead end users/customers for trials and early adoption. Critical in this is conducting trials of new technologies at sufficient scale to prove the business case for profitable commercial adoption. Depending on the application, it can be quite difficult to get the unit cost low enough for prototype production, in order for trials to be economically feasible. End users can face challenges in getting the product to market, e.g., in the case of retail, procuring shelf space.

The Manufacturing Challenge: Resources for SMEs to invest in their own facilities before the market and business case have been proven for manufacturing scale up. Critical in this is creating and accessing sufficient scale-up manufacturing resources, including equipment, skilled people and production lines.

What is an organic LED?

An organic light-emitting diode (OLED) is an LED in which the emissive electroluminescent layer is a film of organic compound that emits light in response to an electric current. Conventional inorganic LEDs are point sources while OLEDs naturally emit light over large areas as sheets or panels. At present, LEDs have higher efficacy, lower cost and a longer lifetime. But OLED performance continues to increase. OLEDs can produce comfortable, uniform, non-glare light in a very thin and potentially flexible form factor.

What are organic photovoltaics (OPV)?

The OPV group refers to organic solar cells or plastic solar cells that use organic electronics—a branch of electronics that deals with conductive organic polymers or small organic molecules—for light absorption and charge transport to produce electricity using the same photovoltaic effect used by conventional solar cells. Although OPV solar cells aren't as efficient as their inorganic counterparts, they have advantages in terms of flexibility, weight, ruggedness and cost. They can be more readily embedded in other materials, such as window blinds, roofing and plastics.

Who do we mean by end users for PE?

Two examples are Unilever and Molson Coors. These global consumer brands want to better engage with consumers and protect their products from tampering and counterfeiting by embedding intelligent functionality into packaging and retail displays.

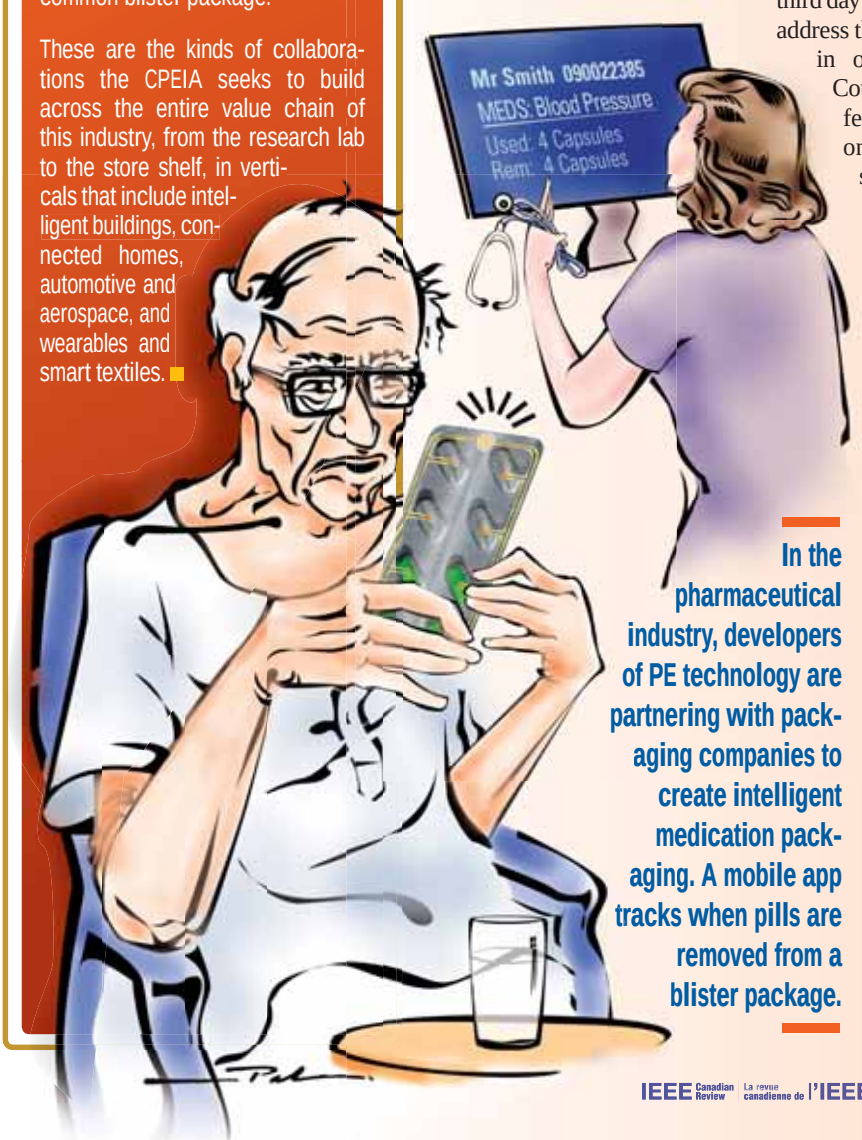
In the pharmaceutical industry, developers of PE technology are partnering with packaging companies to create intelligent medication packaging and market this solution to pharmaceutical companies—the end users. The goal again is brand protection and consumer engagement, along with the means to ensure safe and appropriate medication usage. A mobile app tracks when each pill is removed from a common blister package.

These are the kinds of collaborations the CPEIA seeks to build across the entire value chain of this industry, from the research lab to the store shelf, in verticals that include intelligent buildings, connected homes, automotive and aerospace, and wearables and smart textiles. ■

The Financing Challenge for Scale Up: Access to capital for startups and SMEs at various stages of growth. Critical in this is lack of access to traditional VC funding for materials, electronics or new emerging cross-sector ventures. Printable electronics is largely an unknown commodity for tech investors. Many of the application areas fall into the hardware segment, which overall are a harder sell to investors than a software product.

Why we convene CPES

Held this year May 24-26, CPES is Canada's sole conference and trade show exhibition dedicated to printable, flexible and wearable electronics. It arose from an annual conference held by the National Research Council of Canada, which has its own flagship research program in PE.



In the pharmaceutical industry, developers of PE technology are partnering with packaging companies to create intelligent medication packaging. A mobile app tracks when pills are removed from a blister package.

By working together across the entire eco-system, we can build a robust PE sector befitting Canada's track record for innovation.

Our objective with CPES is to serve as Canada's common meeting ground for technology developers, industrial companies and end-users to meet and discuss how they can work together to commercialize new products and applications for PE. Academic researchers can showcase their research and discover how they can link it to market needs and opportunities.

New this year, we have added a third day of programming to help address the challenges identified in our Sector Leadership Council last November. It features Master Classes on various technical subjects, a Financing Panel to help companies engage with private and government funding sources, and Mentoring Sessions for startups, where they can tap into the support they need to rise to the next level.

CPES, along with the workshops and webinars the CPEIA develops throughout the rest of the year with its strategic partners, rests on the principle that a rising tide floats all ships. Only by working together across the entire eco-system, from the R&D lab to the end-use product, can we build a robust PE sector befitting Canada's track record for innovation. ■

FOR IEEE MEMBERS

As an IEEE member, you are invited to attend CPES2017 at 15 per cent off the standard rate. Please use the discount code: cpeia-partner2017b. Visit **www.cpes2017.ca** to learn more about the conference and to register.

Please note this offer cannot be combined with the CPES2017 student rate. It only applies to Day 1 and Day 2 of the conference. If you wish to attend the Master Classes or Mentoring & Financing Sessions on Day 3, you must pay the regular fee for those activities.

Learn more about PE with our white papers, which can be downloaded for free by IEEE members. Please visit **http://cpeia-acei.ca/cpeia-whitepaper-series/** and use the code ieee!@$2016

CPES 2017
PRINTABLE FLEXIBLE WEARABLE ELECTRONICS SYMPOSIUM

About the Author



Peter Kallai
President & CEO
Canadian Printable Electronics Industry Association

Peter is a senior high-tech management consultant who has worked extensively for leading companies, research organizations and growth-stage companies in the National Capital Region. He has consulted with more than 100 companies and government organizations, and served on various boards and committees.

Peter has been involved with the creation and growth of many startup and growth-phase technology companies. Most recently as VP of Strategic Analysis & Global Marketing, he helped a TSX-listed global communications company grow from $3.2 million to $100+ million in revenues. For the three years prior to the founding of the CPEIA, Peter played an integral role in the National Research Council's efforts to prove the value of the PE opportunity for Canada and to create the PE Consortium.

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Dr. Michel Nakhla Ottawa, ON
"For outstanding contributions to signal integrity of high-speed systems and interconnects"
« Pour des contributions exceptionnelles à l'intégrité de signaux des systèmes à grande vitesse et des interconnexions »

R.A. Fessenden Award
Dr. Leslie Rusch Quebec City, QC
"For contributions to communications systems in optical & wireless technology"
« Pour des contributions aux systèmes de communication en optique et en technologie sans fil »

C.C. Gotlieb Computer Award
Dr. Hussein T Mouftah Ottawa ON
"For outstanding contributions to computer networks science and engineering"
« Pour des contributions exceptionnelles aux sciences et à l'ingénierie des réseaux informatiques »

P.D. Ziogas Electric Power Award
Dr. Praveen K Jain Kingston, ON
"For contributions to the theory and practice of high frequency power converters"
« Pour les contributions à la théorie et la pratique des convertisseurs d'énergie de haute fréquence »

R.H. Tanner Industry Leadership Award
Dr. Weiming Shen Ottawa, ON
"For outstanding contributions to collaborative intelligent systems"
« Pour des contributions exceptionnelles aux systèmes collaboratifs intelligents »

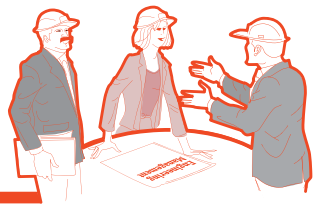
Outstanding Engineer Award
Dr. Federico Rosei Montreal, QC
"For contributions to the study of several classes of nano-materials"
« Pour les contributions à l'étude de plusieurs classes de nano-matériaux »

W.S. Read Outstanding Service Award
Dr. Fabrice Labeau Montreal, QC
"For volunteering within IEEE at the local level and within several societies"
« Pour le bénévolat au sein de l'IEEE au niveau local et au sein de plusieurs sociétés »

E.F. Glass Western Canada Merit Award
Dr. Rossitza Marinova Edmonton, AB
"For volunteering within IEEE at the local level of the Northern Canada Section"
« Pour le bénévolat au sein de l'IEEE au niveau local de la section du Nord du Canada »



What's New in the Literature?



by Terrance Malkinson

Most of us have experienced pain in our lower back—particularly as we age. A new edition of a book by Stuart McGill of Canada's University of Waterloo, *Low Back Disorders: Evidence-Based Prevention and Rehabilitation* [3rd edition. Human Kinetics. 2016. www.humankinetics.com] will provide you with state-of-the-art information on scientifically based functional anatomy, and myths and realities, lowering risk, injury prevention, and effective treatment of back pain. The authoritative 400-page book concludes with information on an effective exercise program to build lower back strength and flexibility. Instructions and photographs are well-drafted. Additionally, upon purchase of the book you are provided with access to a web resource that offers video clips and other important information of value to prevent and treat back problems that invariably result as we age. This Canadian author is a world-renowned lecturer, and expert in spine function, injury prevention and rehabilitation.

The March 2017 issue of *Fast Company* [#213. www.fastcompany.com] provides its annual guide to companies leading the world in innovation. There are detailed profiles of each of the world's 50 most innovative companies. Leading the list is Amazon; followed by Google, Uber, and Apple. Profiles detail why each company is a leader in innovation and presents valuable insights on the organizational culture necessary to be a world leader in innovation. A common theme is talent and the ability of recruiters and managers to recognize natural individual creativity in an individual and then give the person the opportunity and freedom to blossom.

***FORTUNE* magazine provides** its annual list of "The World's Most Admired Companies" in its March 1, 2017 issue. [175(3):113-120. www.fortune.com]. Based upon the opinion of over 3,800 executives, analysts, directors and experts, Apple emerged as the leader in the overall "all-star" listing followed by Amazon and Starbucks. Companies are also ranked within 11 industry categories; profiles of some of the companies are provided for the reader. In the January 1 issue of the magazine the editors provide analysis of 10 new brands that are seen as remarkable breakthrough "superstars" from a survey of over 4,000 consumers in this competitive marketplace. ["Breakthrough Brands 2017" pp.64-69]. Included in the brands profile is information on why the brand was seen as significant. An interesting inset in the article provides the results of an additional query included with the survey on the top-fifteen existing brands and a short article by Jim Stengel on "How to Build a Break-through Brand."

In 1950 Alan Turing devised a thought experiment (Turing Test – "Imitation Game") that has for many years been considered the ultimate test of machine intelligence. The exponential growth of robotic technologies and artificial intelligence are causing researchers to identify and determine new ways to distinguish artificial from human intelligence. "Am I Human?" is the intriguing title of an article by Gary Marcus in the March, 2017 issue of *Scientific American* [316(3):58-63. www.scientificamerican.com]. In this article four different approaches that researchers are developing to potentially replace the Turing test are described.

The exponential growth of robotic technologies and artificial intelligence are causing researchers to identify and determine new ways to distinguish artificial from human intelligence.

How does an organization provide benefits in an age of freelance work, the sharing economy and contract employees? Sara Tatelman explores this topic in her article "The Gig is Up" [*Benefits Canada*. 41(2):10-12. February, 2017. www.benefitscanada.com]. A survey conducted by the Urban Worker Project revealed that the major concern of these "precarious" workers across Canada was access to extended health benefits. The author discusses the complexities of the issue, and provides case studies of some solutions. Additionally, the author provides information on issues related to the classification of a worker as an employee or as an independent contractor.

There has been a substantial increase in the use of prescription opioids to treat pain in the past two decades and accompanying this the number of cases of opioid-related deaths from overdoses and misuse has regrettably risen. Interventions have generally failed to effectively address the root causes of the opioid crisis. Benedikt Fischer, Jurgen Rehm, and Mark Tyndall discuss in their research article what they believe would be an effective Canadian policy for tackling opioid overprescribing. ["Effective Canadian Policy to Reduce Harm from Prescription Opioids; Learning from Past Failures." *Canadian Medical Association Journal*. 188(17/18):1240-1244. December 6, 2016. www.cmaj.ca]. Many people who become addicted to opioids started out taking them for legitimate reasons. An increasing number of people are dying from non-prescription opioid and opioid-related products such as fentanyl.

Many people who become addicted to opioids started out taking them for legitimate reasons.

The April 2017 issue of *Harvard Business Review* [95(2):50-63. www.hbr.org] focuses on the "New Science of Teamwork". Four articles provide information to help you understand how to combine different workstyles to help you manage your team and yourself better. Susan Johnson et al discuss how to get the best from the combination of team member personalities of: pioneer, driver, integrator, and guardian. Alison Bead summarizes research on five executives who discuss how understanding personality has helped them become better leaders. In a second article Alison Beard discusses the neurobiology of personality traits and how to identify and adjust productivity to personality style. In a final article Eben Harrell briefly discusses three personality tests that have been used to assess employees.

The January-February 2017 issue of *Entrepreneur* provides the entrepreneurial reader with many articles of interest. These include their annual ranking and state of the franchising industry ["Franchise 500". pp. 65-237. www.entrepreneur.com]. For anyone interested in franchising this indexed feature provides a wealth of information. Categorized by small, medium, and large companies, "The 153 Best Company Cultures in America" are discussed by the editors of *Entrepreneur*. In its March, 2017 issue [pp. 45-52], US employers were invited to complete a survey used to assess the company's strength across 10 core qualities of culture: collaboration, innovation, agility, communication, support, wellness, mission and value alignment, work environment, responsibility and performance focus. The top company in each category is profiled and insights on what makes the organizational culture of the winners outstanding are provided. ■

For **Terrance Malkinson**'s biography please see page 7.

President's Message/Message du Président

(President's Message cont'd from page 5)

system; develop a global volunteering pathway that allows Young Professionals to progress from micro to macro volunteering).

6. **Effective Engagement** (ensure that every operational unit has diversified representation in leadership roles, including Young Professionals and underserved communities; leverage projects to engage members; invest in conferences, congresses, competitions, and networking).
7. **Career Training and Development** (create an internal IEEE Steering Committee to guide learning needs and an external Advisory Group to guide curriculum; develop a centralized location for all Training & Professional Development that is global and audience-centric).
8. **Infrastructure for 2025** (Create an IEEE One-Stop Portal; create the Infrastructure to Power the Portal; Drive Operational Excellence).
9. **People in Industry** (IEEE will serve industry at the intersection of supply and demand for talent through the offerings and services we provide to Young Professionals, women, millennials, the African continent, entrepreneurs, independent contractors and other underserved communities across their entire career life cycle — student to retirement; develop IEEE Career Navigator to serve individual members across their career life cycle; develop an IEEE Talent Marketplace to connect IEEE Young Professionals and underserved communities to industry globally; create an equivalent site to *Xplore* that increases practical information for industry. Be the industry solution curator and build an experiential library).
10. **Global Culture** (IEEE will define, publish, and disseminate what the organization should look like in 2025 and best practices for achieving global diversity; develop an organization-wide, global succession planning strategy for Young Professionals and other underserved communities; develop and deliver a consistent training program for all volunteers on the IEEE Values and ways of operating).
11. **Entrepreneurship** (Create a series of local entrepreneurial activities in underserved communities to develop a community of practicing entrepreneurs at IEEE; create a hard tech large-scale global event; build and maintain an ecosystem to support entrepreneurial activity).
12. **Student Retention** (drive more robust student engagement; reduce the financial burden of IEEE membership for students; improve internal IEEE partnership/coordination for students.)

This strategy session looked at just one objective: meeting the needs of young professionals and other underserved communities globally in the middle of the next decade. But it will likely serve as a model for IEEE to use our collective experience and insight to address other high priority issues. Its approach could also be adapted by Region 7 in our own strategic planning sessions. No matter where applied, it will be part of IEEE's commitment to develop a more responsive, robust organization serving both present and future members.

As we together make IEEE Canada stronger, I thank our dedicated volunteers for their invaluable gifts of time and expertise. ■

Respectfully submitted,

Witold Kinsner,
PhD, PEng, FEIC, FEC
2016-2017 IEEE Canada President
2016-2017 IEEE Region 7 Director

(Message du Président suite de p. 5)

aux jeunes professionnels de progresser dans leur bénévolat d'une échelle micro à une échelle macro.

6. **Un engagement efficace** (veiller à ce que chaque unité opérationnelle affiche une diversification dans ses dirigeants en faisant place aux jeunes professionnels et aux communautés laissées pour compte; finance des projets pour attirer de nouveaux membres; investisses dans des conférences, des congrès, des concours et du réseautage.)
7. **Formation et perfectionnement professionnels** (créer un comité directeur interne à l'IEEE afin de relever les besoins de formation, de même qu'un groupe consultatif externe afin d'orienter le contenu des programmes d'études et d'assurer un lieu de formation centralisé permettant de répondre à tous les besoins de formation et de perfectionnement professionnels dans le respect de la globalité des besoins de l'auditoire.
8. **Infrastructure 2025** (créer un portail unique pour l'IEEE; créer l'infrastructure permettant d'alimenter ce portail; viser l'excellence opérationnelle.)
9. **À l'écoute de l'industrie** (répondre aux besoins de l'industrie à l'intersection de l'offre et de la demande de talents par des offres et des services aux jeunes professionnels, aux femmes, à la génération du millénaire, au continent africain, aux entrepreneurs, aux entrepreneurs indépendants et à d'autres communautés laissées pour compte tout au long de leur cycle de vie professionnelle, soit des études à la retraite; créer un outil IEEE de navigation professionnelle pour répondre aux besoins des membres individuels tout au long de leur cycle de vie professionnelle; créer un marché de talents mondial qui reliera les jeunes professionnels de l'IEEE, les communautés laissées pour compte et l'industrie; créer un site équivalent à Xplore et y fournir de l'information pratique à l'intention de l'industrie. Jouer le rôle de curateur des solutions de l'industrie et mettre sur pied une bibliothèque expérientielle.)
10. **Une culture mondiale** (définir, publier et publiciser ce à quoi l'organisation devrait ressembler en 2025 et les pratiques exemplaires préconisées pour atteindre cette diversité mondiale; élaborer une stratégie mondiale de planification de la relève à l'échelle de l'organisation à l'intention des jeunes professionnels et d'autres communautés laissées pour compte; créer et mettre en œuvre un programme de formation riche pour tous les bénévoles sur les valeurs de l'IEEE et les modes de fonctionnement.)
11. **Entrepreneuriat** (offrir aux entrepreneurs une série d'activités locales dans les communautés laissées pour compte afin de créer une communauté d'entrepreneurs praticiens au sein de l'IEEE; créer un événement mondial à vaste échelle portant sur les technologies dures; créer et maintenir un écosystème soutenant l'activité entrepreneuriale.)
12. **Persévérance scolaire** (susciter un engagement étudiant plus robuste; réduire le fardeau financier de l'adhésion à l'IEEE pour les étudiants; améliorer le partenariat/la coordination internes à l'IEEE pour les étudiants.)

Cette séance de planification stratégique était axée sur un objectif : répondre aux besoins des jeunes professionnels et d'autres communautés laissées pour compte à l'échelle mondiale. Elle servira probablement de modèle pour l'IEEE afin que notre expérience collective et notre vision permettent de traiter d'autres questions hautement prioritaires. Son approche pourrait également être adaptée par la Région 7 pour ses propres séances de planification stratégique. Peu importe le contexte où elle sera appliquée, elle fera partie de l'engagement de l'IEEE à contribuer à la création d'une organisation plus souple et robuste répondant aux besoins des membres actuels et futurs.

Je remercie nos dévoués bénévoles pour leur inestimable don de leur temps et de leur expertise. Ensemble, nous contribuons à faire de l'IEEE Canada une organisation plus forte. ■

Respectueusement soumis,

Witold Kinsner,
Ph.D., ing., FEIC, FEC
Président d'IEEE Canada pour 2016-2017
Directeur de la région 7 de l'IEEE pour 2016-2017

Reliability Society in Toronto recognized three times with global Chapter Awards



Rabiz Foda; Chair, Engineering & Human Environment (Joint Chapter), IEEE Toronto Section

The IEEE Reliability Society Chapter of Toronto Section was recently recognized for a third time with an award at the society's annual awards banquet, held this year in Orlando on January 27. The Reliability Society (RS) Chapter in Toronto is a part of the E&HE (Engineering & Human Environment) Joint Chapter, representing the following additional IEEE societies: Technology and Engineering Management (TEMS), Education, Professional Communication, Social Implications of Technology (SSIT) and Product Safety Engineering (PSES). Such a serial recognition for the Toronto RS Chapter is a proud moment as it is the only chapter in Region 7 to have earned this distinction three times – in 2013, 2015 and 2016.

The Toronto Chapter found a distinguished place for itself with delivery of quality chapter activities, developing leadership, building bridges with other society chapters in E&HE as well as professional organizations such as The Institution of Engineering and Technology, Professional Engineers Ontario and alumni associations of leading universities in Canada. Member contributions and participation in professional activities of other national and international organizations were other important considerations. Leading the Toronto Chapter team for all three awards has been Rabiz Foda (SMIEEE). Other members of the team are Muthanna Al Khishali (SMIEEE), Jan Jekielek (MIEEE), and Doug Nix (SMIEEE). ■

IEEE Canadian Review

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