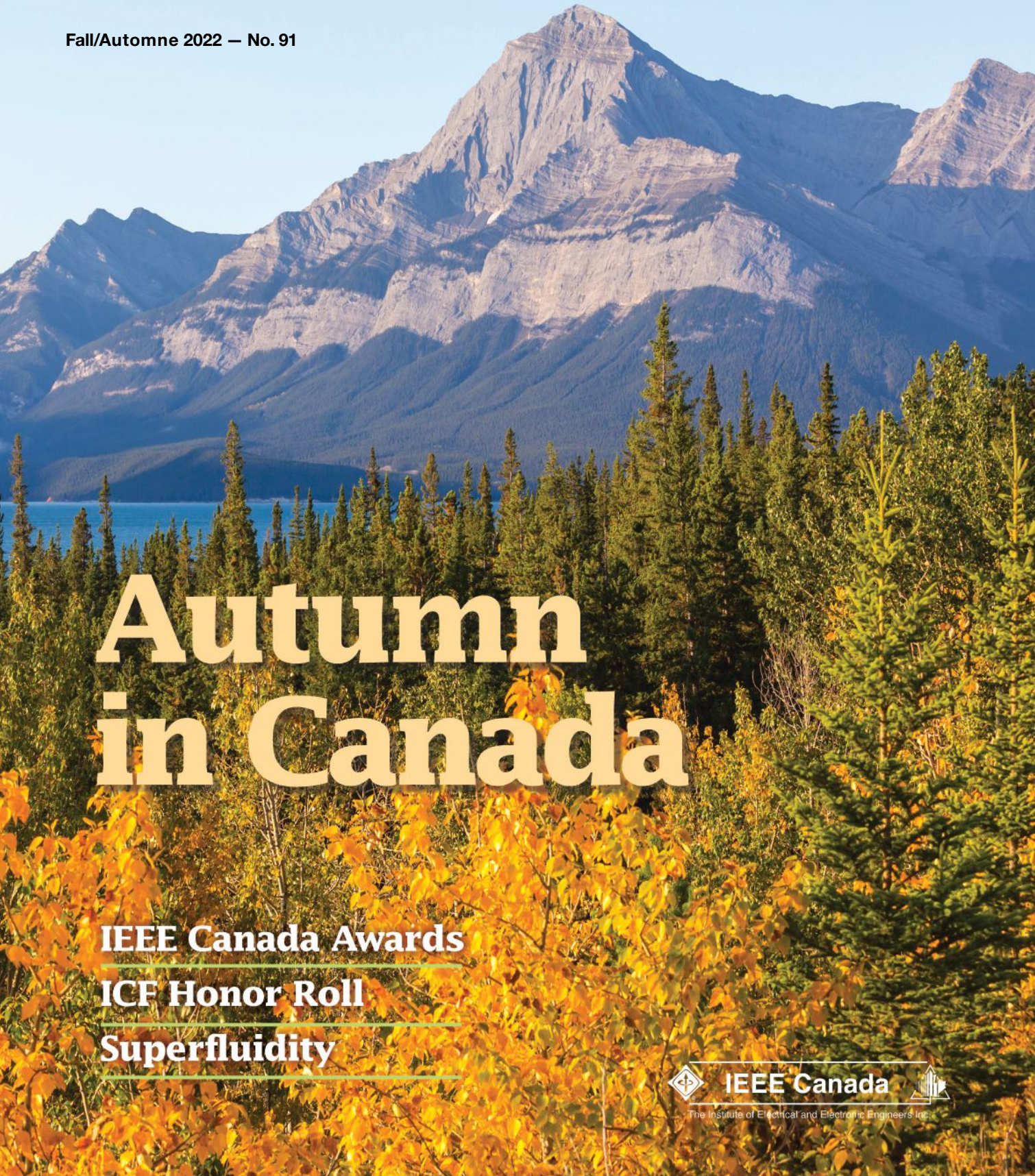
IEEE Canadian Review

La revue canadienne de l'IEEE

Fall/Automne 2022 — No. 91



Autumn in Canada

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Virtually on December 05-07, 2022

IEEE Victoria and Ottawa Sections will be the host for the annual Canadian Electrical Power and Energy Conference (EPEC 2022) that provides an opportunity for experts from industry, academia, government sector and other interested organizations from Canada and abroad to present and discuss the latest developments in the electric power and energy systems: academic, industrial and government research and development, industrial and business trends and challenges, as well as regulatory and policy aspects. This includes debate on the potential impact of these developments on the society. The conference provides an international forum for the presentation of peer-reviewed papers and presentations on power and energy research and development, applications, and their implementations.

TOPICS: EPEC 2022 welcomes submission of papers related to the conference theme, including, but not limited to, the following topics:

- AC/DC Power Quality
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- Wireless Power Transmissions

PAPER SUBMISSION: The format of the paper should follow the IEEE conference paper style. EPEC 2022 will only accept the electronic submission of a full paper in English. Detailed information on the paper format and submission procedure is available at: https://epec2022.ieee.ca/call-for-papers/. EPEC 2022 proceedings will be submitted to IEEE Xplore. The EPEC 2022 authors are invited to submit extended versions of their presented conference papers for publication in the IEEE Canadian Journal of Electrical and Computer Engineering (CJECE) Special Issue, http://journal.ieee.ca.

For any inquiries, please contact Conference Secretary ieee.epec2022@gmail.com

CALL FOR TUTORIAL SPECIAL SESSIONS & WORKSHOPS: All interested researchers or academics who would like to propose and organize a special session or workshop, should send their Special Sessions and Workshop proposal to the Workshop Chair ilampari@uvic.ca.

CALL FOR REVIEWERS: We also encourage you to serve as a member of The Technical Program Review Committee for EPEC 2022 and invite your colleague to join the team by dropping email to the Technical Program Chair shenchao@sce.carleton.ca.

IMPORTANT DATES:

Special Session Proposal due
September 15,2022
Workshop Proposal due
October 15, 2022
Paper Submission due
October 15, 2022
Notification of Acceptance
November 15, 2022



Robert (Rob) Anderson
P.Eng., SMIEEE

2022–2023 IEEE Canada President and Region 7 Director
2022–2023 Président de IEEE Canada et Directeur de la Région 7

Welcome to fall 2022. I do not know about you, but summer went by too fast. I want to extend well wishes to all IEEE Canada members and volunteers. It has been a busy fall for IEEE Canada. Some of the events this year have returned to face-to-face. During the summer, Region 7 (R7) held the annual board meeting. In September, the Executive Committee held a face-to-face meeting to discuss plans and objectives as well as R7's budget for 2023. The Region was able to accomplish a lot operating in hybrid mode to accommodate those who were still not comfortable with travelling and meeting face to face. R7 will continue to monitor the situation with respect to the pandemic over the winter months. The Region, however, expects all events to be back to face-to-face in 2023.

IEEE Canada has been working hard to recover members and volunteers who did not renew their memberships during the pandemic. I am pleased to report that membership is trending in the

(Continued on p. 2)

Bienvenue à l'automne 2022. Je ne sais pas ce qu'il en est de vous, mais l'été est passé trop rapidement. Je souhaite la meilleure des chances à tous les membres et volontaires d'IEEE Canada. L'automne a été très chargé pour IEEE Canada. Certains des événements qui ont eu lieu cette année se sont déroulés en personne. Durant l'été, la Région 7 (R7) a tenu la réunion annuelle du Conseil d'administration. En septembre, le Comité exécutif s'est réuni en personne pour discuter des plans et des objectifs ainsi que du budget R7 pour 2023. La Région a été en mesure d'accomplir beaucoup de choses en mode hybride pour accommoder ceux qui n'étaient pas encore à l'aise de voyager et de se rencontrer en personne. R7 continuera à surveiller la situation pandémique tout au long de l'hiver. Cependant, la Région s'attend à la reprise de tous les événements en personne en 2023.

IEEE Canada a déployé beaucoup d'efforts pour récupérer les membres et les bénévoles qui n'ont pas renouvelé leur adhésion pendant la pandémie. Je suis heureux de signaler que

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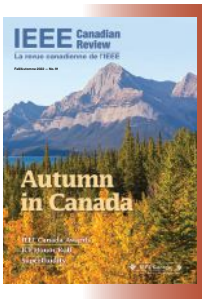
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Autumn in Canada

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(President's Message cont'd from p. 1)

right direction. R7 continues to work on operational efficiencies to ensure our volunteer leaders meet member needs at the local Section levels. This year, the Region developed a strategic plan based on input from the general membership and volunteer leaders. We hope to finalize this plan this fall and roll it out for implementation next year.

The Region and Sections are always looking for eager volunteers. A description of the volunteer positions for the Region can be found at https://www.ieee.ca/en/volunteering/. If you see something that interests you, you can reach out to the Nominations and Appointments Committee (NAC) by contacting past-president@ieee.ca. The NAC will also look for potential candidates to be the R7 director-elect for 2026–2027.

The Multigenerational Congress 2022 was successfully held online on 24–26 September 2022. Students, Young Professionals, Women in Engineering, and Life Members from across Canada participated in the well-attended meeting. One of the main focuses of the congress was mentorship. It also provided opportunities for training, sharing of ideas and issues, and brainstorming. This congress also provided an opportunity for each committee to individually meet.

I am happy to report that the 2022 IEEE Canada Conference on Electrical and Computer Engineering (CCECE 2022) was successfully held face-to-face from 18 to 20 September in Halifax. The organization committee faced the challenges of coming out of the pandemic. The biggest of these was organizing visas for those coming from overseas due to the long lead times required from processing backlogs. CCECE 2022 also hosted the IEEE Canada Awards Gala. Some of the acceptance speeches were prerecorded and played during the gala to accommodate those who were unable to attend in person. The awards brochure from the 2022 gala is included in this magazine. Please congratulate the winners of these very prestigious awards. IEEE Canada gratefully thanks all those who submitted and endorsed this year's nominations and encourages all members to nominate again next year.

This year's date for IEEE Day was 4 October. The event for 2022 was lower key than past events, as the focus was moved back to the Section level. The Region did hold a Senior Member elevation session where the nomination process was outlined in Canada's both official languages. The session was presented by the Students and Young Professionals groups.

IEEE Canada and 19 out of the 21 Sections will be dedicating or already have dedicated an IEEE Milestone for the Trans-Canada Microwave System, which was established in 1958. The dedication ceremonies started the past 1 July and will continue throughout the year. This system made it possible to stream live TV events coast-to-coast and enabled direct-dial long distance, something that we very much take for granted today as our phone and TV come with us on our mobile devices. This milestone will be the largest single dedication of an engineering achievement in IEEE history.

The official nationwide ceremony will be held between Canadian Thanksgiving (10 October) and Remembrance Day (11 November). The corporate sponsors requested this timeframe so that schools will be in session as opposed to the originally planned 1 July date. They want to make a teaching opportunity from a science, technology, engineering, and mathematics and Canadian historical achievement.

(Continued on p. 3)

(Message du Président suite de p. 1)

les adhésions sont sur la bonne voie. R7 continue à travailler sur l'efficacité opérationnelle pour s'assurer que nos dirigeants bénévoles répondent aux besoins des membres à l'échelle locale. Cette année, la région a élaboré un plan stratégique en tenant compte des commentaires des membres et des dirigeants bénévoles. Nous avons hâte de mettre la touche finale à ce plan cet automne et de le mettre en œuvre l'année prochaine.

La région et les sections sont toujours en quête de volontaires enthousiastes. Une description des postes de bénévolat dans la région est disponible à https://www.ieee.ca/fr/volontariat/. Si vous constatez quoi que ce soit d'intéressant, vous pouvez communiquer avec le comité de nomination et désignation (NAC) à past-president@ieee.ca. Le NAC est également à la recherche de candidats pour devenir l'administrateur désigné de la R7 pour 2026–2027.

Le Congrès multigénérationnel 2022 s'est déroulé avec succès en ligne du 24 au 26 septembre 2022. Des étudiants, des jeunes professionnels, des femmes en génie et des membres à vie de tout le Canada ont assisté à la rencontre, qui a attiré beaucoup de monde. Un des principaux objectifs du congrès était le mentorat, mais il offrait aussi des occasions de formation, de partage d'idées et de réflexion.

J'ai le plaisir d'annoncer que l'IEEE Canada 2022 Canadian Conference on Electrical and Computer Engineering (CCECE 2022) s'est déroulée avec succès du 18 au 20 septembre à Halifax. Le comité organisateur a dû composer avec la pandémie. Le plus important était l'organisation des visas pour les gens qui venaient de l'extérieur du Canada à cause des longs délais de traitement. Le CCECE 2022 a également accueillit le gala des prix de l'IEEE Canada. Certains des discours d'acceptation étaient préenregistrés et présentés pendant le gala pour accommoder ceux qui n'étaient pas en mesure d'y assister en personne. La brochure des prix du gala 2022 est incluse dans ce magazine. N'hésitez pas à féliciter les récipiendaires de ces prix très prestigieux. IEEE Canada tient à remercier tous ceux qui ont soumis et endosser les candidatures de cette année et encourage tous les membres à soumettre de nouvelles candidatures dans l'année à venir.

La journée de l'IEEE de cette année a eu lieu le 4 octobre. L'événement de 2022 a été moins important que les événements précédents, car il était axé sur la section. La région a tenu une séance de sélection des membres principaux au cours de laquelle le processus de nomination a été présenté dans les deux langues officielles du Canada. Cette séance a été mise en place par des groupes d'étudiants et de jeunes professionnels.

IEEE Canada et 19 des 21 sections consacreront ou auront consacré un jalon de l'IEEE au système hyperfréquence de Trans-Canada, établi en 1958. Les cérémonies d'inauguration ont commencé le 1 juillet et se poursuivront tout au long de l'année. Ce système a permis de diffuser des événements télévisés en direct d'un bout à l'autre du pays et d'offrir des appels interurbains à composition directe, ce que nous tenons pour acquis aujourd'hui, car notre téléphone et notre télévision nous accompagnent sur nos appareils mobiles. Ce jalon sera le plus important consacré à une réalisation en génie de l'histoire de l'IEEE.

La cérémonie nationale officielle aura lieu entre l'Action de grâce canadienne (10 octobre) et le jour du Souvenir (11 novembre). Les commanditaires corporatifs ont demandé que les écoles participent aux séances, contrairement à la date initialement prévue du 1er juillet. Ils veulent profiter d'une opportunité

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(President's Message cont'd from p. 2)

IEEE Canada encourages all Sections to put forward proposals for an IEEE Milestone to showcase technological growth in Canada.

Lastly, I would like to mention three more major conferences which occurred in Canada this past fall. The first is the 2022 IEEE Canada Electric Power and Energy Conference (EPEC 2022), which was held virtually between 5 and 7 December. This conference provided an opportunity for experts from industry, academia, the government sector, and other interested organizations from Canada and abroad to present and discuss the latest developments in the electric power and energy systems.

The second is the IEEE International Humanitarian Technology Conference, which is a multi-Regional conference series rotating between R7, R8, and R9. This interdisciplinary conference series focused on showcasing challenges, success stories, lessons learnt, case studies, and technological innovation related to achieving the United Nations Sustainable Development Goals, ICT4D and the application of humanitarian technologies (including disaster relief and disaster recovery), and facilitating engagement stakeholders from the public, private, education, research, and societal sectors around the world. The conference placed a particular emphasis on facilitating participation from key stakeholder groups from low- and lower middle-income countries as well as low-resource communities.

(Continued on p. 4)

(Message du Président suite de p. 2)

éducative dans les domaines des sciences, de la technologie, du génie, des mathématiques et de l'histoire du Canada.

IEEE Canada encourage toutes les sections à soumettre des propositions pour un jalon de l'IEEE afin de mettre en évidence la croissance technologique canadienne.

Enfin, j'aimerais mentionner trois autres grandes conférences qui s'est produit au Canada. La première est la Conférence IEEE Canada Electric Power and Energy Conference (EPEC 2022), qui s'est tenue virtuellement du 5 au 7 décembre. Cette conférence donne l'occasion à des experts de l'industrie, du milieu universitaire, du secteur public et d'autres organisations intéressées du Canada et de l'étranger de présenter et de discuter des derniers développements dans les systèmes d'énergie électrique.

La seconde est la Conférence IEEE International Humanitarian Technology Conference, qui est une série de conférences multi-régionales tournant entre R7, R8 et R9. Cette série de conférences interdisciplinaires met l'accent sur les défis, les réussites, les leçons apprises, les études de cas et l'innovation technologique liés à la réalisation des objectifs de développement durable des Nations Unies, l'ICT4D et l'application des technologies humanitaires. (y compris les secours en cas de catastrophe et la reprise après sinistre) et faciliter la mobilisation des intervenants des secteurs public, privé, de l'éducation, de la recherche et de la société dans le monde entier. Nous nous attachons particulièrement

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(President's Message cont'd from p. 3)

The final conference I want to mention is the Wireless Communication in Space and Extreme Environments (WiSEE 2022). This IEEE conference brought together investigators from the National Aeronautics and Space Administration (NASA), the Canadian Space Agency (CSA), the European Space Agency (ESA), and other space agencies, along with the aerospace and space defense industries and academic researchers, to understand and solve the emerging problems facing wireless sensing and communication in space and related extreme environments. This conference was held between 12 and 14 October in Winnipeg, Manitoba. This conference will return to Canada in 2025.

I would like to take this opportunity to wish all the best to our readers and their families. Finally, please feel free to contact me at president@ieee.ca. ■

Robert (Rob) Anderson, P.Eng., SMIEEE
2022–2023 IEEE Canada President
2022–2023 Region 7 Director

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à faciliter la participation des principaux groupes de parties prenantes dans les pays à revenu faible et intermédiaire, ainsi que dans les collectivités à faibles ressources.

La dernière conférence que je souhaite mentionner se tiendra lors de l'impression de cette édition de la Revue canadienne de l'IEEE. Cette conférence est intitulée Wireless Communication in Space and Extreme Environments (WiSEE 2022). Cette conférence de l'IEEE réunira des chercheurs de la National Aeronautics and Space Administration (NASA), de l'Agence spatiale canadienne (ASC), de l'Agence spatiale européenne (ASE) et d'autres agences spatiales, avec les industries de l'aérospatiale et de la défense spatiale et les chercheurs universitaires, pour comprendre et résoudre les problèmes émergents auxquels font face la détection et la communication sans fil dans l'espace et les environnements extrêmes connexes. L'activité se déroulera du 12 au 14 octobre à Winnipeg, au Manitoba. Elle sera à nouveau au Canada en 2025.

Je saisis cette occasion pour souhaiter la meilleure des chances à nos lecteurs et à leurs familles. Enfin, n'hésitez pas à communiquer avec moi à president@ieee.ca. ■

Robert (Rob) Anderson, ing., SMIEEE
Président de l'IEEE Canada 2022–2023
Directeur de la région 7 2022–2023

IEEE Canadian Review
La revue canadienne de l'IEEE

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Jahangir Khan, Ph.D., P.Eng., SMIEEE
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Dear IEEE Canada members and readers everywhere,

Unlike the previous few years, this summer gave us a respite from the pandemic restrictions. Most of us managed to attend in-person meetings and conferences, travel locally or overseas, and taste the simple enjoyments of life. On the downside, the war in Ukraine, high gasoline prices, inflation, and extreme weather events continue to affect us.

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Chers membres de l'IEEE Canada et lecteurs de partout dans le monde,

Contrairement aux années précédentes, cet été nous a donné un répit face aux restrictions liées à la pandémie. La plupart d'entre nous ont été en mesure d'assister à des réunions et des conférences en personne, de voyager localement ou à l'étranger, et de goûter les plaisirs simples de la vie. En revanche, la guerre en

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(A Few Words From the Editor-in-Chief cont'd from p. 5)

Like previous years, in autumn, we find reasons to celebrate the successes of our esteemed colleagues through the IEEE Canada Award events. This edition of *IEEE Canadian Review* presents the award recipients' names and their bios. Also, the IEEE Canadian Foundation recognizes the charitable contributions of our members and guests. The honor roll and the financial summary are presented in this edition. Daryoush Shiri's series article on superfluidity is continued in the fall edition along with many other regular columns.

Like previous years, in autumn, we find reasons to celebrate the successes of our esteemed colleagues through the IEEE Canada Award events.

Enjoy the fall edition of *IEEE Canadian Review*. Merry Christmas and happy new year to you all. Please share your thoughts and suggestions as you read. I can be reached at mjakhan@ieee.org. ■

(Quelques mots du rédacteur en chef suite de p. 5)

Ukraine, les prix élevés de l'essence, l'inflation et les phénomènes météorologiques extrêmes continuent de nous affecter.

Comme les années précédentes, à l'automne, nous trouvons des raisons de célébrer les succès de nos estimés collègues grâce aux événements de remise des prix de l'IEEE Canada. Cette édition de l'IEEE Canadian Review présente les noms des lauréats et leurs biographies. De plus, la Fondation canadienne de l'IEEE reconnaît les contributions caritatives de nos membres et invités. Le tableau d'honneur et le compte rendu financier figurent dans ce numéro. La série d'articles de Daryoush Shiri sur la superfluidité se poursuit en automne avec beaucoup d'autres chroniques régulières.

Comme les années précédentes, à l'automne, nous trouvons des raisons de célébrer les succès de nos estimés collègues grâce aux événements de remise des prix de l'IEEE Canada.

Profitez du numéro d'automne de la revue canadienne de l'IEEE. Joyeux Noël et bonne année à chacun d'entre vous. N'hésitez pas à partager avec nous vos pensées et suggestions issues de cette lecture. On peut me joindre à mjakhan@ieee.org. ■

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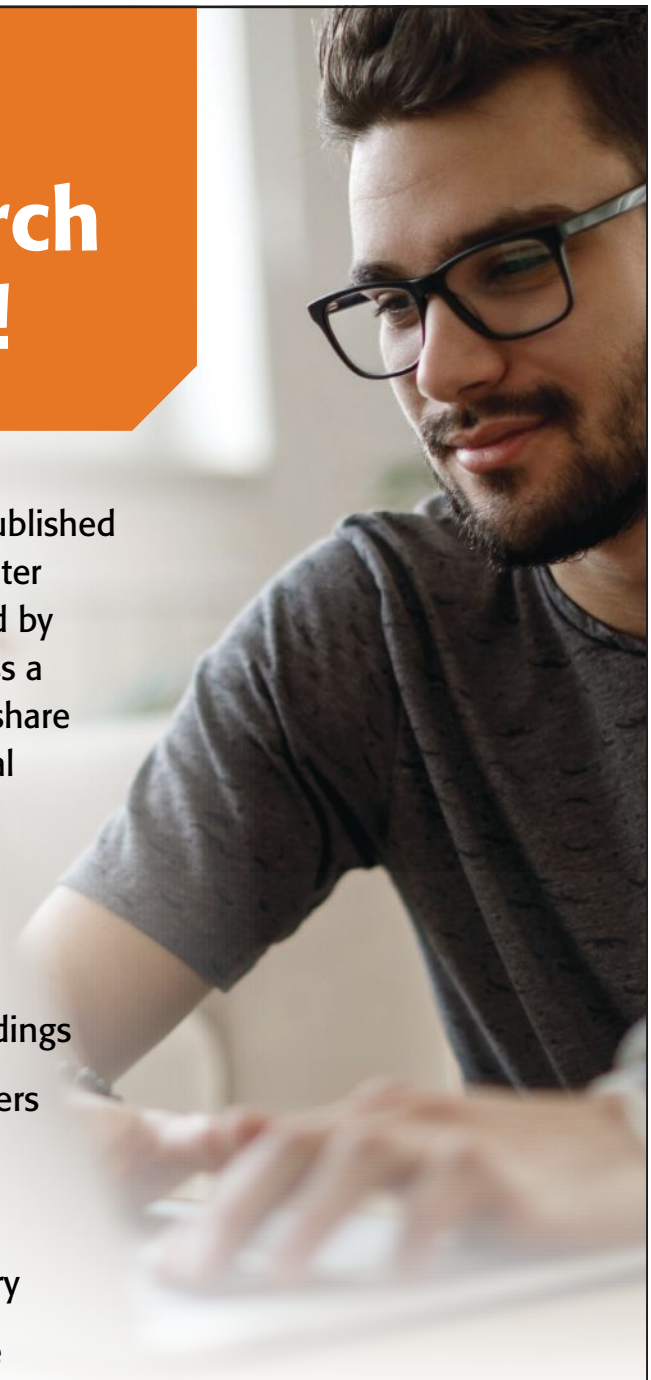
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Superfluidity for Engineers, Part 2: Dilution Refrigerators



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The developments of new cooling techniques pushed the boundaries of low-temperature physics forward and led to discoveries and new theories. These, in turn, resulted in new ideas for reaching lower temperatures. In the second part of this article, we see how the superfluidity of ^{4}He and investigating its properties led to the invention of "dilution" refrigerators (DRs) with which stuff can be cooled down to about 10 mK (10 millidegrees above absolute zero!), much colder than outer space, which is at 2.7 K.

DRs are the most used refrigerators in science and technology these days. They can work continuously, in contrast to one-shot refrigerators, meaning that they can lower the temperature to 10 mK and keep it there for many weeks. They have high cooling power; i.e., they cool down the samples to 10 mK very fast.

Cooling Down to $T = 0.3$ K

In [1], we saw how scientists combined the Joule–Thomson effect and cascade liquefaction to liquefy gases of lighter atoms, e.g., hydrogen and helium. H. K. Onnes succeeded in liquefying ^{4}He at 4 K in his laboratory at Leiden University in 1908. In his lab, his disciples pumped out the vapor from the surface of the boiling liquid helium and cooled down the liquid to as low as

1 K. This evaporative cooling became the basis of ^{4}He cryostats working at 1 K. Removing high-energy atoms from the surface of the liquid and not letting them go back to the liquid lowers the average kinetic energy of the liquid and, hence, its temperature. However, as the temperature drops, the density of hot atoms, which escape from the liquid surface, is also reduced (i.e., vapor pressure is reduced). Then, pumping out the vapor does not help in lowering the temperature further. This saturation occurs at 0.1 mbar for ^{4}He [see Figure 1(a)].

Additionally, it was observed that below 2.17 K (recall the λ point), the boiling suddenly stops, and the ^{4}He enters another phase, later named *superfluidity*. ^{4}He in this phase has zero viscosity, entropy, and heat capacity.

The evaporative cooling of ^{4}He to 1 K helped scientists to liquefy ^{3}He. ^{3}He is a lighter isotope of ^{4}He (since it has one fewer neutron). Due to this, its atoms are more agile than ^{4}He, and it becomes liquid at a lower temperature, which is about 3.19 K. By precooling ^{3}He gas using a sudden expansion in the Joule–Thomson apparatus and passing it through a 1-K pot of liquid ^{4}He, ^{3}He is liquified.

How cold can liquid ^{3}He be? According to Figure 1(a), the evaporative cooling of a liquid ^{3}He pot can cool down the liquid to about 0.3 K, as this is where its vapor pressure saturates.

Before the invention of DRs, it was possible to reach 0.3 K using a cascade of 1-K ^{4}He and 0.3-K ^{3}He pots and continuous pumping of their vapors from the pots [see Figure 1(b)]. The liquid helium at 4 K is poured in from above, and its flow is divided into two pipes by a needle valve. The straight pipe fills the 1-K pot, and the outer pipe fills the outermost wall of the container for thermal isolation. In the 1-K pot, the ^{4}He vapor is pumped out to lower the temperature to 1 K. The cool ^{3}He gas is pumped from above, is passed through the 1-K ^{4}He pot and condensed into a liquid, and then drops into the ^{3}He pot located in the lower section of the fridge. Another pipe pumps out the ^{3}He vapor from this pot, lowering the temperature to 0.3 K. The samples to be cooled are attached to the 0.3-K ^{3}He pot and anchored by copper braids [called *anchors* in Figure 1(b)].

Copper does not become superconductor; therefore, its normal electrons are available to carry the heat (kinetic energy). Hence, it works as a good heat conductor at such low temperatures. On the other hand, superconductors at these temperatures, e.g., aluminum, have no normal electrons available to carry the heat and are not good thermal anchors. Each section of the fridge is isolated from other sections by its dedicated aluminum can, which is screwed to the rim of the flange under each pot. Before starting the liquefaction and vapor pumping, vacuum pumps empty these cans [Figure 1(b)].

The cooling power ($\dot{Q}$) is defined as the amount of heat extracted from an object per second. For ^{3}He, it is an exponential function of temperature (T)—i.e., $\dot{Q} \propto e^{-1/T}$—and it drops very fast as $T \to 0$. Hence, cooling down a big sample needs lots of ^{3}He and strong high-flow pumps. This renders 0.3-K fridges very power consuming [3], [4].

Reaching T = 10 mK

The lowest temperature achievable by evaporative cooling is limited by the saturation of vapor pressure according to the diagrams in Figure 1(a). The way to escape from this limitation was proposed by Heinz London and colleagues [5]. The famous London brothers, Heinz and Fritz, were German physicists who migrated from Nazi Germany to England. Their famous equations, also known as *London equations*, were the first phenomenological theory that could explain the macroscopic electromagnetic properties of superconductors in combination with Maxwell's equations. The elder brother, Fritz, surmised

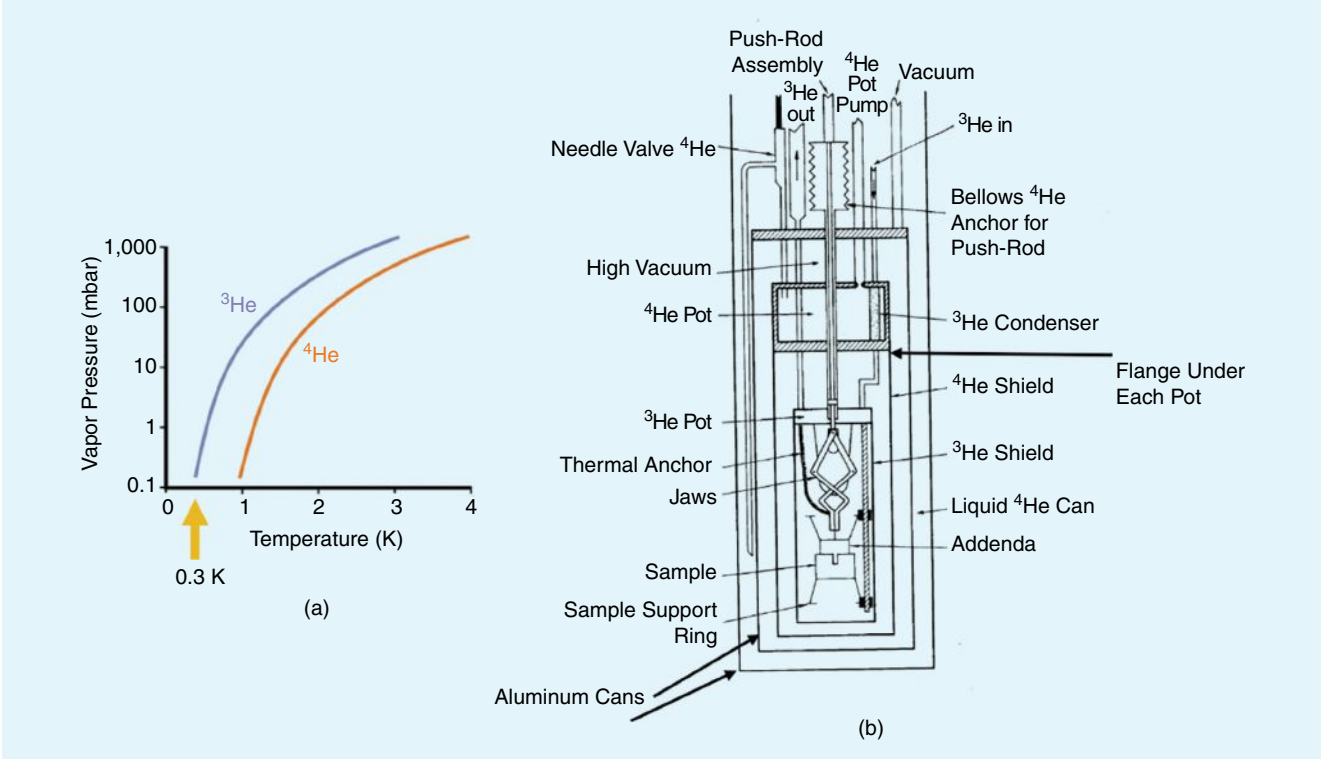


Figure 1: (a) The vapor pressure versus temperature diagram for both isotopes of helium. The minimum achievable temperature by pumping out the vapor is found on the horizontal axis. (Source: [7]; Permission granted by Oxford Instruments.) (b) Using (a) to build a 0.3-K refrigerator. The one shown here is used to measure the specific heat of materials at low temperatures [2]. (Source: Reproduced from Collocott, S. J. (1983) with permission from CSIRO Publishing.)

that superfluidity in ^{4}He must have something of the same origin as superconductivity. In 1962, the younger brother, Heinz, along with R. G. Clarke and E. Mendoza proposed a new refrigerator. They came up with this idea in lieu of experimenting with the mixture of superfluid ^{4}He with normal-fluid ^{3}He and measuring the osmotic pressure build-up between two interconnected containers of dilute and dense ^{3}He/^{4}He mixtures.

To see how "dilution" cooling works, let's look at the phase diagram of the ^{3}He/^{4}He mixture in Figure 2(a), which shows the phases of the mixture as a function of temperature and concentration of ^{3}He doping in ^{4}He solvent or host. The mixture of ^{3}He/^{4}He is a quantum liquid, and understanding it with rigor is beyond the scope of this article. Here, we mainly try to understand the fridge operation using hand-waving arguments. At very low or zero ^{3}He content, moving downward along the temperature axis reminds us of the λ-shaped phase diagram of ^{4}He (see [1]). Below $T = 2.17$ K, ^{4}He becomes superfluid (yellow region). Following the dashed line shows that adding ^{3}He to ^{4}He reduces the temperature at which ^{4}He becomes a superfluid. At high temperatures or high ^{3}He concentrations, the liquid exits superfluidity and stays normal (green region). At very low temperatures and high concentrations of ^{3}He, the mixture splits into two parts and follows the phase along the right border [Figure 2(a)]. Entering the pink region is forbidden, and the mixture only follows the left or right borders on which phase separation occurs.

The phase separation reminds us of the separation of olive oil and vinegar in a salad dressing that is not whisked enough. Here, the role of olive oil is played by the light ^{3}He atoms, and the superfluid heavy ^{4}He atoms are like vinegar. In contrast to your salad dressing, in which you can separate olive oil from vinegar by leaving it unshaken, even at the lowest temperature (0 K), still, 6.6% of the mixture is ^{3}He [see the horizontal axis in Figure 2(a)]. It is as if no matter how long you wait, 6.6% olive oil always remains in the vinegar at the bottom of the container. This dilute and heavy 6.6% ^{3}He/^{4}He mixture is the working principle of the DR [4].

How does the superfluidity of ^{4}He help? The superfluid ^{4}He works as an ideal crystal lattice for ^{3}He atoms; i.e., ^{3}He atoms can sit in the host, and they will not feel any viscosity or impedance by the host (^{4}He) atoms. The light ^{3}He atoms do not see the host and feel as free as being in a gas state. Also, the very low heat capacity of ^{4}He due to its superfluidity does not allow any temperature difference to be built up in the mixture, as it immediately conducts the heat and equalizes the temperature (recall the cessation of boiling in ^{4}He below the λ point [1]).

Now, let's assume we have already prepared liquid ^{3}He and cooled it down to 0.3 K by pumping out its vapor from 0.3-K pot. Then, we inject this cooled liquid ^{3}He into a small chamber of liquid ^{4}He, as shown in Figure 2(b). The ^{3}He atoms happily sit in the lattice of the host liquid. Their quantum mechanical nature, which has given them the name *fermions*, mandates that sitting in ^{4}He be their favorite (minimum-energy or ground) state. Now, if this mixture is brought into contact with the "dilute" mixture, which has only 6.6% ^{3}He, it floats on top of that because more ^{3}He means lighter atoms (recall the olive oil). Sitting at the bottom of the chamber is the heavier liquid, i.e., the one with less (6.6%) ^{3}He content. As a result of this ^{3}He density difference, an osmotic pressure difference is built up between ^{3}He-rich (top) and ^{3}He-poor (bottom) phases [see Figure 2(b)]. The osmotic pressure difference mandates the ^{3}He atoms to move from the top (the rich mixture) to the bottom (the dilute mixture). This is the same mechanism that draws salt out of a pickled salty cucumber if it is left in unsalted water.

However, quantum mechanics tells the ^{3}He atoms in the dense ^{3}He/^{4}He mixture to be happy because this is their favorite low-energy state. As a result, to follow the osmotic pressure difference and to leave the "super"-good ^{4}He host, against their will ^{3}He atoms need energy.

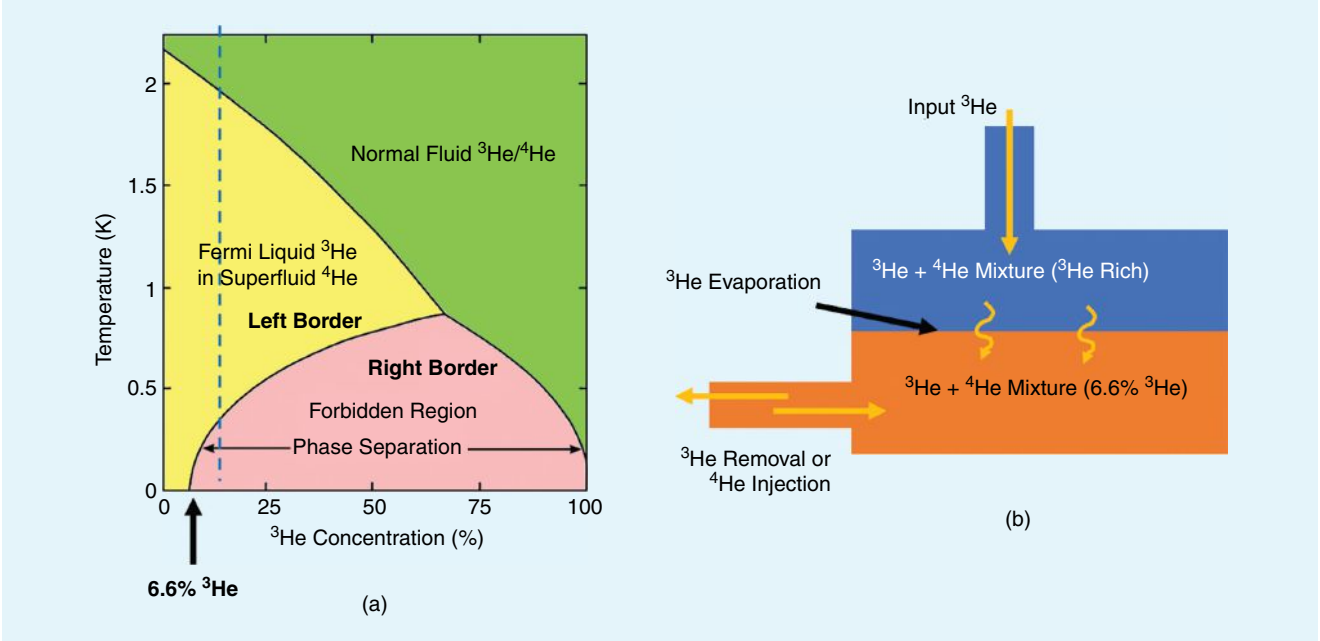


Figure 2: The phase diagram of ^{3}He/^{4}He mixture shows that even the most dilute mixture has 6.6% ^{3}He. (b) A mixing chamber (MC) where the dense mixture is poured from above (the light part) and the dilute (heavy part) sits at the bottom. Removing ^{3}He atoms from the bottom causes the ^{3}He atoms in the top part to enter the dilute phase by absorbing heat from the MC; i.e., they evaporate from the top to the bottom! Alternatively, ^{4}He can be injected to dilute the bottom mixture. (This is not done in modern DRs.)

How do they obtain this energy (called *latent heat*)? They take the heat from the chamber of the mixture and cool down the surrounding environment. It is necessary to close the loop to stabilize the obtained low temperature and put it to good use. This means you must continuously inject cooled 0.3-K ^{3}He into the chamber [which, from now on, we call the *mixing chamber* (*MC*)] from above and somehow remove (pump out) ^{3}He from the "dilute" bottom of the MC using another part called the *still*. Alternatively, we can inject ^{4}He into the MC from the bottom to make the bottom-sitting mixture dilute [see Figure 2(b)].

Before revealing the whole fridge, let's look at the original experiment of measuring osmotic pressure by H. London et al. in Figure 3(a). Here, two containers are connected by a silver orifice filled with silver powder (recall the imaginary experiments with interconnected coffee cups in [1]). The superfluid part of the mixture (^{4}He) passes through the leak without friction and fills the left container at a slightly higher temperature. However, the ^{3}He (normal-fluid) atoms face high friction, and most of them stay in the right container. This density difference builds up osmotic pressure, which is cancelled by the pressure due to the liquid ^{4}He height difference (ρgh) and a slight difference between vapor pressures. Then, they proposed that this could be used as a refrigerator if they closed the cycle, i.e., injecting ^{3}He into the mixture (C) by distilling (boiling off) ^{3}He in (S) and sending ^{3}He back (condensed and cooled) via the 1-K pot (D) to (C) again [see Figure 3(b)]. H. London calculated that the temperature can be down to 100 mK as ^{3}He atoms need energy to leave the dense phase to the dilute phase.

Now, let's see the whole cycle in a modern diagram of the dilution fridge (Figure 4) and start from the bottom (MC) again. As we said before, the ^{3}He atoms in the superfluid ^{4}He host (the top layer of the mixture in the MC) are at their low-energy state. However, if we somehow remove the ^{3}He atoms from the bottom layer and make it dilute (6.6%), the top ^{3}He atoms are forced to leave the host due to this density difference. As a result, they tax the host by removing heat from it and its surroundings. MCs are made of copper, and their internal wall is covered by silver or copper powder to create a large surface. This reduces the MC's thermal resistance (called *Kapitza resistance*). The thermal or Kapitza resistance between helium and solids is given as [3]

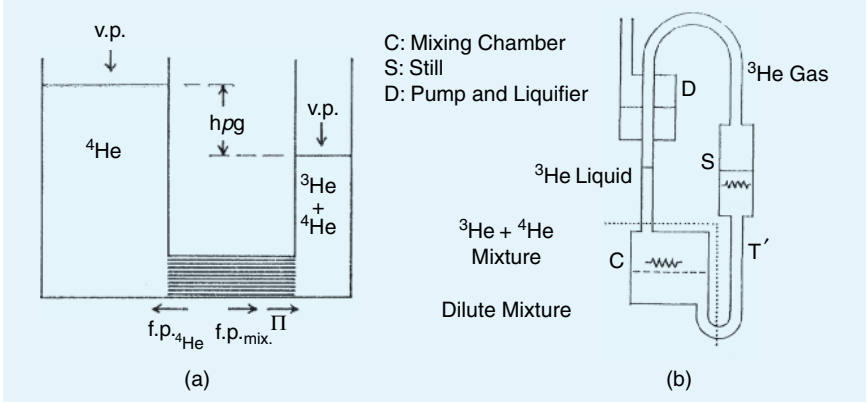


Figure 3: A simplified diagram of a DR was proposed by Heinz London et al. [5]. (a) Their experimental setup is to measure the osmotic pressure difference between dilute and dense mixtures. (b) A proposal to close the cycle and make a refrigerator. C corresponds to a modern MC. S is the still used to distill the dilute the mixture and evaporate ^{3}He. D corresponds to the modern combination of pots, condensers, and heat exchangers. v.p.: vapor pressure. (See Figure 4 for the complete cycle.) (Source: Figure reprinted with permission from H. London, G. R. Clarke, and E. Mendoza, *Physical Review*, vol. 128, no. 5, 1992–2005, 1962, by the American Physical Society.)

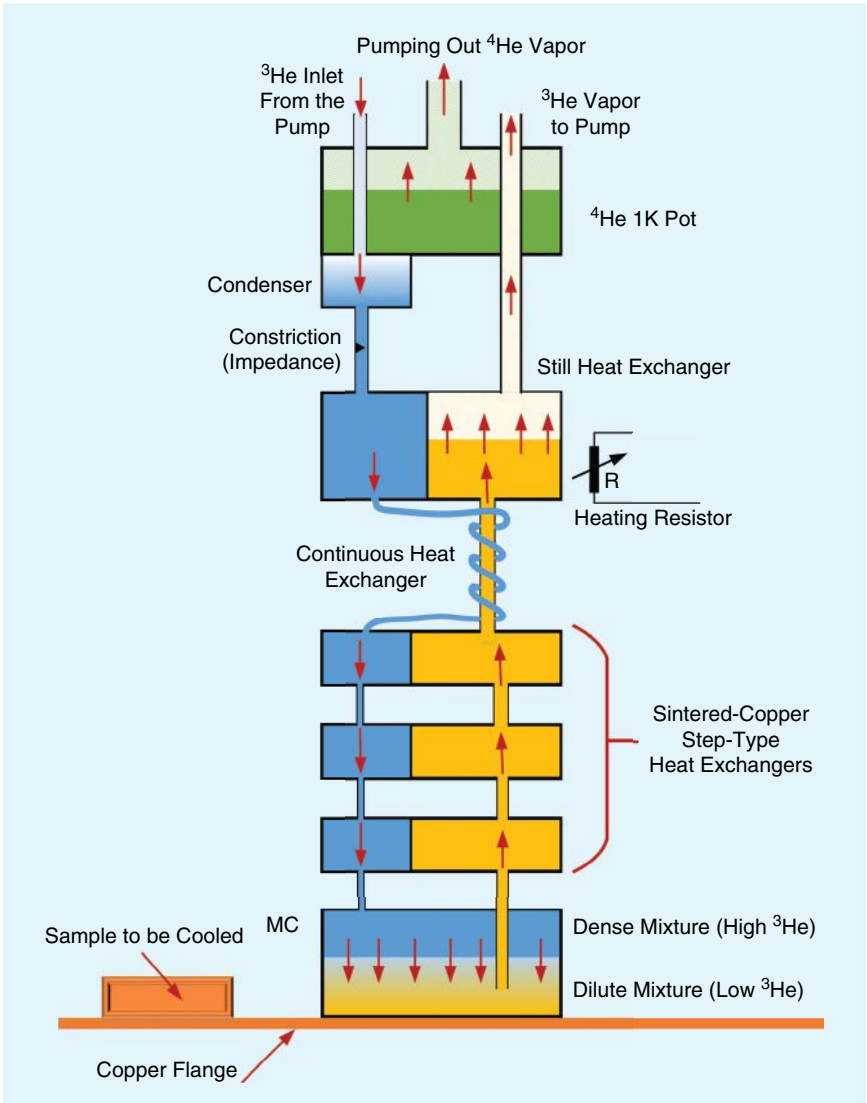


Figure 4: A simplified diagram of the DR showing the MC, still heater, heat exchangers (three step type and one continuous), impedance and condenser, and 1-K ^{4}He pot. The pumps, precooling stages with liquid nitrogen, and cans are not shown. Extracted from [6]. Compare this with Figure 5.

$$R_K = \frac{a}{A} T^{-3}.$$

R_K is expressed in terms of kelvins/watt. A is the area, and T is the absolute temperature. The experimental constant a depends on the helium type. For ^{3}He, $a = 0.05$ m^{2}K^4/W and for a ^{3}He/^{4}He mixture, $a = 0.02$ m^{2}K^4/W. R_K can be lowered by increasing the contact surface area (A), e.g., using sponge copper or a powder of silver or copper.

The next significant part of the DR is the still. This is where the distillation of the dilute mixture occurs, and ^{3}He evaporates by heating it to 0.7 K. A resistor-based heater heats the still—but only hot enough to let the ^{3}He vaporize (not the ^{4}He)—and leaves the mixture as a gas. The gradient of ^{3}He density (i.e., 6.6% at the lower part of MC and 0% at the still) keeps the ^{3}He flow constant. The still can absorb heat from its surroundings, and it is often anchored to the nearby flange. The heater resistor can be programmed to change the temperature between 0.6 and 0.8 K and adjust the evaporation rate of ^{3}He. This, in turn, controls the speed or cooling power of the fridge.

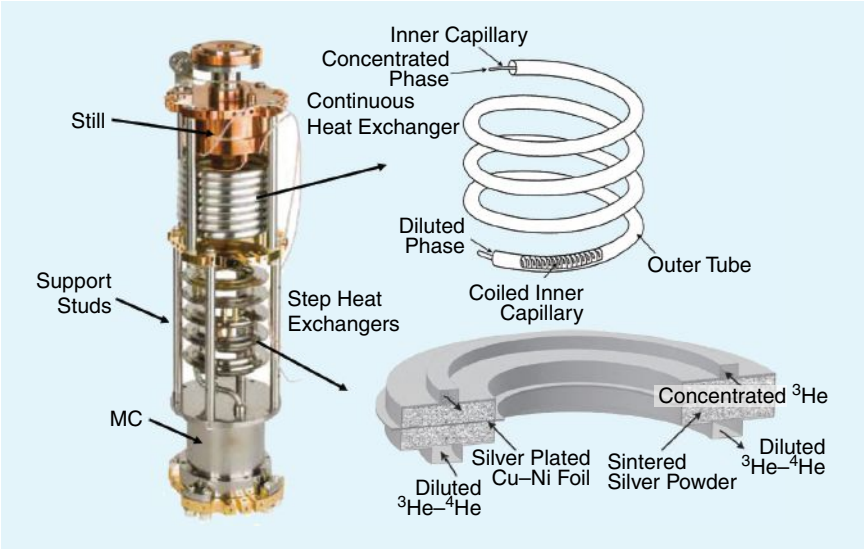


Figure 5: The main three stages of a DR stacked on top of each other. From the bottom to the top, you see the MC, step heat exchangers, continuous heat exchangers, and still and ^{3}He vapor output pipe. The hanging wires are to bias the heating resistance still. (Source: [7]; Permission granted by Oxford Instruments.) The diagrams on the right show the inner parts of heat exchangers. (Source: [3]; used with permission.)

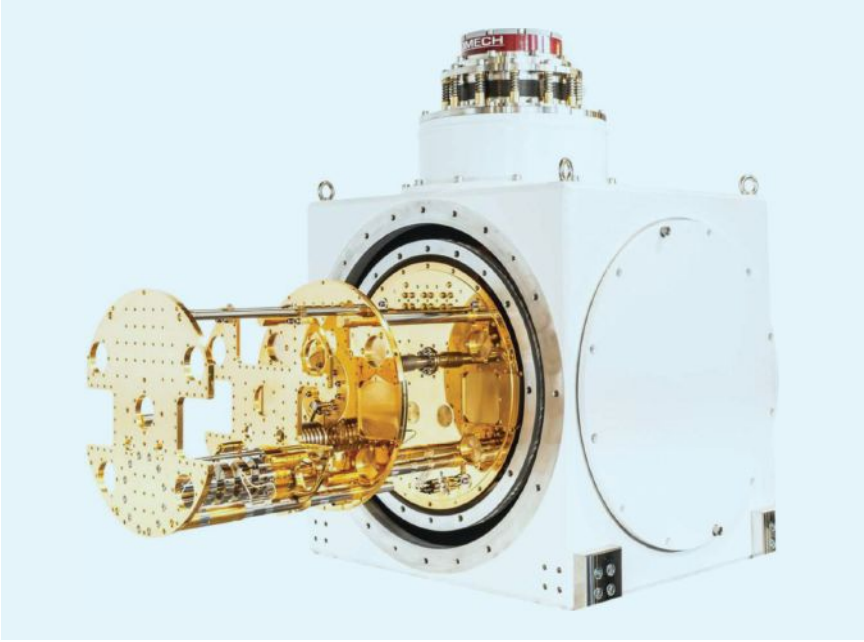


Figure 6: A horizontal DR made for astrophysical experiments. From the left-most flange, you see five-step heat exchangers (similar to cans in Figure 4), a continuous spiral heat exchanger to the still is at the right. Five aluminum cans close the fridge and isolate each stage by fastening them to the rims with screw holes. The precooling parts, e.g., 77-K liquid nitrogen, vacuum pumps, etc., are not shown (Source: [12]; Permission granted by Bluefors Oy).

The supply of ^{3}He to the MC is performed by cooling ^{3}He gas and liquefying it in a ^{4}He 1-K pot (the topmost container in Figure 4). Passing it through a constricted pipe (called *impedance*) after the condenser reduces the pressure before it enters the MC. Before reaching the MC, ^{3}He is again brought in contact with the still to be cooled more by giving off heat to the still.

The cooling power of this method is higher than that of 0.3-K refrigerators. The cooling power of the ^{3}He/^{4}He mixture is proportional to the temperature squared; i.e.,

$$\dot{Q} \propto T^2.$$

As a result, the cooling power decreases more slowly than pure ^{3}He (which was exponential) as $T \to 0$. For example, a 60-m^3/h vapor pump in a 0.3-K fridge with a 1,000-μmol/s flow of ^{3}He gives a cooling power of 0.25 mW. To obtain the same cooling power, a DR only needs a 20-m^3/h vapor pump and much less flow of 35 μmol/s of ^{3}He mixture [3].

Later, it was discovered that, to increase the fridge's efficiency and reach 20 mK and lower, the counterflowing ^{3}He pipes can be brought into contact to exchange heat. The dilute mixture moving up towards the still is colder than the ^{3}He input, which is coming down to the MC. If the upgoing mixture pipe is brought into contact with the downpouring ^{3}He pipe, the input ^{3}He to the MC gets cooler, and the upgoing mixture becomes hotter when it gets to the still, and this reduces the current required to heat the resistor.

Calculations show that, when the new ^{3}He mixture arrives at the MC, it should not be hotter than $3T_{MC}$ (where T_{MC} is the temperature at the MC); otherwise, the fridge cycle stops working. Therefore, heat exchangers and precision in their design and efficiency are necessary to guarantee that the ^{3}He mixture temperature after passing through them is always $T_{ex} < 3T_{MC}$.

This heat-exchanging process is done by passing the upgoing pipes through the downcoming pipes or by snaking the

counterflowing pipes around each other. These are called *continuous heat exchangers*. Figure 4 shows how two counterflows have meandered into each other below the still stage. To increase the cooling power and reach 10 mK, three or more *step heat exchangers* are also added after the MC. In Figure 4, there are three containers after the MC in which down- and upgoing ^{3}He liquid channels exchange heat. In each of these containers, the liquids pass through powders or sponges of copper or silver. A large surface area eases lateral exchange of heat. The downcoming ^{3}He becomes colder, and it warms up the upgoing ^{3}He. This will reduce the load on the still, increases the ^{3}He density gradient, and results in a better cooling power. There exist different designs of heat exchangers, but the most common ones are shown in Figure 5.

In Figure 5 (left), there are five-step heat exchangers after the MC. In each of them, the counterflowing ^{3}He (dense and dilute) exchange heat through the circular containers filled with silver powder [Figure 5 (right)]. After this, the diluted phase goes up through the big spiral pipe made of Cu–Ni alloy. Inside this pipe, a spiral capillary carries the downcoming dense ^{3}He liquid mixture. The thermal conductivity of these pipes must be bad enough to avoid vertical heat exchange between the MC and still through the exterior of the pipes. On the one hand, they should be good enough to let both counterflows exchange heat laterally (side by side) inside the big spiral pipe. Reduced thermal conductivity of copper by Cu–Ni alloying seems to be a good solution for this purpose.

The only issue that superfluidity of ^{4}He brings is its capability of leaking through the tiniest leaks due to its zero viscosity. This mandates precise machining of pots, valves, seals, washers, pipes, etc. to free them from any leaks.

After London's proposal was published, Leiden University built a DR in 1964. James Hall and colleagues built a DR at the University of Manchester in 1965 [8]. The first commercial DR was built in 1966 at Oxford Instruments factory in collaboration with Heinz London himself [7]. Neganov et al. built the first DR in the Soviet Union [9]. Modified versions of DRs were developed by Uhlig in Germany [10] and Wheatly and his colleagues at the University of Illinois, Urbana-Champaign [11].

James (Jim) Maurice Daniels, a Canadian professor at the University of Toronto, built the first DR in Canada following the design proposed by Wheatly. Daniels was also the coinventor of cryogenic temperature sensors based on magnetic salts called *cerous magnesium nitrate*. The magnetic susceptibility–entropy relationship of these salts is used to measure the temperature. They became instrumental in building millikelvin refrigerators and discovering superfluidity in ^{3}He.

DRs come in many forms and sizes—horizontal and even rotating! They also benefit from high-tech improvements, e.g., advanced temperature sensors, proportional-integral-derivative controllers, computerized operations, noise, and vibration cancellation methods, etc. (Figure 6).

Cooling down the giant mirrors and aluminum rods in gravitational wave detectors and cooling superconducting quantum computing chips, astronomical detectors, and telescopes are among the applications of DRs. There are many Nobel-awarded experiments in physics in which DRs played an important role. Rotating DRs, e.g., the one made by Olli Lounasmaa et al. in VTT, Finland, helped them to observe the quantization of vortices in rotating superfluid helium [13].

In the next episode(s), we will see how DRs became the launching pads to build other types of refrigerators and enter the microkelvin realm. This helped scientists to discover the superfluidity in ^{3}He, which occurs at 2.6 mK. Why is ^{3}He so interesting? Because understanding its properties opens new windows to the unknown worlds. The mechanism of coupling between ^{3}He atoms and condensation to a superfluid is the same one that says why some materials become superconductors and some stars, neutron stars. "The universe is in a helium droplet," as the theorist Grigori Volovik suggested by so naming his book [14]. ■

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Daryoush Shiri received his Ph.D. degree in electrical and computer engineering in 2013 from the University of Waterloo, Canada. Prior to this, he worked at a few start-up companies as a radio-frequency/analog CMOS design engineer and team leader. His thesis was devoted to the computational study of electron transport in silicon nanowires. As a postdoctoral fellow at the Institute for Quantum Computing, Waterloo (2013–2015), he collaborated in developing a scalable package for quantum-computing circuits. He moved to Sweden in 2016 as a postdoctoral fellow at the Department of Physics, Chalmers University of Technology, to work on heat transport in 2-D materials. Currently, he is a researcher at the Quantum Technology Laboratory in the same university, working on the simulation of superconducting microwave circuits for quantum computing. He cosupervised several Ph.D. and master's degree students during these years. He loves teaching and always quotes John Archibald Wheeler: "If you would learn, teach."


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M.B. BROUGHTON CENTRAL CANADA MERIT AWARD
for meritorious service in central Canada at the local IEEE Section and area level

J.J. ARCHAMBAULT EASTERN CANADA MERIT AWARD
for meritorious service in eastern Canada at the local IEEE Section and area level

Programme des Prix

Prix de l'IEEE Canada

PRIX DE IEEE CANADA

PRIX A.G.L. MCNAUGHTON
pour contributions exemplaires à la profession d'ingénieur

PRIX R.A. FESSENDEN
pour contributions importantes dans le domaine du génie des télécommunications

PRIX P.D ZIOGAS D'ÉNERGIE ÉLECTRIQUE
pour contributions importantes dans le domaine du génie de l'énergie électrique

PRIX C.C. GOTLIEB D'INFORMATIQUE
pour contributions importantes en informatique

PRIX J.M. HAM D'ÉDUCATEUR EXCEPTIONNEL EN GÉNIE
pour contributions exceptionnelles à l'éducation en génie

PRIX D'INGÉNIEUR EXCEPTIONNEL
pour contributions exceptionnelles au génie électrique et électronique

PRIX R.H. TANNER DU LEADERSHIP DANS L'INDUSTRIE
pour contributions importantes au niveau du leadership dans l'industrie canadienne où il y a une activité significative dans des domaines d'intérêt de l'IEEE

PRIX W.S. READ POUR SERVICE EXCEPTIONNEL
pour service exceptionnel et soutenu à l'IEEE Canada et à l'Institut

PRIX DE MÉRITE E.F. GLASS DE L'OUEST DU CANADA
pour service méritoire dans l'ouest du Canada au niveau des sections et zones locales de l'IEEE

PRIX DE MÉRITE M.B. BROUGHTON DU CENTRE DU CANADA
pour service méritoire au centre du Canada au niveau des sections et zones locales de l'IEEE

PRIX DE MÉRITE J.J. ARCHAMBAULT DE L'EST DU CANADA
pour service méritoire dans l'est du Canada au niveau des sections et zones locales de l'IEEE

2022 IEEE CANADA A.G.L. MCNAUGHTON AWARD
PRIX A.G.L. MCNAUGHTON DE L'IEEE CANADA 2022

For pioneering contributions to free space and optical fiber transmission systems spanning multiple length scales and their enabling silicon photonic technologies.
Pour contributions pionnières aux systèmes de transmission optique et en espace libre s'étendant sur de multiples échelles de longueur, et les technologies de photonique sur silicium ainsi habilitées.

David Plant, Montréal, QC

David V. Plant (Fellow, IEEE): Ph.D., Brown University (1989); Research Engineering—UCLA (1989–1993); professor (1993–present) and chair (2006–2011), Department of Electrical and Computer Engineering, McGill University. James McGill Professor (2001–2019). Tier 1 Canada Research Chair (2019–present).

Currently, Dr. Plant researches optical fiber transmission systems spanning multiple length scales and their enabling optoelectronic technologies. These activities include researching digital signal processing algorithms to increase capacity and reach as well as new transceiver architectures for coherent and direct detection-based systems.

Dr. Plant has received the following awards and recognitions: IEEE Photonics Society Engineering Achievement Award (2017); Fellow, Royal Society of Canada (2016); IEEE Montreal Chapter Gold Medal Achievement Award (2016); Refined Manufacturing Acceleration Process Business-Led National Center of Excellence Commercialization



Award (2015 and 2016); Killam Research Fellowship (2013–2015); IEEE Photonics Society Distinguished Service Award (2015); Christophe Pierre Award for Research Excellence (2014); IEEE Microwave Theory and Techniques Society Microwave Award (2009); Fellow, Canadian Academy of Engineering (2009); Fellow, Engineering Institute of Canada (2009); Outstanding Engineering Educator Award from IEEE Canada (2007); NSERC Synergy Award for Innovation (2006); Fellow of the Optica (2006); R.A. Fessenden Medal from IEEE Canada (2006); and IEEE Photonics Society Distinguished Lecturer (2005–2007). ■

David V. Plant (Fellow, IEEE): Ph.D., Université Brown (1989); Ingénieur de Recherche—UCLA (1989–1993); Professeur (1993–présent) et Directeur (2006–2011), Département de génie électrique et informatique, Université McGill. Professeur James McGill (2001–2019). Chaire de recherche du Canada de niveau 1 (2019–prés.).

Actuellement, Dr. Plant étudie les systèmes de transmission par fibre optique couvrant plusieurs échelles de longueur et leurs technologies optoélectroniques sous-jacentes. Ces activités comprennent la recherche d'algorithmes de traitement numérique du signal pour augmenter la capacité et la portée ainsi que de nouvelles architectures d'émetteur-récepteur pour les systèmes basés sur la détection cohérente et directe.

Dr. Plant a reçu les récompenses et distinctions suivantes: Prix d'excellence en ingénierie de la société de photonique de l'IEEE (2017); membre, Société royale du Canada (2016); Médaille d'or de la section IEEE Montréal (2016); Prix de commercialisation des Centres d'excellence en commercialisation et en recherche (2015, 2016); Bourse de recherche Killam (2013–2015); Prix du service distingué de la société de photonique de l'IEEE (2015); Prix d'excellence en recherche Christophe Pierre (2014); Prix micro-ondes de la société de théorie et techniques des micro-ondes de l'IEEE (2009); Fellow de l'Académie canadienne du génie (2009); Fellow de l'Institut canadien des ingénieurs (2009); Prix du meilleur éducateur en ingénierie de l'IEEE Canada (2007); Prix Synergie pour l'innovation du CRSNG (2006); Fellow de l'Optica (2006); Médaille R. A. Fessenden de l'IEEE Canada (2006); Conférencier émérite de la société de photonique de l'IEEE (2005–2007). ■

2022 IEEE CANADA R.A. FESSENDEN AWARD
PRIX R.A. FESSENDEN DE L'IEEE CANADA 2022

For pioneering contributions to wireless communications, physical layer security, and 5G technologies.
Pour contributions innovantes aux communications sans fil, sécurité de la couche physique et technologies 5G.

Xianbin Wang, London, ON

Dr. Xianbin Wang (Fellow, IEEE) is a professor and Tier 1 Canada Research Chair in 5G and wireless IoT communications at Western University, Canada. He received his Ph.D. degree from the National University of Singapore in 2001. Prior to joining Western in 2008, he was with Communications Research Centre Canada as a research scientist and senior research scientist between 2002 and 2007.

Dr. Wang is highly recognized for his pioneering contributions in the areas of wireless communication and communication security through his over 500 publications, which have dramatically improved the operational outcome of interconnected consumer, industry, and defence systems. In the area of wireless communications, he has led the global evolution of 4G/5G technologies and created many innovative concepts, theories, and designs for dynamic, nonorthogonal, and intelligent use of radio resources in the time, frequency, and space domains. In the area of wireless security, he spearheaded his cutting-edge research by first introducing device-specific, multidimensional, and context-related physical attributes for authentication enhancement. As a visionary innovator, Dr. Wang holds 30 granted and pending patents. His inventions have extensive



technical scope, overcoming the most critical and complex issues in communication systems, and have been adopted in different standards and industry applications.

Dr. Wang is a Fellow of the Canadian Academy of Engineering and a Fellow of the Engineering Institute of Canada. He has received many prestigious awards and recognitions, including Canada Research Chair, Canadian Federal Government Public Service Award, Ontario Early Researcher Award, Research Excellence Award at Western Engineering, and six IEEE Best Paper Awards. He currently serves/has served as an editor-in-chief, associate editor-in-chief, editor, or associate editor for over 10 journals. He was involved in many conferences in different leadership roles including general chair, TPC chair, symposium chair, and keynote speaker. Dr. Wang has also supervised over 200 highly qualified personnel throughout his career. ■

Dr. Xianbin Wang (Fellow, IEEE) est professeur et titulaire de la chair de recherche du Canada de niveau 1 sur la 5G et les communications IdO sans fil à l'Université Western, Canada. Il a reçu son doctorat de l'Université nationale de Singapour en 2001. Avant de se joindre à Western en 2008, il a été chercheur scientifique et chercheur scientifique senior au Centre de recherches sur les communications de 2002 à 2007.

Dr. Wang est hautement reconnu pour ses contributions novatrices dans les domaines de la communication sans fil et la sécurité des communications via plus de 500 publications, qui ont considérablement amélioré les résultats opérationnels dans l'interconnexionn des systèmes pour consommateurs, l'industrie, et la défense. Dans le secteur des communications sans fil, il a présidé à l'évolution des technologies 4G/5G et créé plusieurs concepts innovants, théories et designs pour l'utilisation dynamique nonorthogonale et intelligente des ressources radio dans les domaines temps, fréquence et espace. Dans le secteur de la sécurité sans fil, il a inauguré ses recherches de pointe en introduisant des attributs physiques spécifiques aux appareils, multi-dimensionnels et reliés au contexte dans l'amélioration de l'authentification. En tant qu'innovateur visionnaire, Dr. Wang détient 30 brevets octroyés ou en attente. Ses inventions ont une grande portée technique, répondant aux problèmes les plus critiques et complexes des systèmes de communication, et ont été adoptées dans différents standards et applications industrielles.

Dr. Wang est fellow de l'Académie canadienne du génie et fellow de l'Institut canadien des ingénieurs. Il a reçu plusieurs prix et reconnaissances prestigieuses, incluant une chaire de recherche du Canada, un prix d'excellence de la fonction publique du gouvernement du Canada, une bourse de nouveau chercheur de l'Ontario, un prix d'excellence de Western Engineering et six prix du meilleur article de l'IEEE. Il sert ou a servi en tant que rédacteur en chef, rédacteur en chef adjoint, éditeur/coéditeur pour plus de 10 revues. Il a été impliqué dans de nombreuses conférences dans des roles majeurs tels président de conférence, du comité technique de programme, de symposium, et orateur principal. Dr. Wang a aussi supervisé plus de 200 personnels hautement qualifiés au cours de sa carrière. ■

2022 IEEE CANADA P.D. ZIOGAS ELECTRIC POWER AWARD
PRIX P.D. ZIOGAS D'ÉNERGIE ÉLECTRIQUE DE L'IEEE CANADA 2022

For contributions to the design, analysis, and application of power electronic systems.
Pour contributions à la conception, l'analyse et la mise en oeuvre de systèmes d'électronique de puissance.

Peter Lehn, Toronto, ON

Peter Lehn (Senior Member, IEEE) is a professor in the Department of Electrical and Computer Engineering at the University of Toronto, where he currently serves as associate director of the University of Toronto Electric Vehicle Research Centre (UTEV). He obtained his B.Sc. and M.Sc. degrees in electrical engineering from the University of Manitoba in 1990 and 1992 and his Ph.D. degree from the University of Toronto in 1999.

Prof. Lehn has made notable contributions to the area of power electronics, including the development of new power conversion topologies for medium-/high-voltage dc applications and for electric vehicle applications. His work on dc power electronic technologies and their integration into dc microgrids led to the formation of ARDA Power, which was spun out of his laboratory in 2011. His work on integrated on-vehicle fast chargers for electric vehicles is currently being commercialized by eLeapPower, which recently closed its series A financing. Prof. Lehn has also made advances in the modelling of power converters, through the pursuit of piecewise linear circuit models that can be algebraically solved to ascertain the harmonic distortion that power converters introduce into our power grids. Such models have found their application within the utility sector to diagnose power quality problems.



Prof. Lehn's publications on power electronics have won numerous best paper awards, including one from *IEEE Transactions on Power Electronics*. He holds over a dozen patents related to power electronics and is a recipient of the University of Toronto Inventor of the Year Award. His most prized recognitions, however, are the two teaching awards he received from his class of undergraduate students. Within IEEE, Prof. Lehn has contributed to numerous working groups, served as editor of *IEEE Transactions on Energy Conversion*, and cohosted the IEEE Workshop on Control and Modeling for Power Electronics (COMPEL 2019). ■

Peter Lehn (Senior Member, IEEE) est professeur au département de génie électrique et informatique à l'Université de Toronto, où il sert présentement en tant que directeur adjoint du Centre de recherches sur les véhicules électriques (UTEV). Il a obtenu ses B.Sc. et M.Sc. en génie électrique de l'Université du Manitoba en 1990 et 1992 et son Ph.D. de l'Université de Toronto en 1999.

Prof. Lehn a apporté des contributions notables au secteur de l'électronique de puissance, incluant le développement de nouvelles topologies de conversion de courant pour les applications CC à voltage moyen/élevé et les applications de véhicules électriques. Ses travaux sur les technologies d'électronique de puissance CC et leur intégration aux miniréseaux CC ont mené à la formation d'ARDA Power, dérivée de son laboratoire en 2011. Ses travaux sur l'intégration de chargeurs rapides embarqués pour véhicules électriques sont présentement commercialisés par eLeapPower, qui a récemment complété une levée de fonds de premier tour. Prof. Lehn a aussi accompli des progrès dans la modélisation de convertisseurs de puissance, par le biais de modèles de circuits linéaires par morceaux qui peuvent être résolus algébriquement pour déterminer la distorsion harmonique introduite par les convertisseurs de puissance dans nos réseaux électriques. Ces modèles ont trouvé leur utilité chez les services électriques dans le diagnostic des problèmes de qualité de l'onde.

Les publications de prof. Lehn sur les applications d'électronique de puissance ont remporté plusieurs prix de meilleur article, incluant un *d'IEEE Transactions on Power Electronics*. Il détient une douzaine de brevets reliés à l'électronique de puissance et est récipiendaire du prix d'Inventeur de l'année de l'Université de Toronto. Ses reconnaissances les plus appréciées, cependant, sont les deux prix d'enseignement qu'il a reçus de ses classes d'étudiants de premier cycle. Pour l'IEEE, prof. Lehn a contribué a de nombreux groupes de travail, servi comme éditeur pour *IEEE Transactions on Energy Conversion* et coprésenté l'atelier IEEE sur le contrôle et la modélisation pour l'électronique de puissance (COMPEL 2019). ■

2022 IEEE CANADA C.C. GOTLIEB AWARD
PRIX C.C. GOTLIEB D'INFORMATIQUE DE L'IEEE CANADA 2022

For exceptional contributions to foundational technologies for cyberphysical systems and data analytics.
Pour contributions exceptionnelles aux technologies fondamentales des systèmes cyber-physiques et analyse de données.

Jamal Deen, Hamilton, ON

Dr. M. Jamal Deen (Fellow, IEEE) is a Distinguished University Professor and Senior CRC in Information Technology at McMaster University. He obtained his Ph.D. degree in electrical engineering and applied physics from Case Western Reserve University, Cleveland, USA, for research on the design and modeling of a new CARS spectrometer for dynamic temperature measurements and combustion optimization in rocket and jet engines that was sponsored and used by NASA, Cleveland.

Dr. Deen's current research interests are nanoelectronics, optoelectronics, nanotechnology, data analytics, and their emerging applications in health care and the environment. He has performed pioneering research on smart sensors and data analytics for ubiquitous health care and water-quality monitoring. He is a world-leading researcher in high-performance photodetectors for fiber-optic communications and imaging systems. In wireless communications, he has made fundamental and significant contributions to the understanding of sensitivity/noise in mainstream silicon devices—the dominant technology for cyberphysical systems—by combining unique and innovative experiments with physics-based and engineering modeling.

As an undergraduate student, he won the Chancellor's medal as the second-best graduating student and the Irving Adler prize as the best mathematics student. As a graduate student, he was a Fulbright–Laspau Scholar and an American Vacuum Society Scholar. He was awarded the Callinan Award and the Electronics and Photonics Division Award from the Electrochemical Society; a Humboldt Research Award; the Eadie Medal from the Royal Society of Canada (RSC); and the McNaughton Gold Medal, the Fessenden Medal, and the Ham Education Medal from IEEE Canada. Dr. Deen was elected by his peers as a Fellow/Academician of 12 national academies and professional societies including the RSC, The Chinese Academy of Sciences, and The World Academy of Sciences. He was also awarded four honorary doctorate degrees in recognition of his exceptional research and scholarly accomplishments, exemplary professionalism, and valued services. ■



Dr. M. Jamal Deen (Fellow, IEEE) est professeur universitaire distingué et titulaire d'une CRC senior en technologies de l'information à l'Université McMaster. Il a obtenu son doctorat en génie électrique et physique appliquée de l'Université Case Western Reserve, Cleveland, USA, pour ses recherches sur la conception et modélisation d'un nouveau spectromètre DRASC pour la mesure dynamique des températures et l'optimisation de la combustion dans les moteurs de fusées et à réaction, parrainé et utilisé par la NASA, Cleveland.

Les intérêts de recherche actuels de Dr. Deen sont en nanoélectronique, optoélectronique, nanotechnologie, analyse de données et leurs applications émergentes en santé et environnement. Il a effectué des recherches séminales sur les senseurs intelligents et l'analyse de données pour la surveillance omniprésente en santé et en qualité de l'eau. Il est un chercheur éminent dans le domaine des photodétecteurs à haute performance pour les communications à fibre optique et les systèmes d'imagerie. Pour les communications sans fil, il a apporté des contributions fondamentales et significatives dans la compréhension de la sensibilité/bruit dans les dispositifs au silicium courants - la technologie dominante des systèmes cyber-physiques, en combinant des expériences uniques et innovantes et la modélisation d'ingénierie et basée sur la physique.

Lorsqu'il était étudiant de premier cycle, il a remporté la médaille du recteur en tant que deuxième meilleur étudiant gradué et le prix Irving Adler du meilleur étudiant en mathématiques. Étudiant gradué, il a été boursier Fulbright-Laspau et de l'American Vacuum Society. Il a reçu le prix Callinan et celui de la division d'électronique et photonique de l'Electrochemical Society; une bourse de recherche Humboldt; la médaille Eadie de la Société royale du Canada (SRC); la médaille d'or McNaughton, la médaille Fessenden, et la médaille Ham d'éducateur exceptionnel en génie de l'IEEE Canada. Dr. Deen a été élu par ses pairs fellow/académicien de douze académies nationales et sociétés professionnelles incluant la RSC, l'Académie chinoise des sciences et l'Académie mondiale des sciences. Il s'est aussi vu décerner quatre doctorats honorifiques en reconnaissance de ses réalisations de recherche exceptionnelles, professionnalisme exemplaire et services appréciés. ■

2022 IEEE CANADA J.M. HAM OUTSTANDING ENGINEERING EDUCATOR AWARD
PRIX J.M. HAM D'ÉDUCATEUR EXCEPTIONNEL ENGÉNIE DE L'IEEE CANADA 2022

For outstanding contributions to student learning in engineering through teaching, curriculum development, pedagogical challenge, research, and community building.
Pour contributions remarquables à l'apprentissage étudiant en génie par l'enseignement, le développement du curriculum, les défis pédagogiques, la recherche et le développement communautaire.

Lawrence Chen, Montréal, QC

Lawrence R. Chen (Senior Member, IEEE) received the B.Eng. degree from McGill University in 1995 and the M.A.Sc. and Ph.D. degrees from the University in Toronto in 1997 and 2000, respectively. Since 2000, he has been with the Department of Electrical and Computer Engineering at McGill University, where he is currently a professor. He is also the academic lead of the Enhancing Teaching and Learning in Engineering (ELATE) initiative as well as an ELATE faculty scholar in engineering education research.

Prof. Chen uses diverse active and inductive learning strategies to engage students with course content, stimulate critical thinking and analysis, and promote self-regulated learning. His teaching approach allows students to acquire technical knowledge and develop skills in communication, teamwork, and problem solving. As academic lead of ELATE, his objective is to enhance and promote excellence in teaching and learning experiences in engineering. He has created learning communities for instructors, students, and teaching assistants; brought pedagogical support to instructors (e.g., organizing conferences on teaching and learning that feature renowned researchers in education and that have reached out to >1,000 educators and students in STEM in the local community); reduced pedagogical isolation for instructors; provided support for pedagogical improvement; mobilized and engaged students in their learning process; and expanded communication between faculty and students.



Prof. Chen has served on technical program committees for a number of international conferences, was a guest editor for the IEEE/Optica *Journal of Lightwave Technology* special issue on microwave photonics (2020) and principal guest editor for the *IEEE Journal of Selected Topics in Quantum Electronics* issue on optical signal processing (2021). He received the McGill University Principal's Prize for Excellence in Teaching (2021) and the SALTISE (Supporting Active Learning and Technological Innovation in Studies of Education) Best Practices and Pedagogical Innovators Award (2015). He is a Fellow of Optica. ■

Lawrence R. Chen (Senior Member, IEEE) détient un baccalauréat en génie de l'université McGill (1995) ainsi qu'une maîtrise (1997) et un doctorat (2000) de l'université de Toronto. Il est professeur en génie électrique et génie informatique à McGill, le responsable académique de l'initiative Amélioration de l'apprentissage et de l'enseignement en génie (ELATE) et est titulaire d'une chaire ELATE en recherche sur la formation en génie.

M. Chen utilise diverses stratégies d'apprentissage actives et inductives afin d'impliquer les étudiants dans le contenu des cours, de stimuler la pensée et l'analyse critique et de promouvoir l'apprentissage autorégulé. Son approche pédagogique permet aux étudiants d'acquérir des connaissances techniques et de développer des compétences en matière de communication, de travail en équipe et de résolution de problèmes. En tant que responsable académique d'ELATE, son objectif est d'améliorer et de promouvoir l'excellence dans l'enseignement et l'apprentissage en génie. Il a créé des communautés d'apprentissage professionnelles, apporté un soutien pédagogique aux instructeurs, réduit l'isolement pédagogique des instructeurs, fourni un soutien pour l'amélioration de la pédagogie, mobilisé et engagé les étudiants dans leur processus d'apprentissage et élargi les communications entre le corps enseignant et les étudiants.

M. Chen a fait partie de comités de programme technique pour plusieurs conférences internationales, a été rédacteur invité pour le numéro spécial de l'IEEE/Optica Journal of Lightwave Technology sur la photonique des micro-ondes (2020) et rédacteur invité principal pour le numéro de l'IEEE Journal of Selected Topics in Quantum Electronics sur le traitement des signaux optiques (2021). Il a reçu le prix du principal de l'Université McGill pour l'excellence de son enseignement (2021) et le prix SALTISE (Supporting Active Learning and Technological Innovation in Studies of Education) Best Practices and Pedagogical Innovators Award (2015). Il est membre agréé (Fellow) d'Optica. ■

2022 IEEE CANADA M.B. BROUGHTON CENTRAL CANADA MERIT AWARD
PRIX DE MÉRITE M.B. BROUGHTON DU CENTRE DU CANADA DE L'IEEE CANADA 2022

For leadership in serving the IEEE Canada London Section, IEEE Canada, and the IEEE Communications Society.
Pour son leadership au service de la Section de London, de l'IEEE Canada, et de l'IEEE Communications Society.

Abdallah Shami, London, ON

Abdallah Shami (Senior Member, IEEE) is a professor with the Electrical and Computer Engineering Department, The University of Western Ontario, London, ON, Canada. He is the director of the Optimized Computing and Communications Laboratory, Western University.

He is currently an editor for *IEEE Transactions on Mobile Computing*, *IEEE Transactions on Network and Service Management*, *IEEE Communications Magazine*, and *IEEE Communications Surveys and Tutorials*. He was the IEEE London Section chair and general chair for 2020 IEEE Canadian Conference on Electrical and Computer Engineering. In addition, he has chaired key symposia for IEEE GLOBECOM; IEEE International Conference on Communications; IEEE International Conference on Computing, Networking, and Communications; and International Conference on Wireless and Mobile Computing, Networking, and Communications.



He was the elected chair of the IEEE Communications Society Technical Committee on Communications Software.

Dr. Shami received the 2017 Technical Achievement Award for Outstanding Contributions to Wireless Networking Softwarization, IEEE Communications Society, Communications Software Technical Committee; the IEEE Distinguished Lecturer Award (2016–2017); 2013 Samsung Global Research Outreach (GRO) Award; and six best paper awards and was invited as the keynote speaker at many international and national conferences. ■

Abdallah Shami (Senior Member, IEEE) est professeur au département de génie électrique et informatique, Université Western Ontario, London, Ontario, Canada. Il est directeur du laboratoire d'informatique et communications optimisées, Université Western.

Il est présentement éditeur pour IEEE Transactions on Mobile Computing, IEEE Transactions on Network and Service Management, IEEE Communications Magazine et IEEE Communications Surveys and Tutorials. Il a été président de la Section IEEE de London, et président de la Conférence canadienne de génie électrique et informatique en 2020. De plus, il a présidé des symposiums clés pour IEEE GLOBECOM, l'IEEE International Conference on Communications, l'IEEE International Conference on Computing, Networking and Communications, et l'International Conference on Wireless and Mobile Computing, Networking and Communications. Il a été élu président du comité technique sur les logiciels de communications de l'IEEE Communications Society.

Dr. Shami a obtenu: Le prix de réalisation technique 2017 du comité technique sur les logiciels de communications de l'IEEE Communications Society pour <<Outstanding Contributions to Wireless Networking Softwarization>>; une nomination de conférencier distingué de l'IEEE (2016–2017); un prix Samsung Global Research Outreach (GRO) 2013; 6 prix de meilleur article; et a été invité comme orateur principal à de nombreuses conférences internationales et nationales. ■

IEEE Canadian Foundation
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2022 EIC Fellows/ICI Fellows

The IEEE Canadian Foundation, a registered charity in Canada, is the philanthropic partner of IEEE in Canada. Donations support scholarships and prizes as well as McNaughton Learning Resource Centres and grants to new and innovative initiatives. The IEEE Canadian Foundation welcomes directed gifts from individuals, associations, corporations, and foundations. These are used to endow annual awards that meet worthy but unfilled needs and further the purpose of the donor and the IEEE Canadian Foundation (www.ieeecanadianfoundation.org).

IEEE Canada Women in Engineering Prize/Prix Femmes en Génie de L'IEEE Canada
SADIA KHAF—Montreal Section
IEEE Canadian Foundation Scholarships/Bourses D'études de la Fondation Canadienne de L'IEEE
KEATON MOLBERG (R. Gokaraju SBC)—University of Saskatchewan
HAMAS WAQAR (W. Ye SBC)—Carleton University
IEEE Canadian Foundation Special Grant/Subvention Spèciale de la Fondation Canadienne de L'IEEE
UNIVERSITY OF WATERLOO A—Orbital Canadian Satellite Design Challenge
MEMORIAL UNIVERSITY—Robosub Autonomous Underwater Vehicle team
MEMORIAL UNIVERSITY—IEEE Autonomous Unmanned Aerial Vehicle (UAV) Competition

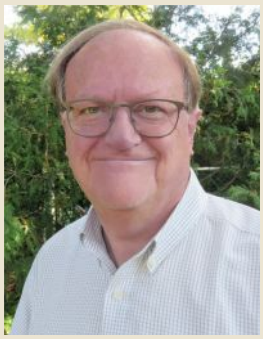
IEEE Canada Members elected as 2022 IEEE Fellows
Membres de l'IEEE Canada élus Fellows de l'IEEE 2022

Prof. Anthony Chan Carusone, Toronto, ON Canada
For contributions to integrated circuits for digital communication
Ibrahim Gedeon, Edmonton, AB Canada
For leadership in consumer-oriented applications of broadband communications
Dr. Steve Hranilovic, Hamilton, ON Canada
For contributions to optical wireless communication systems
Prof. Ihab Ilyas, Waterloo, ON Canada
For contributions to data integration, data cleaning, and rank-aware query processing
Trevor Maguire, Winnipeg, MB Canada
For leadership in the development of large-scale real-time power systems simulators
Roland Malhame, Montreal, QC Canada
For contributions to mean-field games and stochastic hybrid systems
Dr. Mukesh Nagpal, Burnaby, BC Canada
For contributions to economic and safe integration of distributed renewables in electric utility networks
Prof. Babak Nahid-Mobarakeh, Hamilton, ON Canada
For contributions to service continuity of electric motor drive systems
Prof. Joyce Poon, Toronto, ON Canada
For contributions to integrated photonics on silicon and resonant microphotonic devices
Mladen Sasic, Etobicoke, ON Canada
For contributions to the development of diagnostics testing of motor and generator windings
Dr. Ping Wang, Toronto, ON Canada
For contributions to radio resource allocation and performance modeling of heterogeneous wireless networks
Dr. Liang Zhang, Ottawa, ON Canada
For contributions to nonorthogonal multiplexing technology in terrestrial broadcast and broadband systems

IEEE Canadian Foundation
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2021 YEAR IN REVIEW—We want to thank you again and recognize your support to the IEEE Canadian Foundation in 2021. Each gift has an impact on future generations and current practitioners and is managed to meet the highest expectations of donor intentions.

Donations from individuals and organizations were $21,458 to General Fund programs and $115,000 to designated funds and enduring endowments. All programs continued for support of the IEEE Canada community, despite the disruptions to student, academic, industry, and professional life.



Our Mission—Your gifts enhance the learning experience for electrical, electronics, and computer engineering students across Canada with our programs of McNaughton Centres and Scholarships.

We want to thank you again and recognize your support to the IEEE Canadian Foundation in 2021.

Students and other recipients also benefit through the cofunding of special projects that develop engineering enthusiasm and skills at all levels. Increasingly, these projects use technology for the benefit of humanity. "Success Stories" on our website, the monthly IEEE Canada newsletter, and in this magazine demonstrate the wide range of technical, professional, and development opportunities that your gifts support.

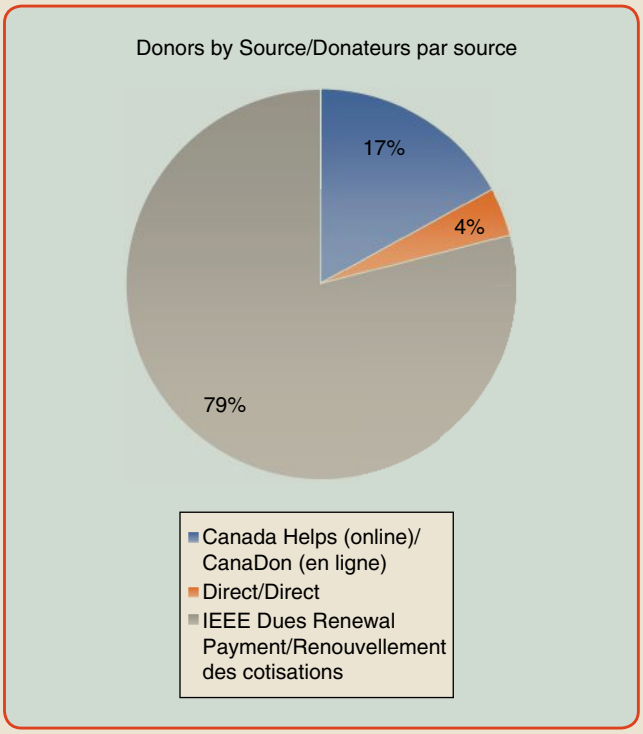
BILAN DE L'ANNÉE 2021—Nous tenons à vous remercier encore une fois et à rcconnaître votre soutien à la Fondation canadienne de l'IEEE en 2021. Chaque don a un impact sur les générations futures et les praticiens actuels et aussi est géré pour rédpondre aux attentes les plus élévees des intentions des donateurs.

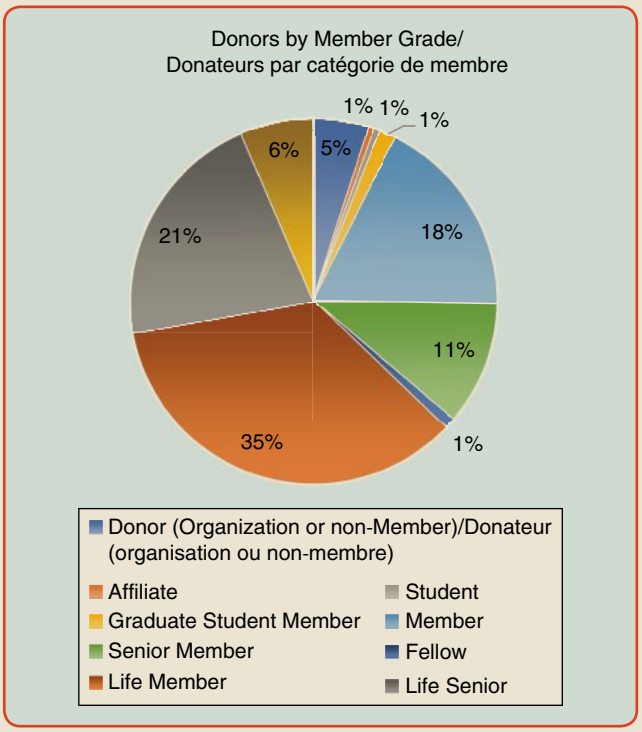
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Notre fonds général est crucial pour notre capacité a fonctionner chaque année, et vos dons non dirigés nous permettent de maintenir notre base solide. Nos fonds de dotation soutiennent un large éventail de récompenses, prix et bourses. Veuillez considérer un don dirigé pour doter un nouveau prix de l'IEEE Canada prix de votre choix.





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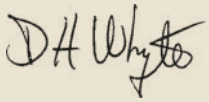
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Looking Ahead—We appreciate your past support and urge you to continue to do so and increase your contributions where possible. If you have not yet made a donation, please join your peers—this is your opportunity to stand with others who choose to make a difference. We could do so much more with your financial support. All the different ways to give and donor recognition programs are fully described on our website.

The IEEE Canadian Foundation wants to hear from you—if we can better engage and support our community, please let us know (info.ieeecanadianfoundation@ieee.ca).

Many IEEE members in Canada contribute to the all-volunteer effort that is the IEEE Canadian Foundation, including the invaluable assistance of Anader Benyamin-Seeyar, Luc Matteau, John Mowbray, and many others in the preparation of this 2021 Honour Roll of Donors.

Yours sincerely,



David H. Whyte
President,
IEEE Canadian Foundation
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Impact des donateurs—Les dons peuvent être attribués à l'un des fonds suivants de la Fondation Canadienne de l'EEE:

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- **Vancouver Section Scholarship Fund**—soutient les bourses accordées par la section Vancouver de l'IEEE
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- **Fonds commémoratif Dave Kemp**—perpétue la mémoire de Dave en soutenant les programmes de l'IEEE qui correspondent à ses passions - y compris les jeunes professionnels et les étudiants au Canada.

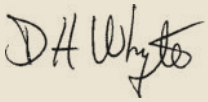
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Regarder vers l'avant—Nous apprécions votre soutien passé et vous exhortons à continuer de donner et d'augmenter vos contributions dans la mesure du possible. Si vous n'avez pas encore fait de don, veuillez vous joindre à vos pairs - c'est l'occasion de vous tenir aux côtés de ceux qui choisissent de faire la différence. Nous pourrions faire bien plus avec votre soutien financier. Toutes les différentes façons de donner et les programmes de reconnaissance des donateurs sont décrits en détail sur notre site Web.

La Fondation canadienne de l'IEEE veut vous entendre - si nous pouvons mieux engager et soutenir votre communauté, veuillez nous le faire savoir. Vous pouvez me contacter à info.ieeecanadianfoundation@ieee.ca

De nombreux membres de l'IEEE au Canada contribuent à l'effort de bénévolat de la Fondation canadienne de l'IEEE, y compris l'aide inestimable de Anader Benyamin-Seeyar, Luc Matteau, John Mowbray et de nombreuses autres personnes pour préparer ce tableau d'honneur des donateurs 2021.

Cordialement,



David H. Whyte
Président de la Fondation Canadienne IEEE
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- nine IEEE Canadian Foundation Special Grants
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- two IEEE Canadian Foundation Québec Science Fair Prizes
- one Findlay Scholarship
- one Gargantini–Strybosch Scholarship
- two Vehicular Technology Awards
- two other endowed Section awards and scholarships.

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- Deux prix IEEE Fondation canadienne Expo-sciences Québec
- Une bourse Findlay
- Une bourse Gargantini-Strybosch
- Deux Prix Technologies véhiculaires de l'IEEE Canada
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We Just Couldn't Resist ...

David Green
St. John's NL
davidgreen@ieee.org

There was quite a buzz in Parry Sound. Hockey legend Bobby Orr was having a private party in his hometown on Saturday night. It had the potential to be quite a large affair, but the venue was only so big. Bobby didn't want to offend anyone by leaving them off an invitation list, so he relied on word of mouth instead. Only the first 300 people would be allowed in, and then only if security deemed that you would be suitable guest. This led to all kinds of rumours about who would and who would not be admitted to the party.



Two of Bobby's former school classmates, Devon and Sheila, met up at a bar for happy hour on the Friday evening before the party. They were talking about attending it. Devon knew he was a shoo-in. "I've known Bobby for over 60 years, and I used to play hockey with him in Junior League."

Only the first 300 people would be allowed in, and then only if security deemed that you would be suitable guest.

Sheila said, "Well, I've known him just as long as you have, but I didn't play hockey—I spent most of my time studying to become an engineer." Devon was worried that Sheila wouldn't make it into the party.

The night of the party came, and there was a long lineup of hopeful would-be attendees just outside the entrance to the venue. As the line advanced, some people were let into the glamourous affair, and others were turned away dejected.

Devon and Sheila were in the lineup. The person ahead of them was a brash young man who couldn't have been more than 30 years old. The security guard asked him, "How do you know Bobby Orr?" The young man replied, "I've known him for decades—I'm the godfather of his kids!" The security guard, seeing right through the obvious lies, sent him away from the party.

Devon stepped up and made his case: "I'm a long-time friend of Bobby, and we used to play hockey together." The security guard was convinced and let Devon in. Devon waited near the entrance, nervous for his friend Sheila.

Sheila approached and pled her case: "I'm also a long-time friend of Bobby, and, uh, I used to be his skating coach." The security guard also waved her in.

"Well, I've known him just as long as you have, but I didn't play hockey—I spent most of my time studying to become an engineer."

Devon was astonished. "You've never laced up a pair of skates in your life! How did you just get away with that?"

Sheila replied, "Eh, it's the Orr gate. Only one of my arguments needs to be true." ■

Honouring a Legacy: John Spencer MacDonald

by Matthew Wilder

John Spencer MacDonald was an engineer, an academic, and a business leader of the highest caliber. British Columbia—even Canada—benefited from his myriad contributions. His career included award-winning instruction at the Massachusetts Institute of Technology (MIT) and University of British Columbia (UBC) as well as leadership in businesses he founded, including MacDonald, Dettwiler & Associates. The common thread through his illustrious career was his unwavering passion for establishing a center of excellence in engineering within his home province, British Columbia.

"John was interested in creating a thriving and robust technology sector in British Columbia. He wanted to create world leaders," recalls Alfredette MacDonald of her late husband. "To him, it started with education. Elementary and high school education in the province were good, and undergraduate studies were good launching pads for further studies, which, at the time, would have to be taken abroad. John wanted to build the equivalent of or better than MIT within Canada. He wanted to see knowledge come together in one center."



John Spencer MacDonald

Honouring a Legacy With a New Scholarship

Executive Committee members of the IEEE Vancouver Section felt it would be appropriate to establish an annual scholarship award in Dr. MacDonald's name. Under the leadership of Bob Gill, the Section established the award and contributed an endowment to the IEEE Canadian Foundation to fund the annual award.

Reflecting on the significance of Dr. MacDonald, Bob Gill noted that "As an engineer, Dr. MacDonald made a major impact in creating good jobs for graduating engineers in the field of electrical and electronics engineering. In that fashion, not only he helped graduating students but emphasized the importance of higher education."

Engineering Leadership and Sustainability

The new award is the fourth annual award available to Student Members of the Vancouver Section. The other awards are named after other distinguished engineers: Thurb Cushing, Hector J. MacLeod, and John Deane. Each award has its own selection criteria, spanning scholastic achievement, Student Branch volunteering,



(Left to right): Bob Gill, Alfredette MacDonald, Talisha Griesbach, and Matthew Wilder.

and pioneering efforts within a chosen academic field. When creating the John S. MacDonald Scholarship, the Section considered the unique contributions of Dr. MacDonald.

In addition to the prolific legacy of his engineering leadership, John was an early proponent of sustainability. His access to RADARSAT imagery made him aware of our globe's shrinking ice cap, which ultimately led to his founding Day 4 Energy, a start-up focused on renewable energy. In recognition of these contributions, the scholarship is awarded to students who have demonstrated an entrepreneurial spirit as well as an interest in sustainability.

First Award Recipient

At the Vancouver Section annual general meeting held 30 March 2022, I had the pleasure of announcing the recipients of the four scholarship awards, including the first-ever recipient of the John S. MacDonald award, Talisha Griesbach. Appropriately, Talisha is studying engineering at UBC and has demonstrated exceptional leadership, specifically in programs revolving around sustainability.

"John was interested in creating a thriving and robust technology sector in British Columbia. He wanted to create world leaders," recalls Alfredette MacDonald of her late husband.

Along with other leaders of the Vancouver Section, I had the opportunity to present the scholarship recipients with their awards later in the spring. We invited Alfredette MacDonald to take part in the presentation, especially for the MacDonald award. It was a privilege to present the award to Talisha, alongside Alfredette and Bob.

Building a Better Tomorrow

John S. MacDonald left a resounding legacy. His contributions as a Canadian engineer, as a leader, and as a member of society serve as an inspiration to make the world a better place, beginning with our own community. ■

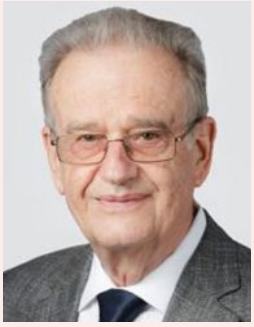
About the Author



Matthew Wilder is an engineer whose passion is to see Internet technology improve lives. He works at TELUS as a network engineer, having held responsibilities including network standards, planning, architecture, security, and systems architecture. He received his M.B.A. degree from the University of Victoria and his B.A.Sc. degree in electrical engineering from the University of British Columbia. He currently serves as the chair of the IEEE Vancouver Section.

Prof. John Bandler Receives the 2023 IEEE Electromagnetics Award

John William Bandler, Fellow, IEEE, has received the prestigious 2023 IEEE Electromagnetics Award. He has been recognized "for contributions to electromagnetic optimization and the modeling of high-frequency structures, circuits, and devices."



Prof. Bandler studied at Imperial College London and received his B.Sc.(Eng.), Ph.D., and D.Sc.(Eng.) degrees from the University of London, England, in 1963, 1967, and 1976, respectively. He joined McMaster University, Canada, in 1969, where he served as chair of his department and dean of the Faculty of Engineering. Currently he is a professor emeritus at McMaster University.

Prof. Bandler published more than 500 technical papers, contributed to many books, founded several cutting-edge companies, and received numerous awards and accolades. He is an engineer; entrepreneur; innovator; researcher; artist; speaker; and author of fiction, including stage plays. Read more about this true Canadian icon at https://www.eng.mcmaster.ca/news/john-bandler-achieves-highly-prestigious-ieee-electromagnetics-award.



Biz Tech Report



by Terrance Malkinson

A team of University of British Columbia engineering students are attempting an autonomous ocean crossing from Victoria, British Columbia, to Maui, Hawaii, of their student-designed 18-ft sailing vessel, *Raye*. Taking six years to build, the vessel is computer programmed and solar powered (https://www.ubcsailbot.org). More than 200 students from a variety of engineering fields and interests were involved in this project, which extends the limits of marine engineering. The team named the new boat after Raye Montague, a U.S. naval engineer who was the first person to design a ship entirely with a computer in 1971. The students had hoped to launch the craft in August 2022, but, due to challenging weather conditions, the launch will be postponed until summer 2023. An earlier attempt in 2017 to cross the Atlantic was unsuccessful. Students still consider the mission a success because of the many lessons they learned, resulting in an improved design, including a stronger hull made of carbon fibre, new algorithms for navigation, and the redundancy of critical components. Top-tier engineering, as these students are demonstrating, requires a worthwhile goal and the persistence to achieve that goal, overcoming obstacles during the journey.

The European Interrail Pass (Eurail Pass) (https://www.interrail.eu/en) has provided convenient rail travel for 50 years (https://www.cnn.com/travel/article/european-interrail-pass-50-year-history/index.html). The concept, beginning in 1972, was to provide young people with the irresistible opportunity to explore Europe inexpensively—experiencing other cultures and ways of thinking in a sociable, communal, and exciting way. The author was one of these adventurers during his university summers. We were young and curious. Every day, there would be a new country or town to explore. We snapped photos the breadth of Europe and saved money by sleeping on the train or bunking down in youth hostels. For me and many others, it was a life-changing experience. Today, the pass is available to everyone of all ages and offers a range of travel options. High-speed rail services are commonplace in many countries. In many regions of the world, rail travel is the preferred provider for local, national, and international business and personal travel because of its convenience, efficiency, low cost, and environmental benefits—all the result of innovations created by engineers. Many massive rail infrastructure projects are being engineered and constructed globally (https://www.railway-technology.com/railway-construction-projects).

Top-tier engineering, as these students are demonstrating, requires a worthwhile goal and the persistence to achieve that goal, overcoming obstacles during the journey.

The pandemic revealed significant problematic issues in Canada's vaccine research and manufacturing capacity. Recently, a $28 million, 285,000-ft^2 vaccine development centre featuring state-of-the-art containment level 2 and 3 infrastructure at the University of Saskatchewan was announced (https://www.cbc.ca/news/canada/saskatchewan/sask-vaccine-manufacturing-facility-first-of-kind-in-canada-1.6503798). This is Canada's largest containment facility and one of only a few in the world. Partners include the City of Saskatoon, the government of Saskatchewan, and the federal government. The new $28 million vaccine development centre is located within VIDO-InterVac's (https://www.vido.org) existing level 3 containment facility. Established in 1975, VIDO has commercialized eight vaccines and has been granted more than 110 patents in Canada and the United States. VIDO's facility is unique because it can make both human and animal vaccines for viruses, categorized up to level 3. Eventually, VIDO would like to acquire level 4 status. The facility can create any kind of vaccine: protein subunit, RNA, viral vector, live, or inactive vaccines. VIDO hopes to have the facility fully functional by the fourth quarter of 2023. For many scientists, this is the best place in Canada, and it is definitely one of the top on the planet to study emerging pathogens. In 2021, the Canadian government released its "Canada's Biomanufacturing and Life Sciences Strategy," outlining the rebuilding of Canada's domestic biomanufacturing sector by focusing on both quick strategic actions and a long-term vision (https://www.ised-isde.canada.ca/site/biomanufacturing/sites/default/files/attachments/1098_01_21_Biomanufacturing_Strategy_EN_WEB.pdf).

More than $628 million was awarded in August for 19 research–infrastructure projects across Canada (https://www.innovation.ca/news/msi-august-2022). Recipients were selected by the Canadian Foundation for Innovation, a federal research-funding agency, as part of a competition to support major science initiatives through 2029. The largest recipient was Ocean Networks Canada (https://www.oceannetworks.ca), which will receive nearly $115 million to maintain and extend its multiple arrays of underwater detectors along the Canadian Pacific, Atlantic, and Arctic coastlines. A subterranean lab (SNOLAB) (https://www.snolab.ca), located in an active mine 2 km below Sudbury, where physicists aim to solve the mystery of dark matter, received $102 million. In 2015, Canadian researcher Arthur McDonald was awarded the Nobel Prize in Physics for his experiments on subatomic particles called *neutrinos* at SNOLAB. Awards to some of the other projects named in Friday's funding announcement include $97 million for the Canadian Light Source in Saskatchewan, a facility that generates

high-intensity light using a particle accelerator; $54 million for the Amundsen, Canada's research icebreaker; and $48 million to support CGEn, Canada's national facility for genome sequencing and analysis, located at Toronto's Hospital for Sick Children.

A group of researchers at Dalhousie University in Halifax has developed a material from the silk of spiders that could one day help regenerate nerve cells and treat paralysis (https://www.cbc.ca/news/canada/nova-scotia/dal-researchers-silk-material-nerve-regeneration-1.6574762). The researchers studied the silk of female garden spiders, which is used to protect their eggs and trap prey. Jan Rainey, a professor at the school's department of biochemistry and molecular biology, said he became interested in spider silks because these natural materials are able to absorb more force than anything that humans can make before they break. We wanted to understand what gives rise to these properties and then to understand how we could modify the material to provide new functionality. Last month, Rainey coauthored a research paper published in the journal *Advanced Functional Materials* that outlines how the silk-based material could one day direct the regrowth of a nerve that has been injured and potentially restore movement.

Twelve of Canada's telephone and Internet service providers have signed an agreement to share network services in the case of a major outage. This would allow a company experiencing a major service interruption to temporarily serve its customers using its competitors' networks. The agreement will replace an informal set of arrangements between some companies and will ensure that the mutual assistance is enforceable by law. The deal includes an "emergency roaming protocol" that will ensure that mobile customers are able to roam onto other networks in the case of an outage. The measure would prevent affected customers from losing access to important services. A "mutual assistance protocol" to be implemented under the new deal will provide measures for the temporary sharing of other resources between telecom companies, including staff, vehicles, equipment, and wireless spectrum. An "emergency network outage communications protocol" outlined in the deal is intended to ensure that telecoms provide timely and clear information about outages to the public and to government authorities.

Calgary-based company SixRing Inc. (https://www.sixring.com) is set to scale up biofuel production, thanks to a $1.4 million grant from the federal government. The company has developed several patented processes to create ultralow-carbon biofuels using crop and forestry waste. The funding will help SixRing scale up production and develop specific fuel types and products, particularly sustainable aviation fuel. The technology uses a wide range of inputs, from unused straw and corn husks to bark, wood chips, and pine beetle-infested wood. The process operates at ambient temperatures and pressures, creating minimal emissions, and can be easily integrated into existing biomass industrial infrastructure.

A group of researchers at Dalhousie University in Halifax has developed a material from the silk of spiders that could one day help regenerate nerve cells and treat paralysis.

The James Webb Space Telescope continues to function well beyond all expectations, exploring the distant universe. In July, NASA revealed the first five full-color images and spectrographic data from the telescope (https://www.nasa.gov/webbfirstimages). In September, the Webb telescope captured its first direct image of an exoplanet located about 385 light-years away from Earth (https://www.cnn.com/2022/09/01/world/webb-telescope-exoplanet-image-scn/index.html). The exoplanet, or planet outside of our solar system, is a gas giant about six to 12 times the mass of Jupiter. Named *HIP 65426 b*, it is about 15–20 million years old. A report on the James Webb Space Telescope development and deployment is available in the Spring 2022 issue (volume 81, pp. 6–12) of *IEEE Canadian Review*. Canadian engineers are major contributors to the design and construction of the telescope. Canadian scientists will be using the telescope in numerous projects exploring the distant universe. ■

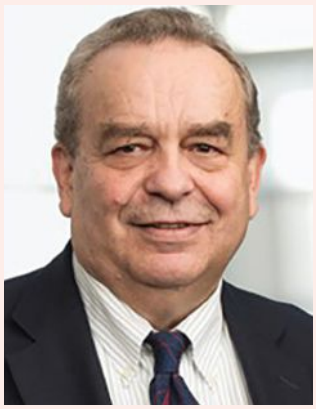
About the Author



Terrance Malkinson (malkinst@telus.net), the author of more than 600 peer- and editorial- reviewed earned publications, is now retired. His diverse career path includes 26 years in medical research as a founding member of the Faculty of Medicine at the University of Calgary and a three-year appointment as a business manager with the General Electric Company followed by a one-year applied research appointment with SAIT Polytechnic. He is an alumnus of continuing professional education programs with Outward Bound International, the Banff Centre for Management, the Massachusetts Institute of Technology, and the University of Colorado. During his long career, he has advanced both basic and applied medical, health and wellness, scientific, and engineering knowledge. He has trained and mentored undergraduate, graduate, and postdoctoral students as well as staff in the business sector and government. He is a 45-year Life Senior Member of IEEE. He has served in many professional public and private governance and publication roles. He is the recipient of several peer-selected earned awards, including induction into the Order of the University of Calgary, IEEE achievement medals, and APEX awards for publication excellence. In retirement, he vigorously continues basic and applied research with an extensive portfolio of projects. Other passions include communicating emerging technologies to the public, investigative journalism, philanthropy, and mentorship. His current research interests in emerging technologies and health and wellness extend to being an accomplished multisport triathlete, including, among other events, the completion of 11 full-distance Ironman Triathlons.

Emil M. Petriu Receives the 2021 IEEE Instrumentation and Measurement Society Career Excellence Award

Prof. Emil M. Petriu received the Career Excellence Award "for a career dedicated to academic research, engineering education, industry R&D, training, and mentorship in the field of intelligent sensors and for outstanding and continuous service to the Instrumentation and Measurement Society's conferences, journal, technical committees, and Administrative Committee."



Prof. Petriu, a Fellow of IEEE, received his Dr.Eng. degree in electrical engineering from the Polytechnic Institute of Timisoara, Romania, in 1978. Currently, he is a professor and University Research Chair in the School of Information Technology, University of Ottawa, Ottawa, ON, Canada. Read more about Prof. Petriu at https://ieee-ims.org/2021-ieee-instrumentation-and-measurement-society-awards-recipients.

Shervin Shirmohammadi Receives the 2021 IEEE Instrumentation and Measurement Society Distinguished Service Award

Prof. Shervin Shirmohammadi, FIEEE, received the Distinguished Service Award "for exceptional and tireless service to the IEEE Instrumentation & Measurement Society and its members and for dedication to elevate the stature of *IEEE Transactions on Instrumentation and Measurement* through quality."



Prof. Shirmohammadi received his Ph.D. degree in electrical engineering in 2000 from the University of Ottawa, Canada, where he is currently a professor with the School of Electrical Engineering and Computer Science. Read more about Prof. Shirmohammadi at https://ieee-ims.org/2021-ieee-instrumentation-and-measurement-society-awards-recipients.



New IEEE Canada History Committee Initiatives

by David G. Michelson
IEEE Canada Historian

Our sense of who we are, our values and beliefs, and our ambitions for the future are guided, in large part, by the stories and anecdotes concerning the past that we share with each other. In this light, history may be viewed as a formal process by which we preserve, organize, and interpret the stories that both matter to us and define us.

While historical fact is immutable, historical evidence is inherently fragile and often irreplaceable. Accordingly, efforts to preserve and interpret the past are among the most valuable of legacies. In this column, we consider some IEEE Canada History Committee initiatives that are currently in development, including IEEE Canada Press, the IEEE Canada Milestones and Landmarks Directory, and the IEEE Canada Museums and Archives Directory.



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In 1980, IEEE established the IEEE History Center to be the staff arm of its History Committee with an aim to preserve, research, and promote the legacy of electrical engineering and computing. Although motivated by the upcoming centennial celebration in 1984, it is noteworthy that the formation of the History Center coincided with the emergence of public history as a professional discipline in North America.

Public history draws from the traditions of historic preservation, oral history, museum curatorship, and archival science. In 2007, the U.S.-based National Council on Public History proposed that public history be defined as "a movement, methodology, and approach that promotes the collaborative study and practice of history with an intent to make the outcomes accessible and useful to the public." Although the proposed definition has been criticized by some, its essential elements are generally accepted.

During the past 30 years, the IEEE Canada History Committee has achieved remarkable success in important activities, such as reprinting John Swettenham's three-volume biography of General Andrew McNaughton and supporting the nomination and dedication of 17 IEEE Milestones in Canada with at least five more in process. The Milestone that recognizes the opening of the Trans Canada Microwave system on 1 July 1958 involves 19 of 21 IEEE Canada Sections and has set a record that is likely to hold for years to come. However, we have a greater opportunity to contribute to the public history of electrical engineering and computing that we do not want to miss.

While we will continue to support and contribute to the IEEE Milestones program and events with public history content, such as the Sections Congress to be held in Ottawa in August 2023, we are also launching three new initiatives that aim to make the history of electrical engineering and computing in Canada ever more accessible to both technology professionals and the public and to add value to the history of the technology community in Canada.

IEEE Canada Press

IEEE Canada's publications currently include *Canadian Journal of Electrical and Computer Engineering*, *IEEE Canadian Review*, *IEEE Canada Newsletter*, and various newsletters issued by committees, such as YP, WIE, and TISP. We are working with the IEEE Canada Publications and Communications Group to add book publishing as a fifth element.

IEEE Canada has already published a handful of books to which ISBNs have been assigned, beginning with *Electricity: The Magic Medium* during the IEEE centennial and, most recently, the reprinting of the three-volume McNaughton biography. Although successful, these volumes were produced and approved in an ad hoc manner, and there is no clearcut path for future authors to publish their works through IEEE Canada.

The IEEE Canada History Committee believes that authors want to publish and promote—and that the community wants access to—important works concerning technology, its history, and its impacts on and implications for Canadian society. However, mainstream publishers are not particularly interested in serving this market. Several Canadian universities operate academic/university presses according to the U.S. model, but all cater exclusively to humanities, business, and social issues.

We propose establishing an imprint called *IEEE Canada Press* that would fill the gap between technology and the humanities and provide a peer-reviewed mechanism for technology historians to share their book-length contributions with both technology professionals and the public. It would follow the model established by the IEEE History Center several years ago, when it began to publish historical works using Amazon's print-on-demand publishing platform.

The IEEE Canadian Foundation and the IEEE Canada History Committee have also used Amazon's print-on-demand publishing platform in their efforts to reprint the three-volume McNaughton biography—with good results. This experience has led both the IEEE Publications and Communications Group and the IEEE Executive Committee to express strong support for the proposal to establish a formal mechanism for reviewing and publishing other books using this platform. We hope to make rapid progress in making IEEE Canada Press a reality during the next year.

IEEE Canada Milestones and Landmarks Directory

The IEEE Milestones program is only one of several programs that recognize significant people, places, and events that are relevant to the history of technology in Canada. Other programs

include the National Historic Sites of Canada, which is administered by the Historic Sites and Monuments Board of Canada, and other programs administered by our sister professional societies.

The IEEE Canada History Committee proposes greatly expanding the current listing of IEEE Milestones on the IEEE Canada website in two ways. The first will be to include more detailed information concerning each Milestone with a particular emphasis on information useful to those who want to see the Milestone plaque in person. The second will be to expand the list to include other sites relevant to the history of technology in Canada that have been recognized by HSMBC or our sister societies. By providing a single place where both technology professionals and the public can see and appreciate the number of such recognitions, we hope to add value to and support all such programs. The directory would also provide an electronic form for the benefit of those wishing to contribute an entry.

Support from local Sections will be critical in supplying much of the information required. However, we believe that the end result will be worth the effort. We hope to make rapid progress in making the IEEE Canada Milestones and Landmarks Directory a reality during the next year.

IEEE Canada Museums and Archives Directory

Canadian museums and archives host important collections of artifacts and records concerning technology, its history, and its impacts on and implications for Canadian society. However, many museums and archives with important collections are very small and lack resources to promote themselves. Technology professionals and members of the public do not have a simple way of locating museums and archives of particular interest to them.

The IEEE Canada History Committee proposes establishing a directory of Canadian Museums and Archives on the IEEE Canada website with collections relevant to the history of technology. Like the Milestones and Landmarks Directory, it would include more detailed information concerning each museum or archive with a particular emphasis on information useful to those wanting to visit the museum or archive in person. The directory would also provide an electronic form for the benefit of those wishing to contribute an entry.

Support from local Sections will be critical in supplying much of the information required. However, we believe that the end result will be worth the effort. We hope to make rapid progress in making the IEEE Canada Museums and Archives Directory a reality during the next year. ■

About the Author



David G. Michelson is the IEEE Canada Historian and chair of the IEEE Canada History Committee. An active contributor to the history of technology for two decades, he has been a member or associate member of the IEEE History Committee since 2012 and is responsible for more than one quarter of the 17 IEEE Milestones that recognize Canadian technology achievements. He is also a member of the Society for the History of Technology (and its Special Interest Group on Telecommunications History) and a member of the History and Archives Committee of the Engineering Institute of Canada. Prof. Michelson's research interests in this area include the historiography of contemporary science and technology, the development and impact of Canadian science and technology since the Second World War, and the development and impact of both wireless technology and space technology since the Second World War. He can be contacted at dmichelson@ieee.org or historian@ieee.ca.

IMPORTANT UPDATES

IEEE Canadian Review (*ICR*) is now a "default-digital" publication.

What does this mean?

- All IEEE Canada members will receive *ICR* in digital formats, either through the website or through the IEEE app.
- Members who have explicitly requested not to receive electronic communication will not receive the digital copies. Default mail delivery of print copies will be discontinued to those members in the future. Members are encouraged to opt in for print copies or modify their electronic communication preferences to receive digital copies.
- A print copy will be delivered only to those full-grade members who request it. This will be provided free of additional costs (included in the annual membership fee). Members can opt in for print or digital copies through IEEE membership renewal web page.

Radio Science in Canada



by David G. Michelson

The International Union of Radio Science (abbreviated URSI, after its French name, Union Radio-Scientifique Internationale) has a long history of cooperating with IEEE to advance international cooperation in the study of electromagnetic fields and waves. This month's column focuses on the URSI–International Telecommunications Union (ITU) Inter-Union Working Group that has been formed to strengthen the URSI–ITU relationship.

URSI–ITU INTER-UNION WORKING GROUP FORMED

Since the earliest days of telecommunications, international bodies have been established to resolve disputes, recommend best practices, and develop technical standards. For example, in 1865, the International Telegraph Union was formed to standardize telegraph equipment, establish Morse code as the international telegraph alphabet, and ensure the privacy of communication.

In 1920, the Union Radio-Scientifique Internationale/International Union of Radio Science (URSI) was formed to coordinate foundational research concerning electromagnetic waves, including work related to antenna design, radio propagation, and atmospheric interference. URSI continues to encourage and coordinate international activity in radio science and its applications as well as the adoption of common measurement methods and instruments. URSI also coordinates studies of the scientific aspects of telecommunications using electromagnetic waves.

In 1932, the International Telegraph Union broadened to include radio communications and telephony, and it changed its name to the International Telecommunications Union (ITU). In 1949, it became a specialized agency of the United Nations, and it now has a membership that includes 193 countries and about 900 businesses, academic institutions, and international and regional organizations. Among its many roles, the ITU promotes the shared global use of the radio spectrum, facilitates international cooperation in assigning satellite orbits, develops worldwide technical standards, and supports improvements to telecommunication infrastructure in the developing world.

The study groups (SGs) of the ITU Radiocommunication Sector (ITU-R) bring together researchers to resolve technical questions arising from world and regional radiocommunication conferences, advances in radiocommunication technology or spectrum management, and changes in radio usage or operation. Such questions are generally seeking a recommendation, handbook, or report from an SG. The SGs particularly relevant to URSI include SG 3 and SG 7:

- SG 3—Radio Wave Propagation is concerned with the propagation of radio waves in ionized and nonionized media and the characteristics of radio noise for the purpose of improving radiocommunication systems. It is divided into four working parties (WPs): WP 3J—Propagation Fundamentals, WP 3K—Point-to-Area Propagation, WP 3L—Ionospheric Propagation and Radio Noise, and WP 3M—Point-to-Point and Earth–Space Propagation.
- SG 7—Science Services is concerned with the standard frequency and time signal, space research, space operation, Earth exploration satellite, meteorological satellite, meteorological aids, and radio astronomy services. It is divided into four WPs: WP 7A—Time Signals and Frequency Standard Emissions, WP 7B—Space Radiocommunication Applications, WP 7C—Remote Sensing Systems, and WP 7D—Radio Astronomy.

URSI continues to encourage and coordinate international activity in radio science and its applications as well as the adoption of common measurement methods and instruments.

COOPERATING TO ADDRESS COMPLEXITY

ITU and URSI have always cooperated, with URSI being ITU's primary scientific partner. Now, with wireless technologies become increasingly complex and the demand for wireless spectrum becoming increasingly urgent, the work of the ITU-R SGs in helping to resolve questions raised at World Radiocommunication Conferences and other meetings has greatly increased.

The categories used to identify the priority and urgency of the questions to be studied include the following:

- *C*: conference-oriented questions associated with work related to specific preparations for and decisions of world and regional radiocommunication conferences
  - *C*1: very urgent and priority studies, required for the next World Radiocommunication Conference
  - *C*2: urgent studies, expected to be required for other radiocommunication conferences
- *S*: questions that are intended to respond to matters referred to the Radiocommunication Assembly by the Plenipotentiary Conference, any other conference, the Council, or the Radio Regulations Board; advances in radiocommunication technology or spectrum management; and changes in radio usage or operation
  - *S*1: urgent studies that are intended to be completed within two years
  - *S*2: important studies, necessary for the development of radiocommunications
  - *S*3: required studies, expected to facilitate the development of radiocommunications.

ITU and URSI are looking to make more researchers and research consortia aware of these questions and encourage them to work together to contribute research results that will help resolve them. To this end, URSI and ITU have formed an Inter-Union Working Group mandated to help ITU more effectively engage the global community of researchers addressing the development, standardization, and deployment of next-generation wireless communications, including 5G and 6G cellular networks.

The URSI–ITU Inter-Union Working Group is chaired by Prof. David Michelson of the University of British Columbia (Canada). URSI representatives include Prof. Sana Salous of Durham University (United Kingdom), Prof. Carlo Riva of Politecnico di Milano (Italy), Prof. Terje Tjelta of the University of Oslo (Norway), and Dr. Ivica Stevanovic of the Federal Office of Communications (Switzerland).

ITU and URSI are looking to make more researchers and research consortia aware of these questions and encourage them to work together to contribute research results that will help resolve them.

ITU-R representatives include Sergio Buonomo, chief of the SG Department at the Radiocommunication Bureau of the ITU; Carol Wilson, chair of SG 3—Radio Wave Propagation; and David Botha, counsellor of SG 3. Other ITU-R SG chairs and counsellors will be invited to participate as required.

During the next year, the new working group will consult with stakeholders within URSI, ITU, and relevant member communities as it prepares its initial strategic plan. The working group will present the plan for approval by the URSI Council at the next URSI General Assembly and Scientific Symposium in Sapporo, Japan, in August 2023. ■

The National Research Council of Canada is the adhering body for Canadian membership in URSI and appoints the members of the Canadian National Committee of URSI.

For more information about URSI International, please visit https://www.ursi.org/.

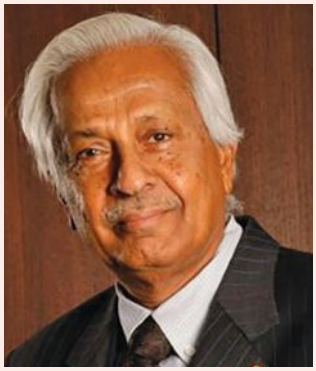
For more information about URSI Canada, please visit https://ursi.ca/.

About the Author



David G. Michelson (davem@ece.ubc.ca) is president of the Canadian National Committee of the International Union of Radio Science (2018–2024). He has led the Radio Science Lab at the Department of Electrical and Computer Engineering, University of British Columbia (UBC), since 2003. His current research focuses on short-range/low-power wireless networks for industrial vertical and transportation applications, millimetre-wave channels and systems, and satellite networks for communications and remote sensing. Prof. Michelson currently serves as a member of the Board of Governors of the IEEE Vehicular Technology Society, as a member of the Steering Committee of the National Institute of Standards and Technology–sponsored NextG Channel Model Alliance, as director of the AURORA Smart Transportation Testbed, and as principal investigator of the Campus as a Wireless Living Lab project at UBC.

M.N.S. Swamy Receives the 2021 IEEE Circuits and Systems Society Mac Van Valkenburg Award



Prof. M.N.S. Swamy, Fellow, IEEE, received the Mac Van Valkenburg Award "for his pioneering and lifelong contributions, particularly in multidimensional signal processing, distributed parameter networks, graph theory, discrete transforms, and image processing. For nearly six decades of outstanding contributions to education and for lifelong dedication to the service of the IEEE Circuits and Systems Society."

Prof. Swamy received his B.Sc. (Hons.) degree in mathematics from the University of Mysore, India; his diploma degree in electrical communication engineering from the Indian Institute of Science, Bangalore; and his M.Sc. and Ph.D. degrees in electrical engineering from the University of Saskatchewan, Saskatoon, SK. He is currently a research professor and tier I research chair at Concordia University. Read more about Prof. Swamy at http://users.encs.concordia.ca/~swamy/.

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