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Celebrating Autumn 2023

IEEE Canada Awards

ICF Honor Roll

Peer-to-Peer Energy

IEEE Canada
The Institute of Electrical and Electronic Engineers Inc.

President's Message/Message du Président

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

Warm greetings to my friends, colleagues, and fellow IEEE Canada members. This is my final article as the President of IEEE Canada and Region 7 (R7) Director. It has been an honour and a privilege to serve all members of IEEE Canada over the last two years. I got to meet members from across the country and around the world. In this article, I recap a few key events that happened over the year.

I want to start by celebrating some of the many contributions of outstanding Canadians. Starting with IEEE Awards, I have several people to recognize. First, congratulations to Kamal Al-Haddad for winning the IEEE Medal in Power Engineering. Kamal was recognized for contributions to power electronics converters for power quality and industrial applications. Second, for the first time that I can remember, Dr. Maike Luiken received both the MGA William W. Middleton Distinguished Service Award and IEEE Canada Wallace S. Read Service Award. Maike received these awards for her service, exemplary leadership, and

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Mes salutations amicales à mes amis, collègues et membres de l'IEEE Canada. Cet article marque la fin de mon mandat en tant que président de l'IEEE Canada et directeur de la région 7 (R7). C'était un véritable honneur et un privilège de servir tous les membres de l'IEEE Canada pendant les deux dernières années. J'ai eu la possibilité de rencontrer des individus de toutes les régions du pays et de tous les coins de la planète. Je résume ici quelques événements importants qui se sont déroulés au cours de l'année.

Je tiens d'abord à souligner certaines des nombreuses contributions de Canadiens exceptionnels. En commençant par les IEEE Awards, j'ai plusieurs personnes à reconnaître. Tout d'abord, je tiens à féliciter Kamal Al-Haddad pour sa médaille IEEE en génie énergétique. Kamal a été récompensé pour ses contributions à la conception de convertisseurs électroniques de puissance, en mettant l'accent sur la qualité de l'alimentation et les applications industrielles. De plus, pour la première fois de ma

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commitment to Member and Geographic Activities, IEEE members and the public, and for championing technological solutions to sustainable development and climate change challenges. The Engineering Institute of Canada (EIC) gave out its awards and awarded fellows of EIC during the month of May in Ottawa. Congratulations to all award winners and fellows. Thanks to everyone who submitted a nomination, and I hope you will do the same in 2024 and beyond.

Rob Anderson (left) handing over Presidential Gavel' to Tom Murad (right).

Tom Murad (à droite) reçoit le marteau présidentiel de la part de Tom Anderson (à gauche).

Back in June 2018, IEEE Canada was awarded the 2020 Sections Congress, which was to be held in Ottawa. Unfortunately, this was cancelled due to the COVID-19 pandemic. In 2022, we were informed that Ottawa would host the 2023 Sections Congress. IEEE volunteer leaders from around world gathered between 11 and 13 August to exchange ideas and learn about the products and programs that IEEE offers to members in their local areas. The theme for this year's event was "Enabling Leaders to Build a Sustainable Future." There were almost 1,100 attendees in the Shaw Convention Centre. I want to thank Alberto Sanchez and his team for their efforts in hosting a very successful event. Everyone who I had a chance to meet spoke very highly of the program, venue, and city. The day before the Congress started, IEEE Canada hosted a tour of the Ingenium Centre in Ottawa. If you are ever in Ottawa, this is a wonderful look at technology throughout history. It's worth the trip. Congratulations to everyone involved.

The Engineering Institute of Canada gave out its awards and awarded fellows of EIC during the month of May in Ottawa.

Our publications continue to be very strong. *IEEE Canadian Review* (*ICR*) continues to come out three times a year. This is a general interest magazine that provides opportunities for topics of interest to Canadians. If you have an idea for an article, please contact the editor-in-chief. It is available digitally to your e-mail, can be found online at ieee.ca under activities/publications, and is available upon special request in hard copy. There is also an archive of past issues available on the IEEE Canada webpage. *ICR*'s sister publication, *IEEE Canadian Journal on Electrical and Computer Engineering* (*ICJECE*), is also published three times a year. *ICJECE* is a technical journal where Canadian authors and researchers can publish their technical activities and findings. I am pleased to report that this past year it achieved a new height in impact factor (IF). IF is a measure of the frequency with which the average article in a journal has been cited in a

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mémoire, M. Maike Luiken a reçu le prix de reconnaissance pour services exceptionnels MGA William W. Middleton et le prix de service Wallace S. Read de l'IEEE Canada. Maike a été récompensée pour ses états de service, son leadership exemplaire et son engagement envers les membres et les activités géographiques, les membres de l'IEEE et le public, en plus de promouvoir des solutions technologiques aux défis du développement durable et du changement climatique. Le mois de mai a été marqué par la cérémonie de remise des prix et de remise de bourses d'études de Institut canadien des ingénieurs (ICI) à Ottawa. . Toutes mes félicitations à tous les gagnants et à tous les bénéficiaires d'une bourse. Je tiens à remercier chaleureusement tous ceux qui ont soumis une candidature. J'espère que vous ferez de même en 2024 et pour les années à venir.

En juin 2018, IEEE Canada a été choisi pour accueillir le Congrès des sections 2020, qui était prévu à Ottawa. Malheureusement, cela a été annulé en raison de la pandémie de COVID-19. Il a été annoncé en 2022 que le Congrès des sections aurait lieu à Ottawa en 2023. Dans le but de partager des idées et d'en apprendre davantage sur les produits et les programmes offerts aux membres de l'IEEE dans leur région, les dirigeants bénévoles de l'IEEE du monde entier se sont rassemblés entre le 11 et le 13 août. Près de 1 100 personnes ont participé à l'événement de cette année, qui avait pour thème « Permettre aux leaders de bâtir un avenir durable ». Je suis reconnaissant envers Alberto Sanchez et son équipe pour leur travail remarquable dans l'organisation d'un événement de grande qualité. Tous les individus que j'ai eu la chance de rencontrer ont exprimé des éloges très positifs à propos du programme, du site et de la ville. Une visite du Centre Ingenium à Ottawa a été organisée par IEEE Canada avant le Congrès. Si vous avez l'occasion de vous rendre à Ottawa, c'est un regard fascinant sur l'évolution de la technologie tout au long de l'histoire. Cela en vaut vraiment la peine. Félicitations à tous les participants.

Nos publications demeurent très solides. Trois fois par an, la revue IEEE Canadian Review (ICR) est publiée. Ce magazine d'intérêt général offre une grande variété de sujets d'intérêt pour les Canadiens. Si vous avez une idée d'article, veuillez contacter le rédacteur en chef. Il est disponible sous forme numérique à votre adresse électronique, il peut être consulté en ligne à ieee.ca sous activités/publications, et il est disponible sur demande spéciale en version papier. La page web de l'IEEE Canada propose également une archive des numéros passés. La revue sœur de l'ICR, IEEE Canadian Journal on Electrical and Computer Engineering (ICJECE), est également mise en ligne trois fois par an. L'ICJECE est une revue technique qui permet aux auteurs et aux chercheurs canadiens de publier leurs activités techniques et

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particular year. It is used to measure the importance or rank of a journal by calculating the times its articles are cited.

I want to personally thank Jahangir Khan and Mohamed Shehata, editors-in-chief of *ICR* and *ICJECE*, respectively, for the hours of dedication and hard work they have both put into these publications. Without you both, these magazines would not be where they are today.

I am also happy to report that the 2023 IEEE Canada Conference on Electrical and Computer Engineering (CCECE 2023) was successfully held from 24 to 27 September. IEEE Canada was again able to hold this 36th annual flagship conference face-to-face in Regina. In addition to the numerous papers presented, there were three tutorials and two panel discussions held in conjunction with the conference. Panel Session 1 was "Indigenous Ways of Knowing Engineering." Moderated by Leanne Bellegarde with panelists John Desjarlais, Dennis Michaelson, and Edward Doolittle, it focused on the diverse complex ways of indigenous teaching and learning. Panel Session 2 was "Socio-Economical Impact due to Initiatives towards Green Engineering." Moderated by Dr. Samantha Sriyananda with panelists Dr. Robert Crawhall, Dr. Maike Luiken, Dr. Richard Boudreault, and Dr. Siddharth Pandey, it focused on the need to understand how engineering design decisions influence the environment positively or negatively. These two panels align nicely with IEEE's mission "advancing technology for the benefit of humanity" and IEEE climate activities, which can be found at https://climate-change.ieee.org/.

As a part of CCECE 2023, the IEEE Canada Awards Gala was hosted at the University of Regina's Innovation Place and chaired by Dr. Om Malik. Dr. Yu Sun was this year's A.G.L. McNaughton Award Gold Medal winner, but he was unable to join us in Regina at the Gala due to a previous commitment. I want to congratulate him and all the other winners of these prestigious awards. IEEE Canada is extremely grateful to all those who submitted and endorsed this year's nominees and encourages all its members to nominate again in the coming year.

I want to thank Raman Paranjape, Dr. Kim-Choong Yow, and the rest of the organizing committee for making this year's edition of CCECE a success.

The Region started a project last year to update the IEEE Canada website. The Executive Committee (ExCom), under IEEE Canada Secretary Michael Lamoureux leadership, updated the content of the main pages of the website. This year, we're following that up with a new design and development. It is time for a fresh look and better tools, so IEEE Canada decided to start a Student Web Competition. Who is better equipped to create a new site than today's tech-savvy students? The competition closes early in 2024 and will select the new design shortly thereafter. Stay tuned for a brand-new look for IEEE Canada's website.

Other highlights from the past two years include the following:

- The approval of a five-point strategic plan. It is the hope that all our future projects will align with our strategic plan.
- The creation of IEEE Canada Press, which focuses on filling the gap between technology and the humanities. It will do so by publishing important works concerning technology, its history, and its impacts on and implications for Canadian society.
- The streamlining of governing documents and governance structure to reduce some of the bureaucracy and overhead.

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leurs résultats. Je suis ravi de vous annoncer que l'année dernière, il a atteint un nouveau sommet en termes de facteur d'impact (FI). La mesure FI est utilisée pour évaluer la fréquence à laquelle l'article été cité en moyenne dans une revue a été cité au cours d'une année donnée. On utilise cette méthode pour évaluer l'importance ou le rang d'une revue en mesurant la fréquence à laquelle ses articles sont cités.

Je souhaite exprimer ma gratitude envers Jahangir Khan et Mohamed Shehata, respectivement rédacteurs en chef de l'ICR et de l'ICJECE, pour leurs efforts considérables et leur dévouement à ces publications. Sans votre contribution, ces magazines ne seraient pas là où ils se trouvent actuellement.

Je suis également ravi de vous annoncer que la Conférence 2023 de l'IEEE Canada sur le génie électrique et informatique (CCECE 2023) s'est déroulée avec succès du 24 au 27 septembre. La 36e conférence annuelle phare d'IEEE Canada a eu lieu en personne à Regina. Parallèlement à la conférence, trois tutoriels et deux tables rondes ont été organisés. La première réunion du groupe d'experts s'intitulait « Les méthodes indigènes d'apprentissage et d'enseignement de l'ingénierie ». Animée par Leanne Bellegarde avec les panélistes John Desjarlais, Dennis Michaelson et Edward Doolittle, elle explorait les diverses manières complexes d'enseignement et d'apprentissage autochtones. La deuxième séance du groupe d'experts portait sur « l'impact socio-économique des initiatives d'ingénierie verte ». Animée par la Dre Samantha Sriyananda et animée par les panélistes Robert Crawhall, Maike Luiken, Richard Boudreault et Siddharth Pandey, elle portait sur la nécessité de comprendre comment les décisions en matière de conception technique influent positivement ou négativement sur l'environnement. La mission de l'IEEE, à savoir « faire progresser la technologie au profit de l'humanité » et les activités climatiques de l'IEEE, sont parfaitement alignées avec ces deux panels.

M. Om Malik a été le président du gala de remise des prix de l'IEEE Canada qui s'est tenu à l'Innovation Place de l'Université de Regina dans le cadre du CCECE 2023. Le Dr. Yu Sun a décroché la médaille d'or du prix A.G.L. McNaughton cette année, mais il a manqué à l'appel lors du gala à Regina en raison d'un engagement antérieur. Je tiens à le féliciter, ainsi que tous les autres lauréats de ces prestigieux prix. IEEE Canada tient à exprimer sa profonde gratitude envers tous ceux qui ont présenté et approuvé les candidats de cette année et encourage tous ses membres à soumettre de nouveau leur candidature au cours de la prochaine année.

Je suis reconnaissant envers Raman Paranjape, le Dr. Kim-Choong Yow et le reste du comité organisateur pour avoir rendu cette édition exceptionnelle.

L'année dernière, la Région a entrepris un projet visant à mettre à jour le site Web de l'IEEE Canada. Le Comité exécutif (ExCom), dirigé par le secrétaire de l'IEEE Canada Michael Lamoureux, a effectué des changements majeurs dans le contenu des pages principales du site Web. Cette année, nous effectuons un suivi en utilisant un nouveau design et un nouveau développement. IEEE Canada a décidé de lancer un concours Web étudiant afin de donner un nouveau regard et de meilleurs outils. Qui est mieux outillé pour concevoir un tout nouveau site que les étudiants technophiles d'aujourd'hui? Le concours prendra fin au début de 2024 et le nouveau design sera sélectionné peu de temps après.

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President's Message/Message du Président

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- The return to face-to-face Region board meetings in 2022, which continued in 2023. This included our two board meetings per year and our annual ExCom and Student Congress.
- The continued fostering of relationships with industry, government, and other professional Societies such as the EIC, Partnership Group for Science and Engineering, Canadian Heads of Electrical and Computer Engineering, and Destination Canada.

In 2024, we will welcome Thamir "Tom" F. Murad from the Toronto Section as IEEE Canada President/R7 Director for 2024–2025.

Welcome to the new president and president-elect. In 2024, we will welcome Thamir "Tom" F. Murad from the Toronto Section as IEEE Canada President/R7 Director for 2024–2025. Our 2024–2025 IEEE Canada President-Elect/R7 Director-Elect is Wahab Almuhtadi from the Ottawa Section. This is also an

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Restez attentif pour découvrir une toute nouvelle version du site Web de l'IEEE Canada.

Voici quelques faits marquants des deux dernières années :

- L'approbation d'un plan d'action en cinq points. Nous souhaitons que tous nos projets futurs s'intègrent parfaitement à notre plan stratégique.
- IEEE Canada Press a été créé dans le but de combler le fossé entre la technologie et les sciences humaines. Dans cette optique, il éditera des ouvrages majeurs sur la technologie, son histoire et ses répercussions sur la société canadienne.
- La rationalisation des documents de gouvernance et de la structure de gouvernance est essentielle pour réduire une partie de la bureaucratie et des coûts généraux.
- Le conseil régional a décidé de renouer avec les réunions en personne en 2022, et cette décision a été maintenue en 2023. Cela englobait nos deux réunions annuelles du conseil d'administration, ainsi que notre congrès annuel du Comité exécutif et des étudiants.
- la poursuite de la promotion des relations avec l'industrie, le gouvernement et d'autres sociétés professionnelles, comme l'EIC, le Partnership Group for Science and Engineering, les responsable canadiens du génie électrique et informatique et Destination Canada.

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IEEE Canadian Review
La revue canadienne de l'IEEE

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To inform Canadian members of IEEE on issues related to the impacts of technology and its role in supporting economic development and societal benefits within Canada. To foster growth in the size and quality of Canada's pool of technology professionals to serve our increasingly knowledge-based economy.

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President's Message/Message du Président

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opportunity for me to welcome all the new and reappointed volunteers to the 2024 IEEE Canada/R7 Board of Directors and its committees.

On 31 December 2023, Dr. Jason Gu will have completed his term as 2022–2023 IEEE Canada Past-President/R7 Past-Director. I want to thank Jason for his dedication and service to IEEE. I would also like to express my appreciation and gratitude to all past R7 volunteers for their willingness to serve our professional community and share their ideas, enthusiasm, effort, and energy.

It has been my pleasure to work with the volunteers and members for the last two unforgettable years. In closing, thank you for investing your vote and confidence in me to lead IEEE Canada. It has been a rewarding and exciting journey. ■

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

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Bienvenue au nouveau président et au président élu. En 2024, nous accueillerons Thamir « Tom » F. Murad, de la section de Toronto, à titre de président de l'IEEE Canada et directeur de la R7 pour 2024-2025. Pour les deux années à venir, Wahab Almuhtadi, de la section d'Ottawa, sera le président élu de l'IEEE Canada et le directeur élu pour R7. C'est également l'occasion pour moi de souhaiter la bienvenue à tous les bénévoles nouvellement nommés et renouvelés au conseil d'administration de 2024 de l'IEEE Canada/R7 et à ses comités.

Le 31 décembre 2023 marquera la fin du mandat de M. Jason Gu en tant que Président sortant de l'IEEE Canada pour 2022-2023/Directeur sortant de l'IEEE Canada/R7. Je suis reconnaissant envers Jason pour son dévouement et son service à l'IEEE. Je suis reconnaissant envers tous les anciens bénévoles de R7 pour leur dévouement à servir notre communauté professionnelle et à partager leurs idées, leur enthousiasme, leurs efforts et leur énergie.

Travailler avec les bénévoles et les membres depuis deux ans a été un plaisir pour moi. Je vous suis reconnaissant d'avoir exprimé votre vote et votre confiance en moi pour assumer la direction de l'IEEE Canada. J'ai vécu une expérience enrichissante et passionnante. ■

Robert (Rob) Anderson, P.Eng., SMIEEE
2022 -2023 Président de l'IEEE Canada
2022–2023 Région 7 Directeur

A Few Words From the Editor-in-Chief / Quelques mots du rédacteur en chef

Jahangir Khan, Ph.D., P.Eng., SMIEEE
mjakhan@ieee.org

As we bid farewell to 2023 and welcome 2024, this edition of *IEEE Canadian Review* (*ICR*) reflects on the great achievements of our distinguished members and celebrates the power of giving. The "IEEE Canada Awards" column, like in previous years, is dedicated to the award winners. I congratulate them all for their commitment, dedication, and contributions. The "ICF Honor Roll" column is another recognition of the enormous contributions made by benevolent donors across Canada. I thank all the contributors and encourage all to donate to this important mission.

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En nous apprêtant à faire nos adieux à 2023 et à accueillir 2024, cette édition de la Revue canadienne de l'IEEE (ICR) met en lumière les remarquables réalisations de nos membres distingués et célèbre le pouvoir du don. Comme les années précédentes, la colonne « Prix de l'IEEE Canada » est réservée aux lauréats. Je leur adresse toutes mes félicitations pour leur engagement, leur dévouement et leur contribution. Une autre reconnaissance des énormes apports faits par les donateurs bénévoles à travers le Canada est la colonne « Tableau d'honneur

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A Few Words From the Editor-in-Chief / Quelques mots du rédacteur en chef

(A Few Words From the Editor-in-Chief cont'd from p. 6)

Jabbar Baig's timely column on blockchain-based peer-to-peer energy trading, Jon Rokne's continued mathematical journey on slide rules, and Terrance Malkinson's article on nuclear fusion energy are also in this edition to provoke your thoughts on a multitude of scientific and technical domains. Hope you will enjoy those, and if so, please share your thoughts with the authors.

I had a great opportunity to meet the IEEE Canada leaders and volunteers at IEEE Region 7 Fall 2023 Board Meeting held in Montréal. Our new president, Thamir "Tom" F. Murad, takes office in 2024 as current President Rob Anderson finishes his term in 2023. We are excited to have Wahab Almuhtadi as the new President Elect. Our Past-President Jason Gu also completes his term in 2023. I want to thank both Rob and Jason for their guidance, support, and contributions to *ICR*. Despite their busy schedules, they always had time to write the "President's Message" column and respond to various editorial matters. I am also excited to start working with Tom in 2024 and beyond. A special shoutout goes to the Publications and Communication Group Chair Ahmed Refaey Hussein who provided all the necessary support when needed.

Our heart goes out to all the IEEE Canada members and colleagues who have been affected by the global conflicts happening in Palestine, Israel, Russia, Ukraine, and Myanmar.

Led by Guest Editor David G. Michelson, a special edition of *ICR* featuring "Naval and Maritime Technology in Canada" was published this fall. Even though it was originally targeted for summer, it had to wait until all the excellent contributions of the authors took shape. I am sure the top-notch thematic articles will compensate for this slight delay.

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

de l'ICF ». Je tiens à exprimer ma gratitude envers tous les contributeurs et les exhorte à faire un don à cette mission d'une grande importance.

La chronique pertinente de Jabbar Baig sur le commerce d'énergie pair à pair basé sur la blockchain, Jon Rokne poursuit son parcours mathématique en explorant les règles à calcul et pour stimuler votre réflexion sur de nombreux domaines scientifiques et techniques, l'article de Terrance Malkinson sur l'énergie de fusion nucléaire est inclus dans ce numéro. J'espère que vous les aimerez, et si tel est le cas, partagez vos réflexions avec les auteurs.

J'ai eu la chance de rencontrer les membres du conseil d'administration et les bénévoles de l'IEEE Canada lors de la réunion du conseil d'administration de la région 7 de l'IEEE à Montréal en automne 2023. Le nouveau président, Thamir « Tom » F. Murad, prendra ses fonctions en 2024, tandis que l'actuel président Rob Anderson quittera ses fonctions en 2023. C'est avec une grande joie que nous accueillons Wahab Almuhtadi comme nouveau président élu. Le mandat de notre président sortant Jason Gu s'achève également en 2023. Je tiens à remercier Rob et Jason pour leurs conseils, leur soutien et leurs contributions à l'IC. Bien qu'ils aient un emploi du temps chargé, ils ont toujours eu le temps d'écrire la chronique « Message du président » et de répondre à diverses questions éditoriales. Je suis également ravi de commencer à travailler avec Tom en 2024 et au-delà. Je tiens à remercier chaleureusement le président du Groupe des publications et de la communication, Ahmed Refaey Hussein, pour son soutien inestimable en cas de besoin.

Dirigée par David G. Michelson, rédacteur en chef invité, une édition spéciale de l'IC intitulée « Naval and Maritime Technology in Canada » a été publiée cet automne. Malgré le fait qu'il était prévu pour l'été, il a fallu patienter jusqu'à ce que toutes les excellentes contributions des auteurs se concrétisent. Je suis persuadé que les articles thématiques de premier choix compenseront ce léger retard.

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A Few Words From the Editor-in-Chief / Quelques mots du rédacteur en chef

(A Few Words From the Editor-in-Chief cont'd from p. 7)

It would be an understatement to say that 2023 was a tumultuous year, looking at the geopolitical events throughout the world. Our heart goes out to all the IEEE Canada members and colleagues who have been affected by the global conflicts happening in Palestine, Israel, Russia, Ukraine, and Myanmar. I hope the new year will bring an end to these tragedies.

As mentioned in the "President's Message," 2023 was a great year for IEEE Canada, geared toward recovery from the COVID-19 pandemic-induced slowdown. We expect this trend to continue in 2024. I am looking forward to more engagements, interesting articles, and thoughtful discussions. Please share your comments and feedback at icr@ieee.ca. ■

(Quelques mots du rédacteur en chef suite de p. 7)

Il est indéniable que l'année 2023 a été tumultueuse, en raison des événements géopolitiques qui ont eu lieu à travers le monde. Nous exprimons notre soutien total envers tous les membres et collègues de l'IEEE Canada qui sont affectés par les conflits mondiaux en Palestine, en Israël, en Russie, en Ukraine et au Myanmar. J'espère que cette nouvelle année mettra un terme à ces tragédies.

D'après le message du président, l'IEEE Canada a connu une année 2023 exceptionnelle, axée sur la reprise après le ralentissement provoqué par la pandémie de COVID-19. En 2024, nous prévoyons que cette tendance se maintienne. J'attends avec impatience d'autres engagements, des articles captivants et des discussions réfléchies. N'hésitez pas à nous faire part de vos commentaires à icr@ieee.ca. ■

A Special Message from Dr. Thamir (Tom) Murad, IEEE Canada President

Thamir (Tom) Murad
P.Eng., F.E.C., SMIEEE

2024–2025 IEEE Canada President and Region 7 Director

Dear IEEE Canada Colleagues,

I am honored to be the IEEE Canada (Region 7) president in 2024 and 2025 and to work with you to further IEEE's mission to advance technology for the benefit of humanity. Indeed, we live in a complicated world with growing mandates and needs, and we definitely have much to accomplish.

The years 2022 and 2023 have been very helpful transitional years as we gradually returned to more in-person meetings and events while, at the same time, continuing to take advantage of advancing technologies that allow us to also work and gather remotely. I believe this combination of in-person and remote meetings will not only allow more volunteers and partners to participate in IEEE's important work but also help to efficiently reduce our carbon footprint.

Indeed, we live in a complicated world with growing mandates and needs, and we definitely have much to accomplish.

I have had the privilege in the last two years of working with the existing IEEE Canada leadership, most specifically President Robert Anderson, and learned a lot about what has to be done and how to achieve the best. In the years to come, I hope that we can continue what we started after the pandemic times and expand our impact on important Canadian and global imperatives, including humanitarian activities for the greater good of all, with excellence, efficiency, and integrity.

By this time, you may be familiar with my ambitions and goals as the incoming president. These may include the following:

- Engineering education and skills enhancement in Canada, as it has always been my passion to prepare our existing technical workforce as well as future generations of Canadian engineers and data scientists to keep up with the fast pace of technology advancement in various areas and applications.
- Empowering our new generations of engineers and experts through adequate mentorship and coaching, with the proper leadership and technical knowledge to secure dignified and sustainable jobs and position them well in Canadian industry as well as research and academia.
- Providing greater value to existing and future industry IEEE Members and to those working on the practical applications and implementation of technology so that they can be actively contributing members and volunteers for the betterment of IEEE's status, engineering communities, and a sustainable Canadian economy.
- Increasing the focus on the retention of younger members, Women in Engineering, and other affinity groups by strengthening our relevance in their professional and personal lives as well as providing them with wider opportunities to grow and make a positive impact on society at large.
- Increasing the general public's awareness about who we are and the technological expertise we provide to the world as well as the impact of engineers on their day-to-day lives and economic prosperity.
- Making important and strategic investments in new resources, processes, and services that can enable IEEE to continue its positive impact on the technological world in which we live and work.
- Finally, I sincerely believe that volunteers are the lifeblood of IEEE. Positioning them well, appreciating their contributions, and recognizing their achievements equally and fairly in both industry and academia is a prime focus of my leadership plan.

Thank you again for all you do, and I encourage you all to keep in touch and provide me with your valuable ideas.

Thank you again for all you do, and I encourage you all to keep in touch and provide me with your valuable ideas. I am looking forward to meeting as many of you as possible in the new year while collaborating on our successful and impactful events, conferences, and other social gatherings. ■

Thamir (Tom) Murad
P.Eng., F.E.C., SMIEEE
2024–2025 IEEE Canada President
2024–2025 Region 7 Director

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Blockchain-Based Peer-to-Peer Energy Trading

by Mirza Jabbar Aziz Baig

The use of renewable energy sources is replacing traditional methods of energy generation in the global energy sector. Prosumers have taken over the role of consumers who previously used to purchase energy from utilities. This results in the creation of a decentralized energy market. Direct purchases of energy are now possible between consumers. An energy exchange directly between buyers and sellers is known as *peer-to-peer* (*P2P*) energy trading. We refer to prosumers and consumers as peers. Peers trade energy among themselves without any assistance of a mediator, which is not the case in the traditional energy market.

There is usually a national level to set for energy market prices in the traditional grid. However, it is the participants in P2P energy trading who decide how the prices will be determined, which can be even less than the traditional market price. P2P energy trading platforms allow users to enjoy complete trading autonomy, financial security, and pricing freedom as well as the flexibility of choosing the most appropriate times for trading sessions. It is a significant feature of P2P energy trading that it facilitates the trade of energy between prosumers in a similar manner to the exchange of goods and services. This results in a return on their investments. Energy trading on a P2P basis has become a major tool for energy management in smart grids. P2P energy trading platforms enable prosumers to trade energy broadly or within a particular community. Microgrids are deemed suitable for P2P energy trading.

A conventional power system uses megawatt-sized power plants in remote regions to generate electricity and then transport

it to end users over long distances through the utility grid. Electricity transmits from producers to consumers; cash flows the other way. The traditional system of transmission and energy exchange involves a unidirectional flow of energy as well as cash. Developments in renewable energy technology have led to market decentralization in the energy sector. Aside from this, traditional energy production methods, such as natural gas, hydropower, coal, etc., result in high transmission losses as well as environmental degradation. As an alternative, renewable energy solutions are environmentally friendly and allow the consumer to control power production and consumption. The electricity market is increasingly dominated by distributed generation.

It is undeniable that renewable energy sources have had a significant impact on the conventional electricity market. Despite this, they have not managed to catch the entire market for conventional electricity.

There will be a need for several new market approaches as distributed energy resources become more prevalent in the residential sector. It is imperative that this newly emerging concept of the energy market be supported by a P2P energy trading platform for trading energy. An exciting revolution is taking place in the P2P energy market due to the Internet of Things (IoT) and blockchain technology. Blockchain technology enables financial transactions to be conducted independently. On the other hand, the IoT and smart devices are low-cost means of transferring energy.

The IoT

Generally speaking, the *IoT* refers to the concept of connecting devices to the Internet. By automating the things, it minimizes the need for human intervention. The result will be improved service and information. The IoT is the process of connecting people, objects, etc., to the Internet and storing information to process and analyze it. Sensors and communication technologies enable the IoT to communicate with things. An autonomous response is generated by objects without the involvement of humans, resulting in a higher level of efficiency. With the advent of the IoT, many traditional methods of living have been transformed. Through the use of the IoT, cities, energy conservation, homes, pollution control, smart transportation, and industries have undergone remarkable transformations. Information and data exchange and control functions are represented in Figure 1 by connections between various smart platforms and the IoT server. As we move through our daily lives, we are constantly experiencing the benefits of the IoT. Prosumers or renewable energy producers will benefit economically from the IoT's contribution to the decentralization of the energy sector. These benefits may include supervisory, control, and data acquisition.

Blockchain

Blockchain is a distributed ledger technology that keeps the accounting records, controlled by participants independently of any central authority. Satoshi Nakamoto announced the concept of blockchain in a white paper on 31 October 2008. He provided a platform for online bitcoin transactions between peers and excluded the requirement for a financial organization. Blockchain consists of blocks that are assembled into chains, and each block contains data for every transaction. As soon as the next block appears in the network, each block links the earlier block to the next block instantly [3]. In a blockchain network, all participants store historical data. They are distributed in the form of blocks, known as *sets of transactions*. Peers can use the hash function and private key to perform digital signatures on transactions. Participants in the network are able to validate the transactions by accessing digital ledgers they maintain. Decentralization, security, and data integrity are some of the characteristics of blockchain technology.

Figure 2 illustrates the basic structure of a blockchain. The blocks contain a variety of information, including an index; a time stamp, which records the exact time of the block mining; a block hash, which identifies the block uniquely; a transaction hash, which identifies each transaction on a blockchain; and data. There is also a chain of blocks formed by each block being connected to the previous block. The genesis block, or the first block of every blockchain, is always present in block B0, as shown in Figure 2. In the blockchain, all subsequent blocks are stacked over the genesis block. In P2P energy trading, blockchain technology has minimized the need for finical institutions, and the peers are able to perform the transactions on their own and to keep the record of transactions.

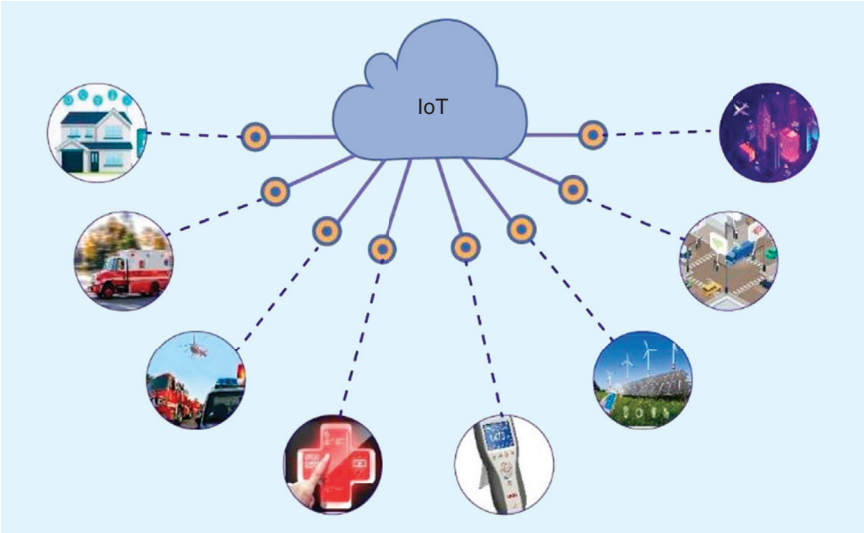

Figure 1: The IoT platform. (Source: [1]; used with permission.)

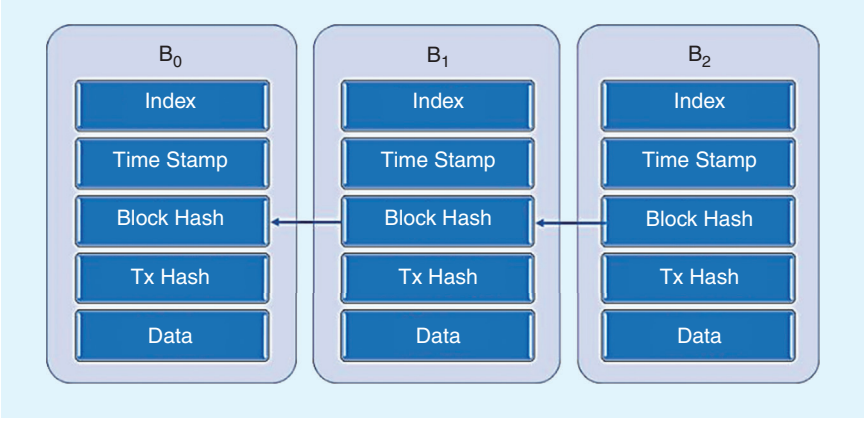

Figure 2: A basic blockchain. (Source: [2]; used with permission.)

Smart Contracts

It was Nick Szabo who brought the idea of smart contracts to the public in 1994, and the advent of blockchain has highlighted the importance of smart contracts. According to Nick, a *smart contract* can be defined as "a computerized transaction protocol that executes the terms of a contract." A smart contract is a script that is stored on the blocks that constitute a blockchain. Each contract on a chain has its own unique address. Transactions are addressed to these contracts to execute these contracts automatically.[5] An example of a smart contract is shown in Figure 3, where the response is determined by predefined conditions. In contrast to conventional agreements, smart contracts do not require a mediator when the predetermined conditions are met. As a result of the application of blockchain technology, a solution to execute smart contracts without a mediator has been found.

Energy Trading Platforms

Figure 4 depicts the overall concept of a P2P energy trading system. Each house in Figure 4 represents a peer on a network and is equipped with a solar photovoltaic (PV) system, battery bank, and load. In addition, the energy trading platform is hosted on a local network that can be accessed using a human–machine interface (HMI). When any of the peers want to trade energy, they can access the energy trading platform by using the HMI and perform trading actions, such as buying and selling. There is also a relay (electrically operated switch) associated with each house, represented by R_1 to R_{10} in Figure 4, that turns on when the trading operation starts or stops.

Figure 5 represents the user interface of an energy trading platform. It allows the participants of the energy trading platform to buy or sell energy. This also allows the peers to select the right quantity and price of energy and give other peers a choice to purchase energy at the most suitable price. The user can access their account ("My Account") to know the remaining balance in their account and also have access to the trading logs on the network.

The authors of [1], [2], [6], and [7] have developed energy trading platforms that facilitate P2P energy trading. Such platforms are deemed crucial due to the recent shift of the energy market from fossil fuels to renewables. Not only do these platforms give participants full energy monitoring and control liberty, but participants can also gain returns on their original investments. To add to this, the peers can access such platforms remotely. It is equally important to have access to distributed generation as it is to have a platform that facilitates energy trading and generates returns on investments. The absence of such platforms prevents the use of renewable energy in countries with abundant renewable energy resources. The possibility of obtaining appropriate returns on energy investments may also contribute to the electrification of remote regions globally.

Conclusion

It is now common for energy consumers to become prosumers, and a great deal of energy is generated by renewable energy sources, specifically, solar PV panels. There are a number of ways to sell self-generated energy on the energy market, and participants are looking for platforms that will allow them to realize a return on their investments in renewable energy resources. In the P2P energy trading market, renewable energy is becoming more available to individuals, and participants are making better use of energy generated from renewable sources. Platforms such as these can promote the growth of renewable energy resources as well as reduce the additional burden on the power grid. The P2P energy trading platform also provides participants with the opportunity to make a profit from their investments.

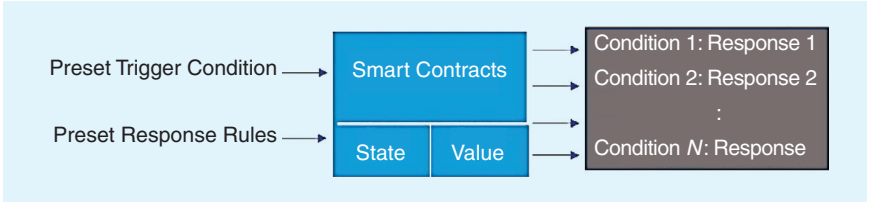

Figure 3: The working of a smart contract. (Source: [2]; used with permission.)

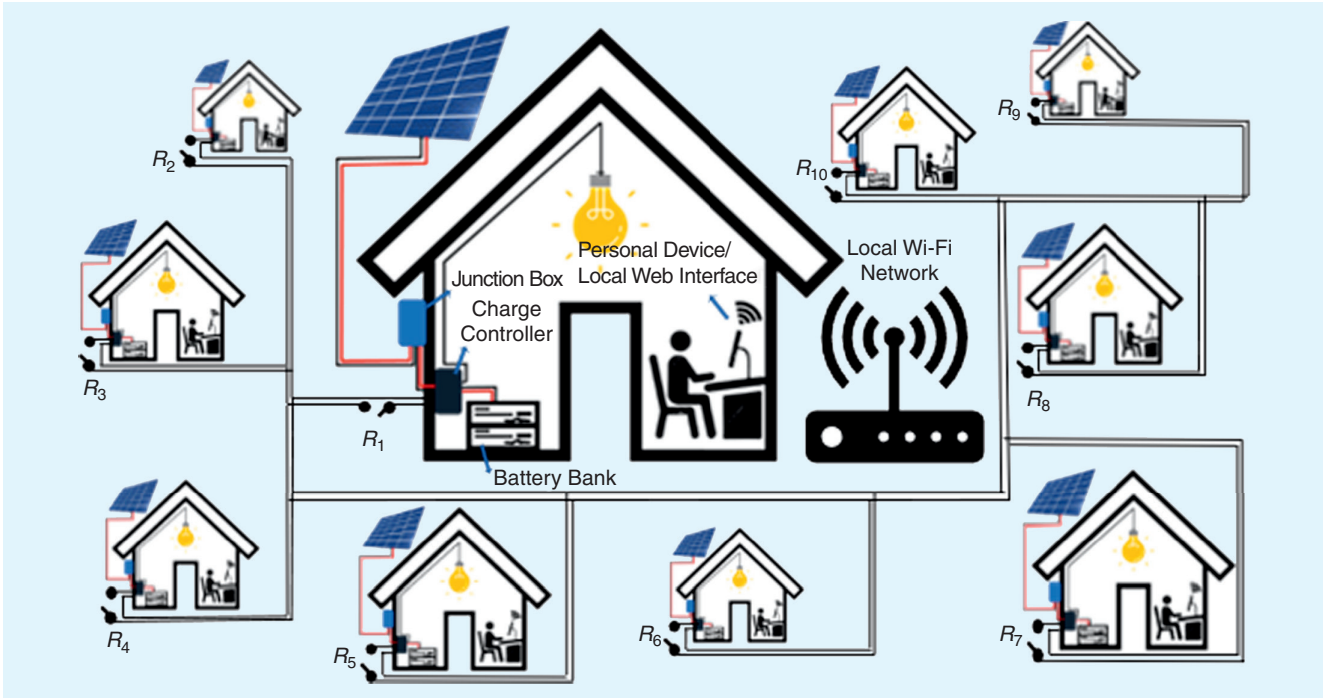

Figure 4: The user interface of an energy trading platform [6].

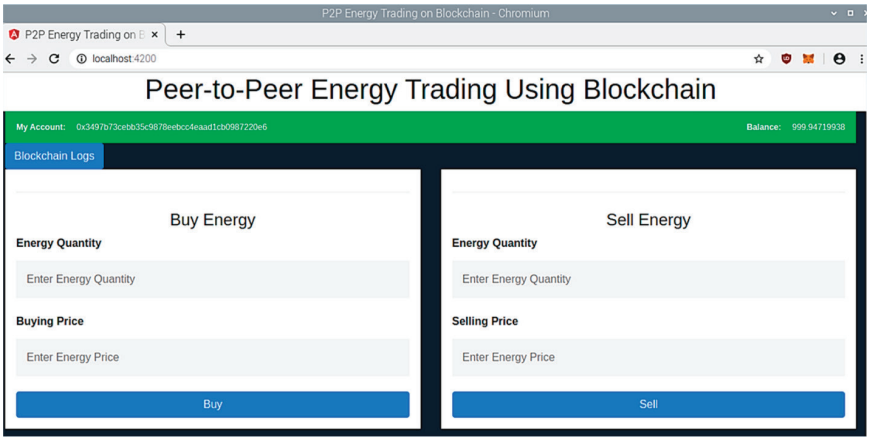

Figure 5: User interface of an energy trading platform [7].

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About the Author

Mirza Jabbar Aziz Baig (mjabaig@mun.ca) received a bachelor of science degree in electrical engineering from the University of Azad Jammu and Kashmir, Muzaffarabad, Pakistan, in 2009. In the following years, he held the position of lecturer at Mirpur University of Science and Technology, Mirpur, AJK, Pakistan. He earned his master of science degree in electrical engineering from the same university in 2013. He is currently pursuing a Ph.D. degree at Memorial University of Newfoundland, St. John's, NL, Canada. His research interests include blockchain, the Internet of Things, renewable energy, and power systems.


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For outstanding contributions to the engineering profession and pioneering contributions to robotics and automation at micronanoscales.
Pour contributions remarquables à la profession d'ingénieur et contributions pionnières à la robotique et l'automatisation aux échelles micro-nano

Yu Sun, Toronto, ON

Yun Sun (Fellow, IEEE) is a professor and Tier 1 Canada Research Chair at the University of Toronto. He was the founding director of the University of Toronto Robotics Institute. He received his Ph.D. degree from the University of Minnesota in 2003 and did his postdoctoral research at ETH Zürich.

Dr. Sun has made outstanding contributions to robotics and automation at micronanoscales and pioneering contributions to robotic cell manipulation. He was among the first to invent robotic approaches for automated cell manipulation. He solved the long-standing challenge of the lack of precision multiaxis force feedback in robotic micronanomanipulation. He also pioneered robotic technologies for performing precise, untethered manipulation and measurement inside single cells and deep in tissue.

Dr. Sun is the editor-in-chief of *IEEE Transactions on Automation Science and Engineering* and an editorial board member of the AAAS journal *Science Robotics*. He is a Fellow of IEEE, the ASME, AAAS, NAI, AIMBE, CAE, CAHS, and RSC. Among the awards he received were the ASRM Technical Achievement Award, NSERC E.W.R. Steacie Memorial Fellowship, NSERC Synergy Award for Innovation, and IEEE EMBS Technical Achievement Award. ■

Yun Sun (FIEEE) est professeur et titulaire d'une chaire de recherche du Canada de niveau 1 à l'Université de Toronto. Il a été le directeur fondateur de l'Institut de robotique de l'Université de Toronto. Il a obtenu son doctorat de l'Université du Minnesota en 2003 et a effectué ses recherches postdoctorales à l'EPF de Zurich. Dr. Sun a apporté des contributions exceptionnelles à la robotique et à l'automatisation à l'échelle micro-nanométrique et des contributions pionnières à la manipulation de cellules robotiques. Il a été parmi les premiers à inventer des approches robotiques pour la manipulation automatisée des cellules. Il a résolu le défi de longue date du manque de précision du retour de force multi-axes dans la micro-nanomanipulation robotique. Il a également conçu des technologies robotiques de manipulations et mesures précises sans fils dans les cellules individuelles et profondément dans les tissus.

Dr. Sun est rédacteur en chef d'IEEE Trans. Automation Science and Engineering et membre du comité de rédaction de la revue Science Robotics de l'AAAS. Il est fellow de l'IEEE, l'ASME, l'AAAS, la NAI, l'AIMBE, l'ACI, l'ACSS et la SRC. Parmi les prix qu'il a reçus, mentionnons le Prix de réalisation technique de l'ASRM, la Bourse commémorative E.W.R. Steacie du CRSNG, le Prix Synergie du CRSNG pour l'innovation et le Prix de réalisation technique de l'IEEE EMBS. ■

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Fadhel Ghannouchi, Calgary, AB

Fadhel M. Ghannouchi (Fellow, IEEE) received his Ph.D. degree in electrical engineering from École Polytechnique Montréal, was a faculty with at École Polytechnique from 1987–2005, and since 2005 is a professor and director of the iRadio Laboratory in the Department of Electrical and Software Engineering at the University of Calgary, AB, Canada.

Dr. Ghannouchi was a Tier 1 Canada Research Chair (2005–2019) and Alberta Innovate Strategic Chair (2005–2023).

Dr. Ghannouchi is well known for his contributions to microwave electronics, wireless communications, radio signal processing, and related fields: RF power amplifiers, behavior modeling of communications systems, digital predistortion, and impairment compensation techniques applied to wireless, satellite, and optical communications. A leading figure in this field, Dr. Ghannouchi has pursued a research program aimed at developing highly efficient RF amplifiers and environmentally friendly "green" software-defined radio transmitter architectures, along with their appropriate signal processing fundamentals and algorithms, leading in technological evolution and changing landscape and evolving communications standards and needs.

Dr. Ghannouchi is an IEEE Fellow and an Emeritus Distinguished Microwave Lecturer for the IEEE MTT-S. He is a fellow of the Academy of Science of the Royal Society of Canada, Canadian Academy of Engineering, and Engineering Institute of Canada. He received the Outstanding Leadership in Alberta Technology Award from the ASTech Foundation in 2014 and a Special Lifetime Achievement Award from the same foundation in 2019. He was a Thousand Talent Professor and Distinguished Invited Professor at Tsinghua University, China (2019–2021). Dr. Ghannouchi received a Research Excellence Award from APEGA (2009) as well as Research Excellence and Peak Scholarship in Entrepreneurship Innovation awards from the University of Calgary.

Dr. Ghannouchi has published six books; according to Google Scholar, Dr. Ghannouchi's publication number is 950. Among these, 670 are refereed papers archived in IEEE *Xplore*. Dr. Ghannouchi holds 30 U.S. patents. ■

Fadhel M. Ghannouchi (FIEEE) est titulaire d'un Ph.D. en génie électrique de l'École Polytechnique de Montréal. Il y a été professeur à de 1987 à 2005, et est depuis professeur et directeur du laboratoire iRadio au Département de génie électrique et logiciel de l'Université de Calgary. Dr. Ghannouchi a été titulaire d'une chaire de recherche du Canada de niveau 1 (2005–2019) et d'une chaire stratégique Alberta Innovate (2005–2023).

Dr. Ghannouchi est bien connu pour ses contributions à l'électronique micro-ondes, aux communications sans fil, au traitement du signal radio et domaines connexes: amplificateurs de puissance RF, modélisation du comportement des systèmes de communication, prédistorsion numérique et techniques de compensation de déficience appliquées aux communications sans fil, par satellite et optiques. Figure de proue dans ce domaine, il a poursuivi un programme de recherche visant à développer des amplificateurs RF hautement efficaces et des architectures « vertes » d'émetteurs radio définis par logiciel respectueuses de l'environnement, ainsi que leurs principes fondamentaux et algorithmes de traitement du signal appropriés, à la pointe de l'évolution du secteur, des technologies, des normes et besoins en matière de communications.

Dr. Ghannouchi est Fellow de l'IEEE et conférencier émérite en micro-ondes pour la Société IEEE MTT. Il est Fellow de l'Académie des sciences de la Société royale du Canada, de l'Académie canadienne du génie et de l'Institut canadien des ingénieurs. Il a reçu le prix de Leadership exceptionnel en technologie de l'Alberta de la Fondation ASTech en 2014 et un prix spécial pour l'ensemble de son oeuvre de la même fondation en 2019. Il a été « Professeur aux mille talents » et professeur invité distingué à l'Université Tsinghua, en Chine (2019–2021). Dr. Ghannouchi a reçu en 2009 un prix d'excellence en recherche de l'APEGA, ainsi que des prix d'excellence en recherche et une bourse d'études Peak en innovation entrepreneuriale de l'Université de Calgary.

Dr. Ghannouchi a publié six livres; selon Google Scholar, il a 950 publications à son actif. Parmi celles-ci, 670 sont des articles évalués par les pairs archivés dans IEEE Xplore. Dr. Ghannouchi détient 30 brevets américains. ■

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For outstanding contributions to the training of the next generation of scientists and engineers in mobile computing, networking, and e-learning.
Pour contributions remarquables à la formation de la prochaine génération de scientifiques et ingénieurs en informatique mobile, réseautique et apprentissage en ligne

Samuel Pierre, Montréal, PQ

Samuel Pierre (Senior Member, IEEE) is a full professor in the Department of Computer Engineering and Software Engineering at Polytechnique Montréal, where he chairs the Mobile Computing and Networking Research Laboratory. He received his bachelor's degree in civil engineering from Polytechnique Montréal in 1981, his bachelor's (1984) and master's degrees (1985) in mathematics-computer science from UQAM, his master's degree in economics from the University of Montréal in 1987, and his Ph.D. degree in electrical engineering from Polytechnique Montréal in 1991. From 2002 to 2014, he held the NSERC/Ericsson Industrial Research Chair in Next Generation Mobile Networking Systems. He has also taught at UQAM, UQTR, Télé-Université, Université Paris-7, and the École Polytechnique Fédérale de Lausanne in Switzerland.

Dr. Pierre is an internationally renowned expert who works in the field of information and communication technologies: telecommunications network planning, networking and mobile computing, distance education, and e-learning. For five years, he acted as an expert for the International Organization of La Francophonie in France. Over the past 30 years, he has led or participated in projects totaling over $32 million; he also supervised the theses of more than 160 graduate students, including 43 doctoral theses.

Dr. Pierre has more than 600 scientific publications to his credit. He has received prestigious honors during his career, including the Member of the Order of Canada, Officer of the National Order of Quebec, Officer of the Order of Montréal, Engineers Canada Gold Medal, Grand Professional Excellence Award from the Ordre des ingénieurs du Québec, El Fassi Prize from the AUF to highlight the action of a person who has exercised a significant influence through the quality of his expertise and the innovative nature of his achievements internationally in the areas of research, training, international cooperation and knowledge transfer. ■

Samuel Pierre, (Membre sénior de IEEE) est professeur titulaire au département de génie informatique et génie logiciel de Polytechnique Montréal où il dirige le Laboratoire de recherche en réseautique et informatique mobile (LARIM). Il a obtenu un baccalauréat en génie civil de Polytechnique Montréal en 1981, un baccalauréat (1984) et une maîtrise (1985) en mathématiques-informatique de l'UQAM, une maîtrise en sciences économiques de l'Université de Montréal en 1987, et un doctorat en génie électrique de Polytechnique Montréal en 1991. De 2002 à 2014, il a été titulaire de la Chaire de recherche industrielle CRSNG/Ericsson en systèmes réseautiques mobiles de prochaines générations. Il a aussi enseigné à l'UQAM, à l'UQTR, à la Télé-Université, à l'Université Paris-7, et à l'École Polytechnique Fédérale de Lausanne en Suisse.

Dr. Pierre est un expert de réputation internationale qui œuvre dans le domaine des technologies de l'information et de la communication : planification de réseaux de télécommunications, réseautique et informatique mobile, formation à distance, e-Learning. Pendant 5 ans, il a agi comme expert pour l'Organisation internationale de la Francophonie (OIF), en France. Au cours des 30 dernières années, il a dirigé ou participé à des projets qui totalisent plus de 32 millions de dollars; il a aussi supervisé les mémoires et thèses de plus de 160 étudiants aux études supérieures, dont 43 thèses de doctorat.

Dr. Pierre a à son actif plus de 600 publications scientifiques. Il a reçu de prestigieuses distinctions au cours de sa carrière, parmi lesquelles: Membre de l'Ordre du Canada, Officier de l'Ordre national du Québec, Officier de l'Ordre de Montréal, Médaille d'or d'Ingénieurs Canada, Grand prix d'excellence professionnelle de l'Ordre des ingénieurs du Québec, le Prix El Fassi de l'AUF pour souligner l'action d'une personne qui a exercé une influence importante par la qualité de son expertise et le caractère innovant de ses réalisations à l'échelle internationale dans les domaines de la recherche, de la formation, de la coopération internationale et du transfert de connaissances. ■

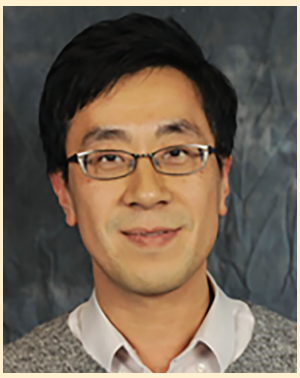
2023 IEEE CANADA OUTSTANDING ENGINEER AWARD
PRIX D'INGÉNIEUR EXCEPTIONNEL DE L'IEEE CANADA 2023

For outstanding contributions to signal processing, sensor networks, and information fusion.
Pour contributions remarquables aux domaines du traitement de signal, réseaux de capteurs, et fusion d'information

Henry Leung, Calgary, AB

Henry Leung (Fellow, IEEE) is currently the Schulich Industry Research Chair and a professor in the Department of Electrical and Software Engineering at the University of Calgary. He received his B.Sc., M.Sc., and Ph.D. degrees from the University of Waterloo, University of Toronto, and McMaster University, respectively. He was previously with the Department of National Defence of Canada as a defence scientist to conduct R&D on automated multisensor surveillance systems.

Dr. Leung has been conducting research on object detection, tracking, recognition, sensor fusion, and information fusion. Previously a defence scientist, Dr. Leung led the team to solve the real-time quality control problem of ghost tracks appearing in the NORAD air defence system. He was appointed the national leader on data fusion for The Technical Cooperation Program. At the University of Calgary, he developed an integrated multisensor decision support system to address the "white shipping problem" for smuggling in Canada. This system has also been adopted for autonomous driving, infrastructure monitoring, oil and gas drilling, and environmental sensing through collaboration with industries. His efforts on intelligent noise monitoring with the city of Calgary's LoRAWAN network received two innovation and Smart City awards. He has published more than 350 journal papers, 250 conference papers, six books, and 20 patents. He has delivered 30+ keynote/invited speeches and over 100 technical presentations in conferences and industrial meetings.



Dr. Leung is the editor of the Springer book series on "Information Fusion and Data Science." He has been the associate editor of various journals, such as the *International Journal on Information Fusion, Nature Scientific Reports, IEEE Signal Processing Letters*, and *IEEE Transactions on Aerospace and Electronic Systems*. He is currently serving on the IEEE Executive Committee on IoT and cochairing the Technical Committee on Brain-Inspired Cognitive Systems of the SMC Society. He was chair of the IEEE Technical Committee on Nonlinear Circuits and Systems. He has also chaired various conferences, such as the IEEE Cyber Technology Congress and International Conference on Information Fusion. He is currently chair of the NSERC Discovery Grant Electrical Engineering Group and was a member of the Canadian Expert Group on Imaging, Sensing and Fusion. He is a Fellow of IEEE, SPIE, and EIC. He received the Faculty Teaching Achievement Award and Outstanding Teaching Excellence Award from the University of Calgary. He was a finalist for the NATO Innovation Challenge on Disinformation and Fake News Detection. ■

Henry Leung (FIEEE) est titulaire de la chaire de recherche industrielle Schulich et professeur au Département de génie électrique et logiciel de l'Université de Calgary. Il a obtenu son baccalauréat ès sciences, sa maîtrise et son doctorat des universités de Waterloo, Toronto et McMaster respectivement. Auparavant, il a travaillé au ministère de la Défense nationale du Canada à titre de scientifique de la Défense pour mener des activités de recherche et développement sur les systèmes automatisés de surveillance multicapteurs.

Dr. Leung a mené des recherches sur la détection, le suivi, la reconnaissance, la fusion de capteurs et la fusion d'informations. Il a dirigé l'équipe de résolution du problème de contrôle de la qualité en temps réel des traces fantômes apparaissant dans le système de défense aérienne du NORAD. Il a été nommé chef national de la fusion des données pour le Programme de coopération technique (TTCP). À l'Université de Calgary, il a mis au point un système intégré d'aide à la décision multi-capteurs pour résoudre le problème d'utilisation de vaisseaux civils pour la contrebande au Canada. Ce système a également été adopté pour la conduite autonome, la surveillance des infrastructures, le forage pétrolier et gazier et la détection environnementale grâce à la collaboration avec les industries. Ses efforts sur la surveillance intelligente du bruit avec le réseau LoRAWAN de la ville de Calgary ont été couronnés par deux prix d'innovation et ville intelligente. Il a publié plus de 350 articles de revues scientifiques, 250 articles de conférence, 6 livres et obtenu 20 brevets. Il a prononcé 30+ discours d'ouverture / invités et plus de 100 présentations techniques lors de conférences et de rencontres industrielles.

Dr. Leung est l'éditeur de la série de livres Springer sur « Information Fusion and Data Science ». Il a été rédacteur en chef adjoint de diverses revues telles que l'International Journal on Information Fusion, Nature Scientific Reports, IEEE Signal Processing Letters, IEEE Trans. Aerospace and Electronic Systems. Il siège actuellement au comité exécutif de l'IEEE sur l'IdO et co-préside le comité technique sur les systèmes cognitifs inspirés du cerveau de la société SMC. Il a été président du comité technique de l'IEEE sur les circuits et systèmes non linéaires. Il a également présidé diverses conférences telles que IEEE Cyber Technology Congress, et International Conference on Information Fusion. Il est actuellement président du Groupe génie électrique des subventions à la découverte du CRSNG et a été membre du Groupe d'experts canadien sur l'imagerie, la détection et la fusion. Il est Fellow de la SPIE, de l'IEEE et de l'ICI. Il a reçu un prix d'excellence en enseignement de sa faculté et un prix exceptionnel d'excellence en enseignement de l'Université de Calgary. Il a été finaliste du Défi d'innovation de l'OTAN sur la désinformation et la détection des fausses nouvelles. ■

2023 IEEE CANADA R.H. TANNER INDUSTRY LEADERSHIP AWARD
PRIX R.H. TANNER DE LEADERSHIP DANS L'INDUSTRIE DE L'IEEE CANADA 2023

For leadership in technology transfer in the areas of telecommunications network planning, orchestration and optimization, and the Industrial Internet of Things.
Pour leadership en transfert de technologies dans les domaines de la planification des réseaux de télécommunications, orchestration et optimisation et l'internet des objets

Abdallah Shami, London, ON

Abdallah Shami (Senior Member, IEEE) is a professor in the Department of Electrical and Computer Engineering at Western University in London, ON, Canada. He is also director of the Optimized Computing and Communications Laboratory within the same institution.

Dr. Shami has made innovative contributions in the field of network management and orchestration as well as in the domain of cyber-physical systems His publications and open source codes are highly cited, widely recognized, and have helped and inspired many researchers. Dr. Shami has played a crucial role in translating theoretical knowledge and academic research into practical industry applications, with his contributions being integrated into the products of major international companies.

Dr. Shami served as general chair of the 2020 IEEE Canadian Conference on Electrical and Computer Engineering. He has also chaired key symposia for esteemed conferences such as IEEE GLOBECOM, IEEE International Conference on

Communications, and IEEE International Conference on Computing, Networking and Communications. Furthermore, he was the elected chair of the IEEE Communications Society Technical Committee on Communications Software and held the position of IEEE London Ontario Section chair. Dr. Shami currently serves as an editor for prestigious journals including *IEEE Transactions on Information Forensics and Security*, *IEEE Internet of Things Journal*, *IEEE Communications Magazine*, and *IEEE Communications Surveys and Tutorials*. Dr. Shami is a fellow of the Canadian Academy of Engineering and Engineering Institute of Canada. ■

Abdallah Shami (SMIEEE) est professeur au Département de génie électrique et informatique de l'Université Western à London, ON, Canada. Il est également directeur du Laboratoire d'informatique et de communications optimisées au sein de la même institution.

Dr. Shami a apporté des contributions novatrices dans le domaine de la gestion et de l'orchestration des réseaux, ainsi que dans le domaine des systèmes cyber-physiques. Ses publications et ses codes sources libres sont très cités, largement reconnus et ont aidé et inspiré de nombreux chercheurs. Dr. Shami a joué un rôle crucial dans la valorisation des connaissances théoriques et de la recherche universitaire en applications industrielles, ses contributions étant intégrées dans les produits de grandes entreprises internationales. Dr. Shami a été président général de la Conférence canadienne de génie électrique et informatique de l'IEEE 2020. Il a également présidé des symposiums clés pour des conférences prestigieuses telles que l'IEEE GLOBECOM, la Conférence internationale sur les communications de l'IEEE et la Conférence internationale de l'IEEE sur l'informatique, les réseaux et les communications. De plus, il a été élu président du comité technique de l'IEEE Communications Society sur les logiciels de communication et été président de la section de l'IEEE à London, Ontario. Dr Shami est actuellement rédacteur en chef de revues prestigieuses, notamment IEEE Transactions on Information Forensics and Security, IEEE Internet of Things Journal, IEEE Communications Magazine et IEEE Communications Surveys and Tutorials. Dr. Shami est membre de l'Académie canadienne du génie (ACG) et de l'Institut canadien des ingénieurs (ICI). ■

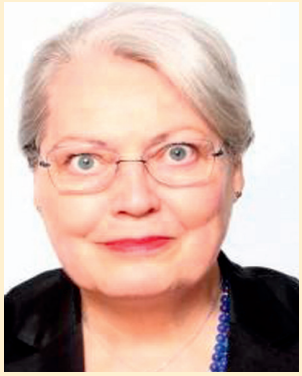
2023 IEEE CANADA W.S. READ OUTSTANDING SERVICE AWARD
PRIX W.S. READ POUR SERVICE EXCEPTIONNEL DE L'IEEE CANADA 2023

For influential leadership at the IEEE Section, Region, and MGA levels, focusing on improving the organization; and passionate support for sustainability.
Pour leadership influent aux niveaux Section IEEE, Région et MGA, focalisant sur l'amélioration de l'organisation; et son soutien passionné pour la durabilité environnementale

Maike Luiken, Sarnia, ON

Dr. Maike Luiken (Senior Member, IEEE; HKN; FEIC) chairs the Planet Positive 2030 Initiative, supported by the IEEE Standards Association. She is the managing director, R&D, at CARBOVATE Development Corp. and an adjunct research professor at Western University. Her career spanned 35 years, mostly in academia as a professor and department head (electronics) at Algonquin College, dean (technology, sustainability, research) at Lambton College, Canada, and at Tufts University, USA. She received her Staatsexamen in mathematics and physics from the Technical University of Braunschweig, Germany (1979), and her Ph.D. degree in physics from the University of Waterloo (1982).

Dr. Luiken has been described as a "builder" and a passionate leader. She is committed to a more sustainable planet. She is a founding cochair of the IEEE Joint Organizational Units Ad Hoc on Sustainability (2020), raising engagement to provide technology solutions to achieve sustainability goals. She champions "local groups" to foster local member and community cooperation. In 2021, as VP, she led the MGA entirely online. She restructured the Ottawa Section's financial system—OU-based (project-based) accounting (2003); she led the revitalization of the London



Section, starting in 2006. At IEEE Canada, she led the streamlining of award/volunteer nomination processes and initiated Region committee restructuring and strategic planning.

Luiken's volunteer and professional recognitions include the 2023 IEEE MGA William W. Middleton Distinguished Service Award, 2015 Lambton College's inaugural Applied Research and Entrepreneurship Award, 2011 IEEE Canada M.B. Broughton Central Canada Merit Award, and 2009 Fellow of the Engineering Institute of Canada. As Section chair, Luiken received the 2005 RAB Outstanding Large Section Award, Ottawa Section; IEEE Canada Exemplary Small Section Award, London (2008 and 2011); and 2011 MGA Small Section Award, London Section. Luiken is an active Rotary member and serves on the Sarnia Rotary Foundation Board and IEEE Canadian Foundation Board. ■

Dr. Maike Luiken (SMIEEE, HKN, FEIC) préside l'initiative Planet Positive 2030 – soutenue par l'IEEE Standards Association. Elle est directrice générale, R&D, chez CARBOVATE Development Corp. et professeure associée de recherche à l'Université Western. Sa carrière s'est établie sur 35 ans, principalement dans le milieu universitaire en tant que professeure, chef de département (électronique) au Collège Algonquin, doyenne (technologie, durabilité, recherche) du Collège Lambton, au Canada, et à l'Université Tufts, aux États-Unis. Elle a obtenu son Staatsexamen en mathématiques et physique de l'Université technique de Braunschweig, en Allemagne (1979) et son doctorat en physique de l'Université de Waterloo (1982).

Maike a été décrite comme « une bâtisseuse et une meneuse passionnée. » Elle souscrit à une planète plus durable. Elle a été coprésidente fondatrice des Unités organisationnelles conjointes Ad Hoc de l'IEEE sur la durabilité en 2020, suscitant l'engagement à fournir des solutions technologiques pour atteindre des objectifs de durabilité. Elle se fait championne des 'groupes locaux' pour favoriser la coopération locale des membres et de la communauté. En 2021, en tant que vice-présidente MGA, elle l'a dirigée entièrement en ligne. Elle a restructuré en 2003 le système financier de la Section d'Ottawa – comptabilité basée sur les unités administratives (par projets); elle a dirigé la revitalisation de la section de London à partir de 2006. À l'IEEE Canada, elle a dirigé la rationalisation des processus de nomination des bénévoles et pour les prix, et a initié la restructuration du comité Régional et la planification stratégique.

Les reconnaissances de Maike en tant que bénévole et professionnelle comprennent: IEEE MGA William W. Middleton Distinguished Service Award 2023; le premier Prix de recherche appliquée et d'entrepreneuriat du Collège Lambton en 2015; le Prix de mérite M.B. Broughton du centre du Canada en 2011; et Fellow de l'Institut canadien des ingénieurs en 2009. En tant que présidente de section, Maike a reçu le Prix de grande section exceptionnelle RAB pour la section d'Ottawa en 2005; le Prix de petite section exemplaire de l'IEEE Canada, section de London en 2008 et 2011; et le Prix de petite section MGA, section de London en 2011. Maike est membre active du Rotary, siège au conseil d'administration de la Fondation Rotary de Sarnia et au conseil d'administration de la Fondation canadienne de l'IEEE. ■

E.F. GLASS WESTERN CANADA MERIT AWARD
PRIX DE MÉRITE E.F. GLASS DE L'OUEST DU CANADA DE L'IEEE CANADA 2023

For outstanding service to IEEE Canada, the members, and the profession.
Pour service remarquable à l'IEEE Canada, les membres, et la profession

Ekram Hossain, Winnipeg, MB

Ekram Hossain (Fellow, IEEE) is a professor and the associate head (graduate studies) in the Department of Electrical and Computer Engineering at University of Manitoba, Canada. He received his Ph.D. degree in electrical engineering from the University of Victoria, Canada, in 2001.

He has been very active in leadership roles in IEEE Canada and in the wider IEEE community, including serving as a member of the IEEE Canada Board of Directors, Publications and Communications (PCG) Group chair, IEEE Winnipeg Section chair, and IEEE Winnipeg Communications Society Chapter chair. Through these roles, he spent significant efforts to serve IEEE Canada and its members in the IEEE Winnipeg Section. As the PCG chair of IEEE Canada, Dr. Hossain played a key role in revamping the *Canadian Journal of Electrical and Computer Engineering*.

Prof. Hossain is a Member (Class of 2016) of the College of the Royal Society of Canada. Also, he is a fellow of the Canadian Academy of Engineering and Engineering Institute of Canada. He has won several research awards, including the 2017 IEEE

Communications Society Best Survey Paper Award and 2011 IEEE Communications Society Fred Ellersick Prize Paper Award. He was listed as a Clarivate Analytics Highly Cited Researcher in *Computer Science* in 2017–2022. Currently, he serves as an editor for *IEEE Transactions on Mobile Computing*. Previously, he served as editor-in-chief (EiC) of IEEE Press (2018–2021) and *IEEE Communications Surveys and Tutorials* (2012–2016). He was a Distinguished Lecturer of the IEEE Communications Society and IEEE Vehicular Technology Society. He served as director of magazines for the IEEE Communications Society (2020–2021). Also, he was an elected member of the Board of Governors of the IEEE Communications Society for the 2018–2020 term. ■

Ekram Hossain (FIEEE) est professeur et directeur associé (études supérieures) au Département de génie électrique et informatique de l'Université du Manitoba. Il a obtenu son doctorat en génie électrique de l'Université de Victoria en 2001.

Il a été très actif dans des rôles de leadership à l'IEEE Canada et dans la communauté élargie de l'IEEE, notamment en tant que membre du conseil d'administration de l'IEEE Canada, président du groupe Publications and Communications (PCG), président de la section IEEE Winnipeg et de son chapitre Communications. À ce titre, il a déployé des efforts considérables pour servir l'IEEE Canada et les membres de sa section. En tant que président du PCG, M. Hossain a joué un rôle clé dans la refonte du Journal Canadien de Génie Électrique et Informatique (JCGEI).

Prof. Hossain est membre (promotion 2016) du Collège de la Société royale du Canada. Il est aussi Fellow de l'Académie canadienne du génie et de l'Institut canadien des ingénieurs. Il a remporté plusieurs prix de recherche, dont le Prix du meilleur article de synthèse de l'IEEE Communications Society en 2017 et le Prix Fred W. Ellersick de l'IEEE Communications Society en 2011. Il a été répertorié comme Chercheur hautement cité en informatique de Clarivate Analytics chaque année de 2017 à 2022. Il est présentement rédacteur pour IEEE Transactions on Mobile Computing. Il a été rédacteur en chef de l'IEEE Press (2018–2021) et de IEEE Communications Surveys and Tutorials (2012–2016). Il a été conférencier distingué de l'IEEE Communications Society et de l'IEEE Vehicular Technology Society, directeur des magazines pour l'IEEE Communications Society (2020–2021), et élu au Conseil des gouverneurs de l'IEEE Communications Society pour 2018–2020. ■

2023 IEEE CANADA J.J. ARCHAMBAULT EASTERN CANADA MERIT AWARD
PRIX DE MÉRITE J.J. ARCHAMBAULT DE L'EST DU CANADA DE L'IEEE CANADA 2023

For energetic service to the Canadian Atlantic Section, IEEE Canada, and the IEEE Oceanic Engineering Society.
Pour service dynamique à la section Canada Atlantique, l'IEEE Canada et l'IEEE Oceanic Engineering Society

Christopher Whitt, Dartmouth, NS

Christopher Whitt (Senior Member, IEEE) is an electrical engineer specializing in signal processing and acoustics. Currently, he is the ship signature engineer for Irving Shipbuilding in Halifax, NS, Canada, responsible for the noise, RF, IR, and EM signatures for the new Canadian frigate program. Previously, he was a project engineer and project manager at JASCO Applied Sciences in Halifax, NS, Canada. In that role, he was involved with many wide-scale ocean acoustic monitoring projects, particularly in the Arctic.

Whitt was the Canadian Atlantic Section (CAS) chair for 2016, and then the Area East chair for 2017–2018. Whitt coordinated CAS contributions to the Sections Congress recommendation process for 2014. As area chair, he coordinated all the Region recommendations for Sections Congress (SC) 2017. As an early graduate of the Volunteer Leadership Training program (VoLT), he helped several CAS volunteers also get accepted for VoLT. In 2018, Whitt was asked to be program chair for SC2020, planned for Ottawa. Although SC2020 was postponed, the 2023 edition in Ottawa followed much of what the organization had planned for 2020.

In 2017, Whitt also became involved with the Oceanic Engineering Society, leading a successful proposal to host the flagship OCEANS Conference and Exhibition in Halifax in 2024.

After winning approval for OCEANS 2024 to be hosted in Halifax, Whitt was elected to the Administrative Committee of the Oceanic Engineering Society (OES). In 2021, Whitt became IEEE OES president and is currently serving in that role. Whitt is a registered professional engineer in Nova Scotia. He received his undergraduate (B.Eng., 2000) and graduate degrees (M.Eng., 2010) from Memorial University, St. John's, NL, Canada. Whitt is also a project management professional. In addition to ocean engineering, Whitt has broad personal interests, including sustainability, music, aviation, and sports. ■

Christopher Whitt (S'95, M'02, SM'15) est un ingénieur électricien spécialisé dans le traitement du signal et l'acoustique. Il est présentement ingénieur de signature de navire chez Irving Shipbuilding à Halifax, responsable du bruit, des signatures RF, IR et EM pour le nouveau programme de frégates canadiennes. Auparavant il a été ingénieur de projet et chef de projet chez JASCO Applied Sciences à Halifax. À ce titre, il a participé à plusieurs projets de surveillance acoustique océanique à grande échelle, en particulier dans l'Arctique.

Christopher a été président de la Section Canada Atlantique (SCA) en 2016, puis de la Zone Est de l'IEEE Canada en 2017–2018. Il a coordonné les contributions de la SCA au processus de recommandation du Congrès des sections 2014. En tant que président de Zone, il a coordonné toutes les recommandations régionales pour le Congrès des sections 2017. En tant que premier diplômé du Programme de formation en leadership bénévole (VoLT), il a aidé plusieurs bénévoles de la SCA à être acceptés pour VoLT. En 2018, Christopher a été invité à être président du programme du Congrès des sections 2020, prévu à Ottawa. Alors que SC2020 a été reporté, l'édition 2023 à Ottawa suit une grande partie de l'organisation prévue pour 2020. En 2017, Christopher s'est également impliqué dans l'Oceanic Engineering Society, dirigeant une proposition réussie pour accueillir la conférence et exposition phare OCEANS à Halifax en 2024. Il a ensuite été élu au comité administratif (AdCom) de l'Oceanic Engineering Society (OES). En 2021, il est devenu président de l'OES et occupe actuellement ce poste.

Christopher est ingénieur professionnel agréé (P.Eng.) en Nouvelle-Écosse. Il a obtenu ses diplômes de premier cycle (B.Eng. 2000) et d'études supérieures (M.Eng. 2010) à l'Université Memorial à St. John's, Terre-Neuve-et-Labrador, Canada. Il est également Professionnel en gestion de projet (PMP). En plus du génie océanique, Christopher a de vastes intérêts personnels, y compris la durabilité, la musique, l'aviation et les sports. ■

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 Canadian Foundation Scholarships

Manjeet Kumar—Conestoga College
Kareem El Assad—Carleton University
Riki Romana—University of Ottawa
Ahmed Khan—University of Saskatchewan

IEEE Canadian Foundation Power Quality Scholarship

Dareen Paetz—University of Alberta

IEEE Canadian Foundation Gargantini–Strybosch Scholarship

Aziz Rakhimov—University of British Columbia—Okanagan Campus

IEEE Canadian Foundation Nick Cercone Graduate Scholarship in Computer Science

Benno Krojer—Mila Québec AI Institute and McGill University

IEEE Canada Members elected as 2023 IEEE Fellows/Membres de l'IEEE Canada élus Fellows de l'IEEE 2023

Amir G. Aghdam, Montréal, QC Canada
For research leadership in distributed control of large-scale interconnected systems

Jason H. Anderson, Toronto, ON Canada
For contributions to high-level synthesis and low-power FPGAs

Pavel Cheben, Ottawa, ON Canada
For contributions to silicon and metamaterial photonics

Julian Z. Cheng, Kelowna, BC Canada
For contributions to mathematical modeling of wireless systems and energy-efficient resource management of wireless networks

Hai Jiang, Edmonton, AB Canada
For contributions to cognitive radio networking and wireless performance analysis

Jonathan Li, Waterloo, ON Canada
For contribution to point cloud analytics in lidar remote sensing

Karon Maclean, Vancouver, BC Canada
For contributions to the design of haptic communication

Tamara Munzner, Vancouver, BC Canada
For contributions to principles, processes, and design for visualization

Jianping Pan, Victoria, BC Canada
For contributions to topology control of wireless networks

Yihong Qi, Waterloo, ON Canada
For contributions to over-the-air testing of massive MIMO systems and development of over-the-air measurement systems

Howard G. Sedding, Elgin, ON Canada
For contributions to practical partial discharge testing of electrical equipment

Vesna Sossi, Vancouver, BC Canada
For contributions to quantitative and translational brain PET imaging

Abdelhamid Tayebi, Thunder Bay, ON Canada
For contributions to the control of unmanned aerial vehicles and learning-based control for robot manipulators

Zbigniew Roman Wasilewski, Waterloo, ON Canada
For contributions to molecular beam epitaxy growth technology and photonic devices

Youmin Zhang, Montréal, QC Canada
For contributions to fault diagnosis and fault-tolerant control systems

MGA William W. Middleton Distinguished Service Award

Maike Luiken, London, ON Canada

For exemplary leadership and commitment to MGA, IEEE Members, and the public, and for championing technological solutions to sustainable development and climate change challenges

Pour un leadership et un engagement exemplaires envers le MGA, les membres de l'IEEE et le public, et l'appui à des solutions technologiques aux défis du développement durable et des changements climatiques

MGA 2023 Small Section Award/Prix de la petite section MGA 2023

South Saskatchewan Section

For successful efforts in fulfilling the educational and scientific goals of IEEE for the benefit of the public by maintaining, enhancing, and supporting the student branches, technical Chapters, and affinity groups within their geographic boundaries

Pour des efforts couronnés de succès dans la réalisation des objectifs éducatifs et scientifiques de l'IEEE au profit du public par la maintenance, l'amélioration et le soutien aux branches étudiantes, chapitres techniques et groupes d'affinité dans leurs milieux géographiques

IEEE Medal in Power Engineering/Médaille IEEE de génie électrique

Kamal Al-Haddad, Montréal, QC Canada

For contributions to power electronics converters for power quality and industrial applications

Pour contributions aux convertisseurs d'électronique de puissance pour la qualité de l'onde et applications industrielles

2023 IEEE Awards

IEEE Fourier Award for Signal Processing

Rabab Kreidieh Ward, Vancouver, BC Canada

For outstanding contributions to advancing signal processing techniques and their practical applications, and for technical leadership

IEEE Electromagnetics Award

John William Bandler, Hamilton, ON Canada

For contributions to electromagnetic optimization and the modeling of high-frequency structures, circuits, and devices

IEEE Joseph F. Keithley Award in Instrumentation and Measurement

Richard G. Green, Ottawa, ON Canada

For low-uncertainty measurement of Planck's constant of fundamental importance to the redefinition of the International System of Units (SI); and

Barry M. Wood, Ottawa, ON Canada

For low-uncertainty measurement of Planck's constant of fundamental importance to the redefinition of the International System of Units (SI)

IEEE Richard W. Hamming Medal

Frank Kschischang, Toronto, ON Canada

For contributions to the theory and practice of error correcting codes and optical communications

IEEE Canada Exemplary Section Awards/Prix de sections exemplaires de l'IEEE Canada

For good section leadership, management, and adminstration

Pour un bon leadership, la gestion et l'administration de la section

Exemplary Large Section Award/Prix de grande section exemplaire

Toronto Section

Exemplary Medium Section Award/Prix de section moyenne exemplaire

Kitchener–Waterloo Section

Exemplary Small Section Award/Prix de petite section exemplaire

South Saskatchewan Section

IEEE Canada WIE, LM, and YP Awards/Prix IEEE Canada WIE, LM & YP

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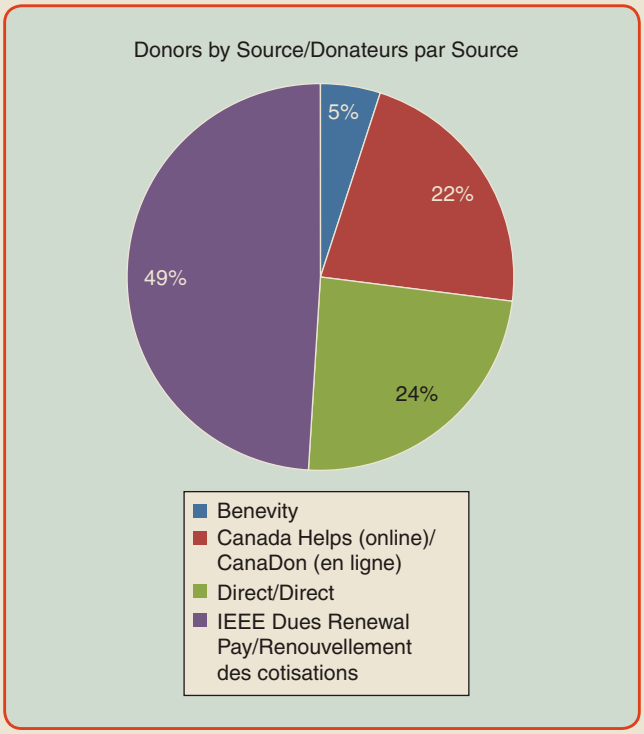

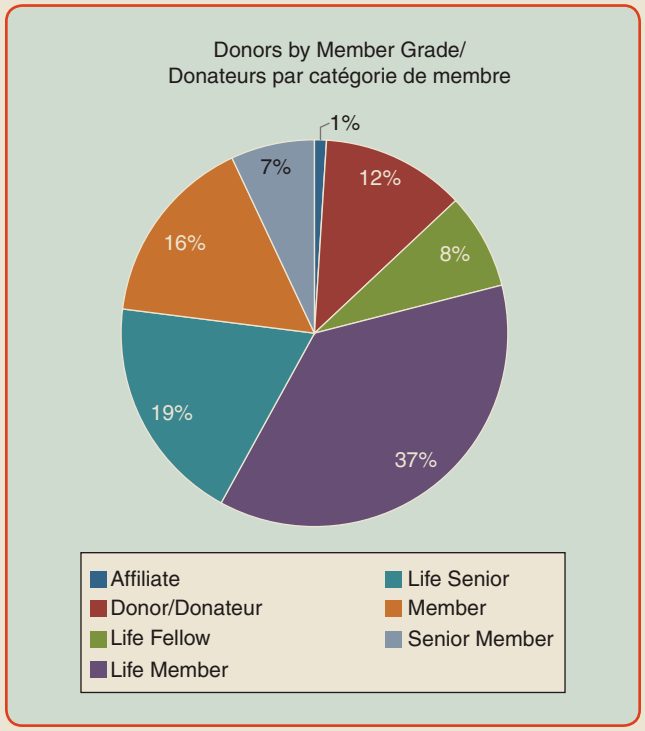

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Yours sincerely,

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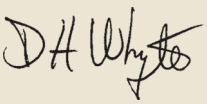

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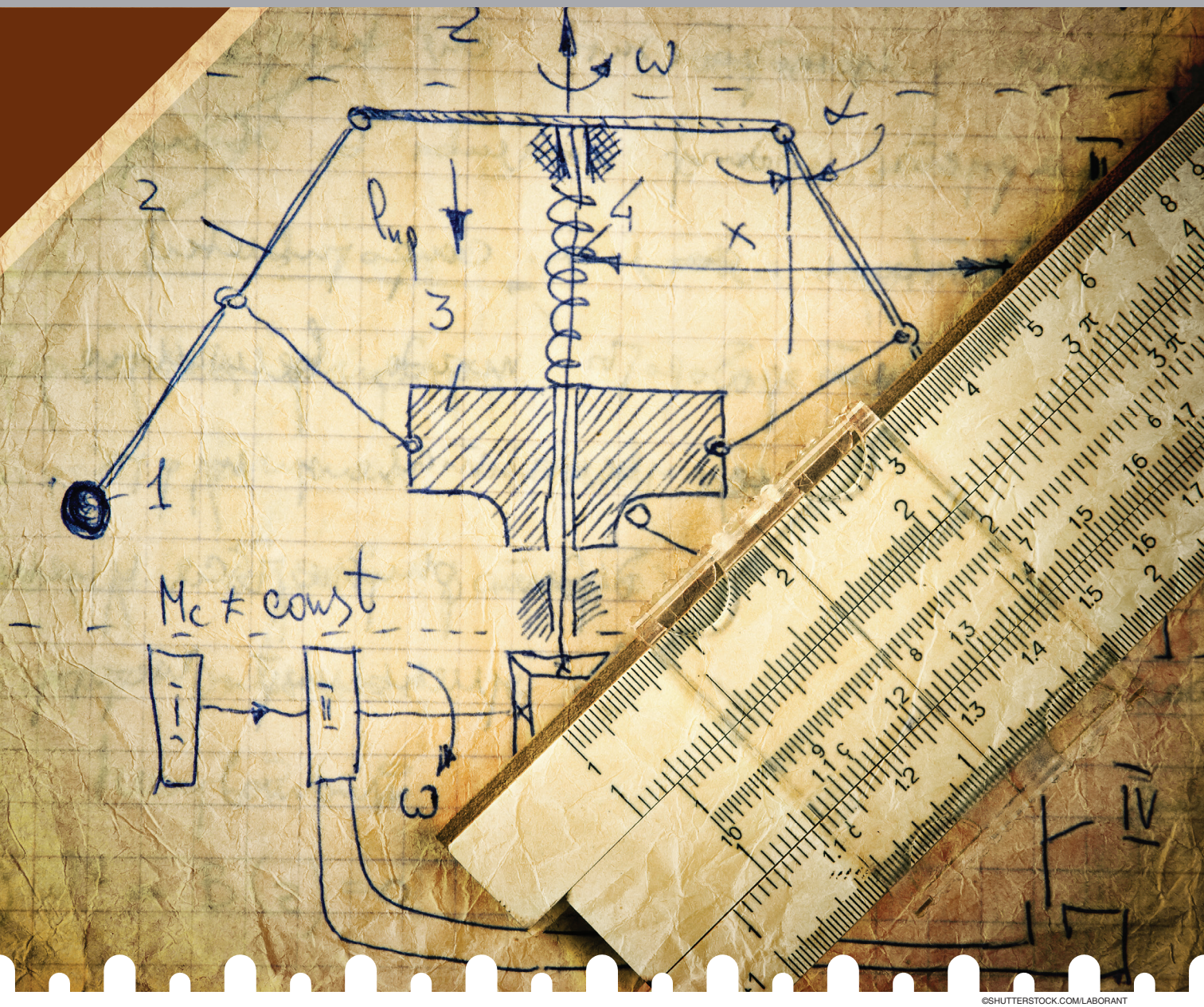

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Once Upon a Slide Rule

by Jon Rokne

The state of engineering calculations using paper and pencil aided by tables and slide rules was mostly unchanged for the first half of the 20th century. Then, in the 1950s, programmable computers and electronic calculators became available. As these devices were quite expensive, the calculations were still done by the traditional methods using slide rules and paper and pencil. However, this changed radically when programmable computers and electronic calculators became affordable in the 1970s so that they are now almost universally the tools used for scientific and engineering calculations.

The question, "Do you know how to use the slide rule?" is often met with a blank stare and frequently with another question: "What is a slide rule?" Needless to say, knowledge of the use of the slide rule is fast disappearing. In this note, an attempt is therefore made to provide a nostalgic view of the past engineering calculating practices as they had a certain elegance that is missing in the current digital computer era.

The tables of function values were generally found in books that included values of logarithms in a range from one to 10 and values of other special functions, such as sines, cosines, tangents, and their logarithms over appropriate ranges. These books ranged from inexpensive small booklets containing four-digit tables of logarithms and other functions up to larger books with listings of five-, six-, or seven-digit values. As an example, the booklet by Castle [1] shown in Figure 1 had tables of five-digit values. A photo of a rather large book of tables by Smoley [2] is given in

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Figure 2. The tables were comparatively easy to use, but their accuracy was limited to the number of digits provided for the

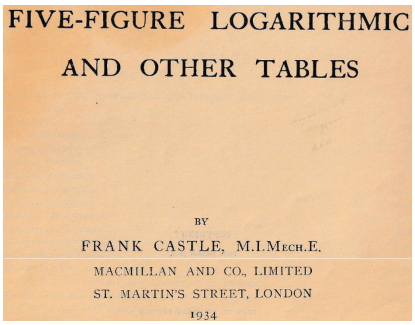

Figure 1: Tables of logarithms and other useful functions.

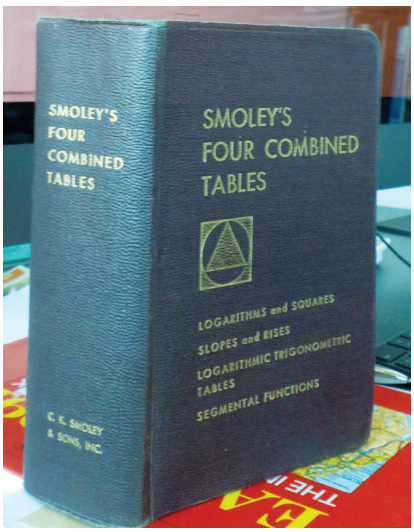

Figure 2: The book of tables by Smoley.

function values. A basic understanding of divided differences and interpolation was required if higher accuracy was needed.

The slide rules were analog simulations of calculations using logarithms. This was accomplished by mapping the scale between one and 10 as a continuous set of numbers onto two continuous logarithmic scales. Hence, the numbers on the logarithmic scales were the logarithms of the original numbers, at which point, the properties of logarithms such as the fact that the multiplication of numbers between one and 10 was equivalent to the addition of the logarithms of the relevant numbers could be executed by sliding the two scales relative to each other.

In its basic form, as provided by simple slide rules for high school students, it was used to multiply and divide numbers by adding or subtracting the logarithms of the numbers on the two basic scales, as noted earlier. More advanced slide rules had further scales that displayed the logarithms of exponential, trigonometrical, and possibly other functions. This was very useful for engineering and scientific calculations, but not of much use in day-to-day calculations.

The slide rules had to be precision manufactured because the numbers had to be read off the slide rule as accurately as possible. As an example of a calculation, the value of $2 \times \pi$ was calculated using the Versalog slide rule shown in Figure 3, which has the regular logarithmic scales as well as logarithmic scales with the origin (i.e., the start of the scales) shifted by π. When reading the result off the appropriate scale, it was clear that the first two digits were "6" and "2," with a guess for the next digit being "8." So, the result would be 6.28 with the "8" being somewhat uncertain, showing that the precision obtained using a slide rule was limited to the resolution of gradation on the scales.

The slide rules were analog computers, as noted previously. They were used to perform engineering calculations for determining voltages, displacements, rates of flow, strengths of structures, and other quantities required to construct electronic devices, machines, and so on. One feature of the slide rules was that they had no "intelligence," and hence, the intelligence had to be supplied by the user. They required step-by-step instructions for their use, i.e., a recipe or a program. That is, the steps required for a particular calculation had to be known to the user and executed in an orderly manner, and this required extensive practice. The instructions for how to use the Versalog slide rule were, for example, provided in book form [3]. Some ability for estimating of the order of the final result was also required as the results were only produced modulo 10, as noted previously.

In general, only students of higher educational institutions such as universities and technical institutes would acquire a precision slide rule for their studies, both due to the cost and the skills needed to

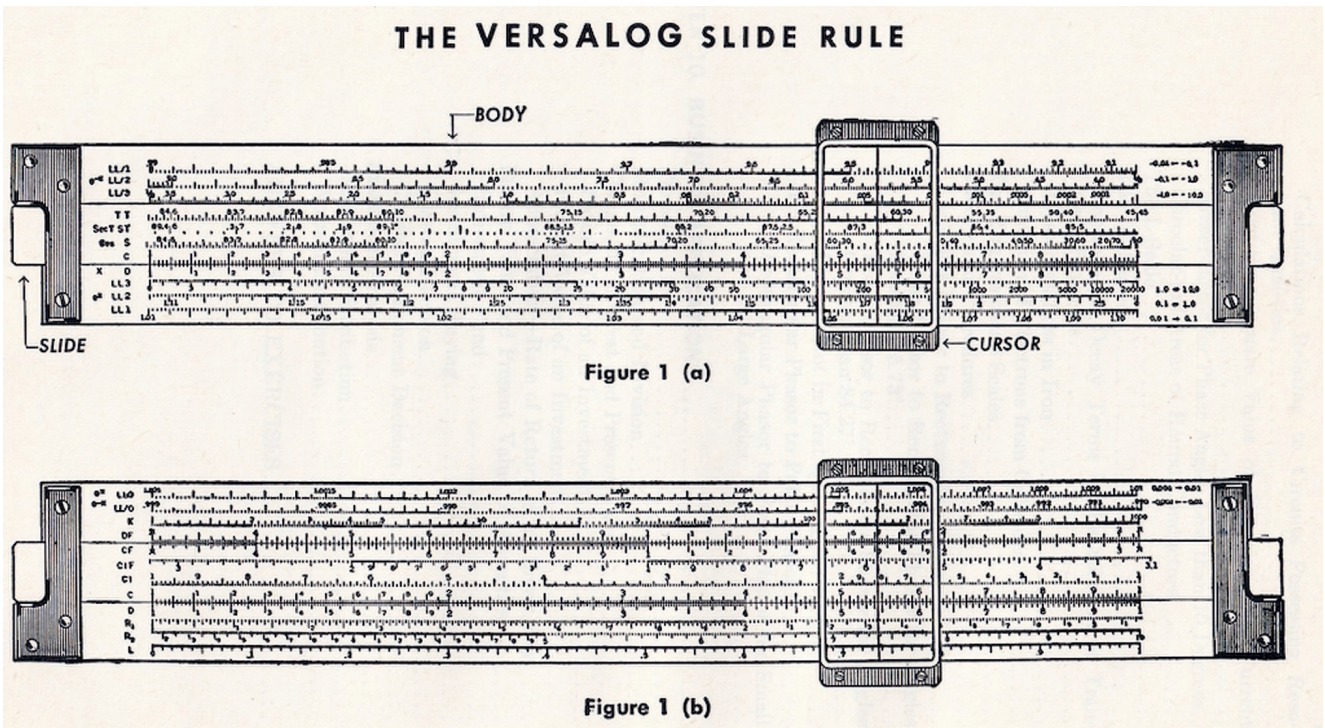

Figure 3: The Versalog slide rule.

use the slide rule effectively. Once they became professionals, such as engineers and scientists, the slid rule became a constant companion for their work. There was a certain pride in being able to use the slide rule effectively, and it was an indication that one belonged to the engineering and science community. A quality slide rule was also not an instrument acquired by the average individual, as in today's currency the cost of a quality slide rule was comparable to the cost of a standard smartphone.

A number of companies existed for making slide rules as well as other devices for scientific and engineering calculations and experiments. One of the companies, Keuffel & Esser Co., had a catalogue, the front page of which is shown in Figure 4. This catalogue included slide rules as part of a collection of precision instruments for various geometry and tasks as well as engineering calculations.

A drawing from "Arithmetic for Engineers" [4] of a typical simple slide rule is shown in Figure 5.

More advanced slide rules (such as those used by "real" engineers) had more scales on both sides of the device, such as the slide rule depicted in Figure 3. The main scales of this slide rule were denoted by *A*, *B*, *C*, and *D* on one side and *C*, *D*, *CF*, and *DF* on the other. The *D* and *A* scales were fixed and the *C* and *B* scales moved relative to the fixed scales. The *A* scale had the squares of the numbers on the *D* scales. *DF* and *CF* were scales shifted by π relative to the *C* and *D* scales, respectively. This labeling of scales was generally used by slide rule manufacturers.

Most of the slide rules came with an instruction booklet or a book. The Versalog slide rule had, for example, an instruction manual as shown in Figure 3 [3]. Effective use of a slide rule required an understanding of the operations of the slide rule, and learning to effectively execute calculations on a slide rule through extensive practice. The ability to estimate the results of a calculation was also useful, especially because results were only obtained modulo a power of 10. A main advantage of slide rules was also that they needed no batteries for their operation, and hence, they were perfectly environmentally friendly and did not contribute to global warming when used.

The typical operation of a simple slide rule is shown in Figure 6 and described as follows:

- Move the sliding middle section with scale "C" (the slide) so that the "1" on the scale matches the "3" on the "D" scale.
- Now read along the "C" scale to the "2" and see what it says on the "D" scale.

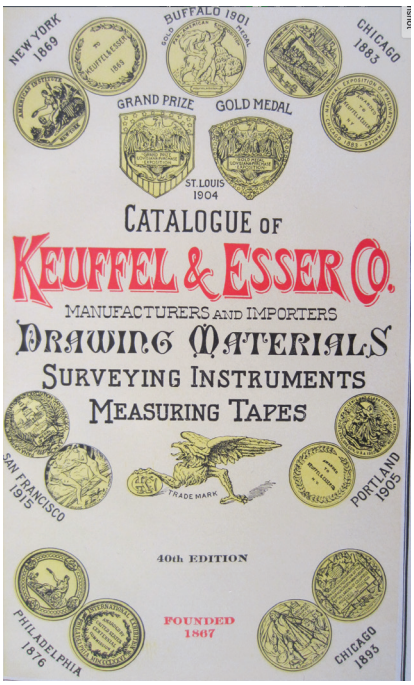

Figure 4: The Keuffel & Esser catalogue.

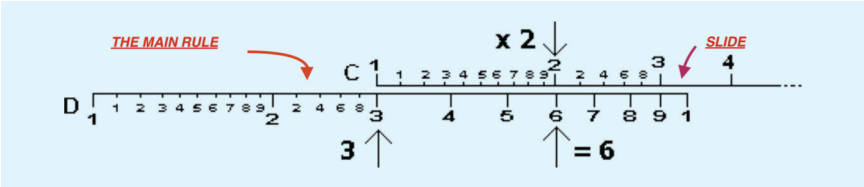

Figure 6: Calculating 3 × 2 on a slide rule.

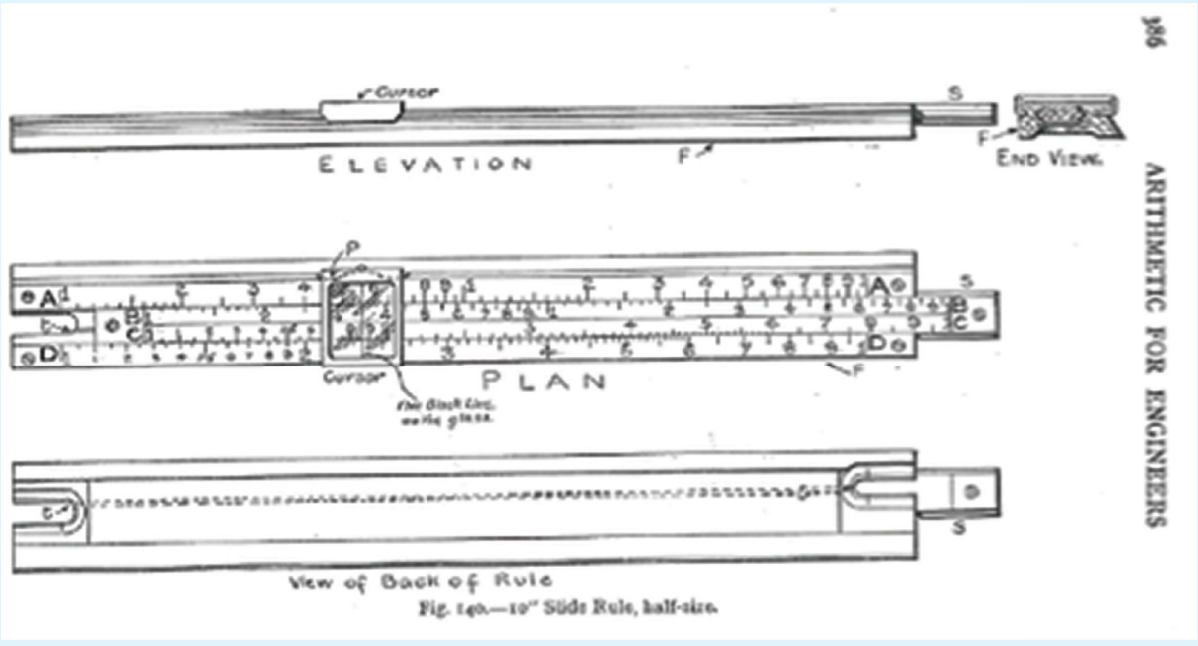

Figure 5: The views of a slide rule from [4].

- It should show approximately "6." The correct answer is, of course, exactly "6."
- We have just added a log of "3" distance on the bottom to a log of "2" distance on the top to get a log of the "6" distance on the bottom. Assuming that the power involved was "1," the result would be "6." Calculating 20 × 3, 2 × 30, 20 × 30, and so on would involve exactly the same operations on the slide rule. The only change would be that the power by which the result had to be multiplied by would change. In the case of 20 × 30, the result would be 6 × 10 to the power of two.

Even today, there are slide rule enthusiasts. In [9], the question, "Why a program on slide rules?" is asked. The following discussion provides the answer [9]:

> When you work on electronic calculators and screens, numbers appear out of nowhere, transform mysteriously inside microcircuits, and then disappear into electronic oblivion, all at the tap of a key. Slide Rules provide a physical, observable pallet for numbers and a way to visualize and even feel how they relate, operate, and change during mathematical operations. The tactile and visual input of a Slide Rule can transform your understanding of math and boost your proficiency in tackling equations. You'll also develop an appreciation for the genius behind the Slide Rule and the three and a half centuries of invention, calculation, and construction it made possible before our modern world.

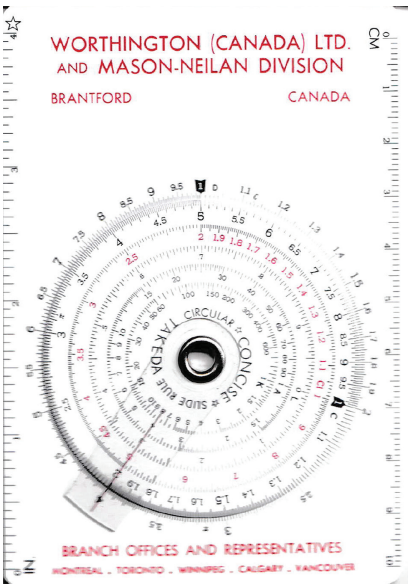

Figure 7: A circular slide rule.

There were other variations of slide rules, such as circular slide rules, as seen in Figure 7. It was, as can be seen from the figure, a promotional item, and the size was approximately 3 × 4.5 in. In this figure, the calculation of 2 × 3 is indicated to be approximately "6," as read from the main inside circular rule.

The circular slide rule more clearly embodies the important fact about slide rules, that is, that any calculation is made modulo a power of 10, as noted previously. The calculations of 2 × 2, 20 × 2, 20,000 × 2, and so on take place on the same points of the slide rule. After the calculation has been performed, the actual power of 10 associated with the result is a secondary issue that the user has to establish by other means.

At the other end of the size scale, one would find slide rules used for classroom instruction. The slide rule shown in Figure 8 is roughly 7 ft long. It was used at the Southern Alberta Institute of Technology for instructing budding engineering technologists in the intricacies of calculations using slide rules.

The history of the slide rule and its related calculating instruments is preserved by the International Slide Rule Museum [7], located in Louisville, Colorado. They have an extensive collection of slide rules and manage a Slide Rule Instructions Library Preservation Project. Among its activities, they have produced 34 volumes of reprints of slide rules instruction manuals for all known brands, countries of origin, and languages used.

Slide rules also have been featured in science fiction, which an easy Internet search can verify. Its use is even the topic of a book by the well-known science fiction writer Isaac Asimov [8].

A nicely illustrated website can be found at https://www.stempunked.com/when-slide-rules-ruled. ■

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About the Author

Jon Rokne (rokne@ucalgary.ca) is a professor and former head of the Computer Science Department at the University of Calgary. Educated in Norway and Canada, he received his Ph.D. degree in mathematics from the University of Calgary. He chaired the Computer Science Department at the University of Calgary from 1989 to 1996. He has published extensively in mathematics and computer science, including coauthorship of the *Encyclopedia of Social Network Analysis and Mining*. He is also a co-organizer of the IEEE/Association for Computing Machinery International Conference on Advances in Social Networks Analysis and Mining conference series. He has been extensively involved with IEEE activities, including having been the IEEE Publications Services and Products Board vice president in 2009–2010, holding membership on a number of boards and committees, and developing several new IEEE transactions and magazines.

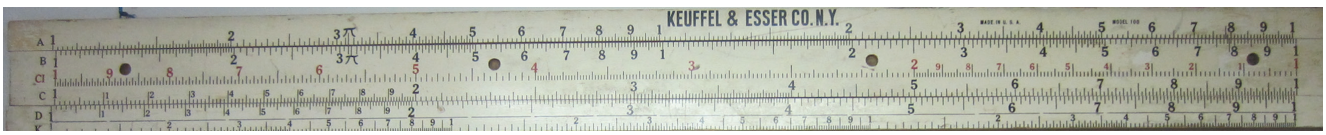

Figure 8: The 7-ft slide rule used for instruction (less cursor).

Nuclear Fusion Energy

by Terrance Malkinson

Policymakers and concerned citizens are shifting away from fossil fuels as a primary energy source and encouraging transition to renewable energy technologies to meet the Paris Agreement's target of full decarbonization by 2050. Hydroelectric, geothermal, and tidal power can function in only a limited number of sites. Renewable energy from wind and solar is currently the most cost-efficient form of new zero-carbon electrical generation. Batteries and other forms of energy storage have not yet reached the level of development for large-scale deployment. The demand for zero- or low-carbon electricity will increase as society worldwide becomes increasing electrified. This will also require upgraded and more electricity high-voltage transmission lines from the energy source to the point of use. Fusion energy has the potential for cost-effective zero-carbon electricity grids.

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In 1920, the English astronomer, physicist, and mathematician Arthur Eddington suggested that hydrogen–helium fusion could be the primary source of stellar energy. Since then, scientists have been studying nuclear fusion with the objective of developing it as a technology that would provide limitless, cost-effective, minimal-emission, carbon-free energy available to all. On 13 December 2022, scientists at Lawrence Livermore National Laboratory's (LLNL's) National Ignition Facility (see Figure 1) (www.llnl.gov) made history announcing their success in producing the first small nuclear fusion reaction, which resulted in a net energy gain (www.llnl.gov/news/national-ignition-facility-achieves-fusion-ignition).

This event proved that it is possible to create more energy than is needed to produce it. Engineers and scientists worldwide consider this to be a milestone in the quest for safe, clean energy. The influential British Science Media Centre's expert reaction to this advance in nuclear fusion from LLNL is largely favourable (www.sciencemediacentre.org/expert-reaction-to-fusion-announcement-from-the-lawrence-livermore-national-laboratory). There are many more development steps necessary before its full implementation. Scientists and engineers need to determine how to produce controlled sustained fusion energy from nuclear fusion on a large scale and how to reduce the cost. Scientists also need to develop methods to harvest the heat energy produced by fusion and transfer it to the power grid as electricity. It will take years, perhaps even decades, before fusion will produce unlimited amounts of clean energy.

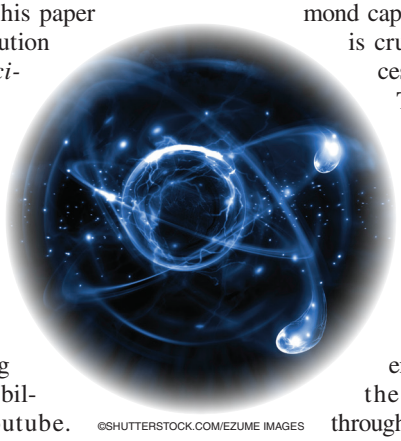
It is important to note that nuclear fusion is much different from nuclear fission. Fission is the process of splitting a larger atom into two or more smaller ones and is the kind of energy that powers nuclear reactors and weapons of mass destruction or the risk of catastrophic events such as that of the Fukushima and Chernobyl fission reactors. Nuclear fusion (see Figure 2), on the other hand, happens when two or more atoms are fused into one larger one, a process that generates a massive amount of energy as heat without harmful emissions such as nuclear waste. The heat can be used to create steam, which then turns turbines to generate electrical power. Nuclear fission is nearly 8,000-times more

Figure 1: The target chamber of LLNL's National Ignition Facility, where 192 laser beams delivered more than 2 million joules of ultraviolet energy to a tiny fuel pellet to create fusion ignition. [Source: Reproduced as governed by the permissions of the Creative Commons Copyright License (www.creativecommons.org/licenses/by-nc-sa/4.0/); (www.llnl.gov/copyright-and-reuse)].

Figure 2: The Sun generates its energy by nuclear fusion. (Source: LV4260: iStock.)

efficient at producing energy than traditional fossil fuels.

Fusion is a man-made process that replicates the same energy that powers the Sun. Eddington anticipated the discovery and mechanism of nuclear fusion processes in stars in 1920 in his paper "The Internal Constitution of the Stars" (*The Scientific Monthly*. 11(4): 297–303, 1920). The Sun fuses 620 billion kg of hydrogen nuclei into helium, to produce 384.6 TJ of energy per second at a solar-core temperature of 14 million K and has been doing this for the past 4.57 billion years (www.youtube.com/watch?v=xR88vSiOvY4); (www.universavvy.com/nuclear-fusion-in-sun).



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Nuclear fusion is the process by which two light atomic nuclei combine to form a single heavier one. This combination releases massive amounts of energy in the form of heat. Fusion projects use the isotopes of hydrogen: deuterium (one proton and one neutron) and tritium (one proton and two neutrons) (see Figure 3). The reaction creates helium (two protons and two neutrons) and the release of one free neutron (www.youtube.com/watch?v=Hy8fB32GZoc).

There is a variety of approaches to fusion that follow different technologies. There are two competing primary designs for fusion plants that have emerged. The first uses high-intensity lasers that trigger a series of reactions that slam atoms together many times per second. The second uses strong magnets to contain a cloud of plasma that burns hotter than the Sun (www.bloomberg.com/graphics/2023-fusion-power-path-lasers-versus-magnets/?leadSource=uverify%20wall):

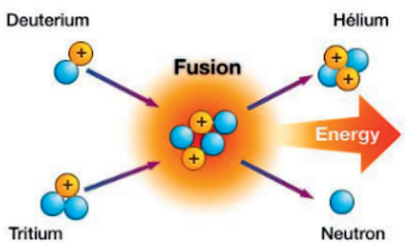

Figure 3: Fusion of deuterium with tritium creating helium, freeing a neutron. (Source: Clip art from Microsoft Bing.)

- The Inertial Confinement Fusion approach used by LLNL uses powerful lasers to blast very small targets consisting of isotopes of hydrogen packed inside a diamond shell. Engineering of the peppercorn-sized synthetic diamond capsule that holds the fuel is crucial to creating a successful fusion experiment. The sphere has to be perfectly smooth and contaminant free. The precisely engineered spheres are the result of years of work by Diamond Materials (www.diamond-materials.com/en), which manufactures the synthetic diamond through a process called *chemical vapour deposition* (www.bbc.com/news/business-64553796). When the diamond capsules arrive at LLNL, the silicon core is removed and a tiny glass tube is used to fill the hollow sphere with deuterium and tritium. When operational, the laser beam converges on the target from multiple directions and rapidly compresses it in a timescale of roughly one billionth of a second. At that point, the hydrogen isotopes, deuterium, and tritium are squeezed to a state where they are converted into helium, momentarily releasing energy in the process. In this case, 192 high-energy lasers converged on a target, heating a capsule of deuterium and tritium to higher than 3 million °C, briefly simulating the conditions of a star. The LLNL experiment generated 3.15 MJ of energy from 2.05 MJ of input from the laser (www.llnl.gov/news/national-ignition-facility-achieves-fusion-ignition).
- The International Thermonuclear Experimental Reactor (ITER) is an experimental fusion reactor based on the "tokamak" concept, a toroidal magnetic configuration that creates and maintains the conditions for controlled-fusion reactions. Magnetic confinement traps high-temperature plasma in a powerful magnetic field until fusion reactions can take place (www.iterus.org). The advantages of this method are that, in theory, the plasma could be held in a steady state, producing energy for many years, and that the method has a large scale, which is best for commercial electricity generation. This is the strategy behind ITER, a giant demonstration reactor that is nearing completion in France and expected to begin operations in 2025. Thirty-five countries are collaborating. The plans are to conduct its first experiments in the second half of this decade, and full-power experiments are planned to commence in 2036.

The International Atomic Energy Agency launched the *Nuclear Fusion Journal* (www.iaea.org/publications/nuclear-fusion) in 1960 to exchange information about advances in nuclear fusion. The *Journal*'s scope includes the production, heating, and confinement of high-temperature plasmas, the physical properties of such plasmas, the experimental or theoretical methods of exploring or explaining them, fusion reactor physics, reactor concepts, and fusion technologies.

There are a number of alternative approaches that are in the early stages of exploration, with the goal of creating fusion designs that might be smaller, cheaper, and easier to deploy than the two mainline approaches.

Canadian Involvement in Nuclear Fusion Energy Development

Today, there are pockets of small-scale fusion-related research occurring across Canada at universities and at private-sector start-up companies. Although these groups are contributing to fusion research, Canada needs to step up by increasing its involvement to see the benefits that will come from the development of commercial fusion energy. Canada has the financial resources and brainpower to do this. Canadian scientists and engineers are highly respected internationally, as exemplified by our significant involvement in the James Webb Telescope (https://canrev.ieee.ca/en/cr89/, pp. 6–12) space exploration, and many other important projects. We simply have to make the effort by making it a national priority (www.cbc.ca/news/canada/british-columbia/canada-nuclear-fusion-2030-1.3953187).

Fusion energy has the potential for cost-effective zero-carbon electricity grids.

Vancouver-based fusion energy company General Fusion has entered into an agreement with the United Kingdom

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Atomic Energy Authority to build a nuclear fusion demonstration plant using a unique approach to generating clean energy (www.cbc.ca/radio/quirks/could-a-canadian-company-s-new-project-finally-make-fusion-power-a-reality-1.6071064).

Members of the Fusion Energy Council of Canada (www.fusionenergycanada.ca) established in 2016 represent engineers, scientists, government representatives, the energy and utility industries, financiers, businesspeople, academics, and individuals with an interest in fusion and spin-off technologies. The council is proposing a revitalized Canadian fusion program with the vision that by 2030, Canada will support the deployment of a demonstration fusion power plant.

The Fusion 2030 Roadmap For Canada (www.cns-snc.ca/wp-content/uploads/2022/08/Fusion-2030-Roadmap-for-Canada.pdf) lays out the goal to position Canada to be a world player in fusion research in five years and a leader in 10. It calls for a revitalized national Canadian fusion program in concert with provincial initiatives to prepare Canada for the coming fusion era. Preparedness and participation are the key attributes of the strategy. Climate change, clean technology, and innovation are identified as major issues facing Canada's future. This report provides the reader with a comprehensive discussion of the state of the art related to nuclear fusion.

The call for action presented in the Fusion 2030 Roadmap For Canada presents the following two phases for action:

1) The first phase would start with a capacity-building phase of approximately five years to position Canada with basic expertise and facilities in the key areas currently advancing in fusion energy.
2) The second phase of the program would be ramping up to the participation in a demonstration reactor project.

As stated in the report, "through this process Canada will build world leadership in a number of areas and build strong international linkages in the integrated high technology economy of the future. Most importantly, Canada will help accelerate the process of developing fusion energy with Canadian knowledge and expertise."

Nuclear fission is nearly 8,000-times more efficient at producing energy than traditional fossil fuels.

Conclusion

The world's population is expected to be 9 billion by 2040. With a growing population comes a growth in energy demand. In the next 20 years, the largest growth by energy commodity will be electricity, with its demand projected to increase by 45% by 2040. The current energy policy, in large part, is being driven by public objectives concerning climate change. The goal is a zero-carbon energy grid. Volatility in the energy markets and geopolitical challenges complicate the transition to net zero in the short term. In the longer term, the benefit and economics of renewable power sources will drive investment. The success last December at the LLNL's National Ignition Facility is likely to give the sector a boost as government, philanthropic, and corporate funding will be easier to obtain. More than US$4.8 billion has been invested privately and by government into companies pursuing fusion.

Nuclear fusion is the energy process that powers the Sun. Fusion energy is safe, reliable, clean, and sustainable. It has the highest energy density, best energy payback ratio, and lowest carbon footprint of any source. It is an excellent solution to the problems of global climate change and long-term energy security. In addition, fusion energy research pushes the bounds of fundamental and applied research in areas ranging from plasma physics to materials science, high-performance computing, and power engineering, to name just a few areas:

- Fusion fuel is unlimited. Fusion requires deuterium and tritium, isotopes that can be extracted from seawater and derived from lithium. There is enough supply to meet the world's energy demand for millions of years. Fusion energy is inherently safe.
- Fusion produces zero greenhouse gas emissions, emitting only helium as exhaust. There is no radioactive waste. Land and water use and biodiversity impacts are minimal.
- Fusion ranks the highest in terms of the ratio of useable energy available given the amount of energy required to make that useable energy. Fusion has the best energy density of any energy system in terms of the amount of energy produced by the amount of land/water/area needed.

Sustainable, clean base-load energy to replace carbon fuels is the paramount issue of this century, and fusion is a major part

of the solution. Fusion energy research also has the potential to enhance research, innovation, and industrial development. Canada needs to be involved in a leading role. We have the engineering expertise and financial resources. Development of a fusion energy solution is a nation-sized challenge that requires coordinated national research leadership. Recent advances by international research consortia, universities, and private industry are showing that practical fusion energy production is getting closer and will likely be achieved in the next 20 years. The development of enabling technologies has allowed fusion to overcome many barriers, and innovative engineering will overcome those that remain. Additionally, although fusion technology is inherently less susceptible to serious safety incidents, a regulatory framework for licensing fusion power plants will be required for deployment while ensuring safety. The next 5–10 years will be critical for the development of fusion energy. Business leaders need to start preparing for the opportunities presented by technology. ■

Late Breaking News

During the 28th session of the Conference of the Parties (COP28), an international engagement plan on nuclear fusion as a dominant source of clear energy, involving a worldwide consortium of 35 nations in the fight against climate change, was announced. The plan focuses on key areas including research and development; a strong, robust, and secure supply chain management; and regulatory frameworks with the goal to triple global nuclear energy generation by 2050. The strategy aims to address climate change, ensure long-term energy security, and promote international collaboration in the fight against climate change while building public trust in nuclear fusion technology. This emerged as a policy departure as nuclear has received little attention at past conferences. This international engagement plan may well be a game-changer in creating a sustainable energy future. The plan is detailed at: www.energy.gov/articles/cop28-countries-launch-declaration-triple-nuclear-energy-capacity-2050-recognizing-key

Further Reading

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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, 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 50-year, Life Senior Member of IEEE. He has served in many professional public and private governance and publication roles. He is a founding member of *IEEE USA Insight*. 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. He is a manuscript reviewer and a special topic editor for several journals. Other passions include communicating emerging technologies to the public, investigative journalism, philanthropy, and mentorship. His current research interest in emerging technologies and health and wellness extends to being an accomplished multisports triathlete, including, among other events, the completion of 11 full-distance Ironman Triathlons.

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-ITU Inter-Union Working Group, the IEEE AP-S/URSI conference to be held in Ottawa in 2025, Citizen Radio Science, and the potential role of IEEE Canada and CNC-URSI in bringing together members of the engineering community with an interest in amateur radio and supporting the use of amateur radio in teaching and research in universities across Canada.

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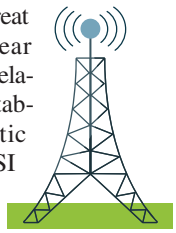
URSI–INTERNATIONAL TELECOMMUNICATIONS UNION INTER-UNION WORKING GROUP

Canada's efforts to promote establishment of an URSI–International Telecommunications Union (ITU) Inter-Union Working Group have achieved great success. After a 25-year lapse, the URSI–ITU relationship has been reestablished with enthusiastic support from the URSI Board of Officers and senior leaders in the ITU, including Radiocommunication Bureau Director Mario Maniewicz and ITU Radiocommunications Study Group Department Chief Sergio Buonomo. We look forward to seeing how URSI and ITU can work together to address some of the technical issues facing the spectrum regulatory community.



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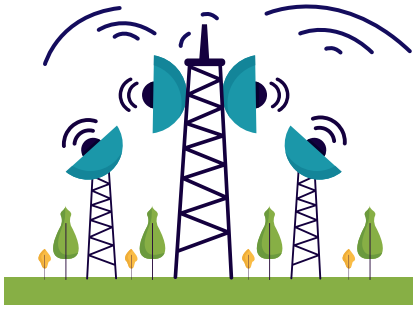
IEEE ANTENNAS AND PROPAGATION SOCIETY/URSI 2025: 13–18 JULY 2025, OTTAWA

In just over eighteen months, Canada will host the IEEE Antennas and Propagation Society (AP-S) International Symposium and North American Radio Science Meeting (IEEE AP-S/URSI) at the Shaw Center in Ottawa. Running from 13 to 18 July 2025, the conference will bring as many as 2,000 researchers from around the world together to share their latest work in antennas, propagation, and radio science.

The Canadian National Committee of URSI will take the lead in organizing the conference. Planning for the major events of this conference starts early as members of the local organizing committee



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are recruited, venue contracts are signed, room blocks at nearby hotels are reserved, social events are planned, and patrons and exhibitors sign on. With just over eighteen months to go, preparations are moving into high gear.

Since the first IEEE AP-S/URSI conference was held in Canada in Quebec City in 1980, our community has earned a solid reputation for delivering high value to participating academic researchers. An important goal for the 2025 edition is to ensure that we also deliver high value to participating government and industrial organizations.

For executives and managers of government and industrial organizations, IEEE AP-S/URSI offers an opportunity to share success stories, increase visibility and recognition, engage with potential collaborators, and recruit new talent. For the local organizing committee, the challenge is to ensure that such outcomes occur reliably and consistently.

One way is to ensure that executives and managers fully appreciate the opportunities that the conference brings and provide advice on how they can achieve the benefits that visibility and recognition bring. Encouraging their staff to submit presentations, take on volunteer roles, and organize and chair sessions is a great start.

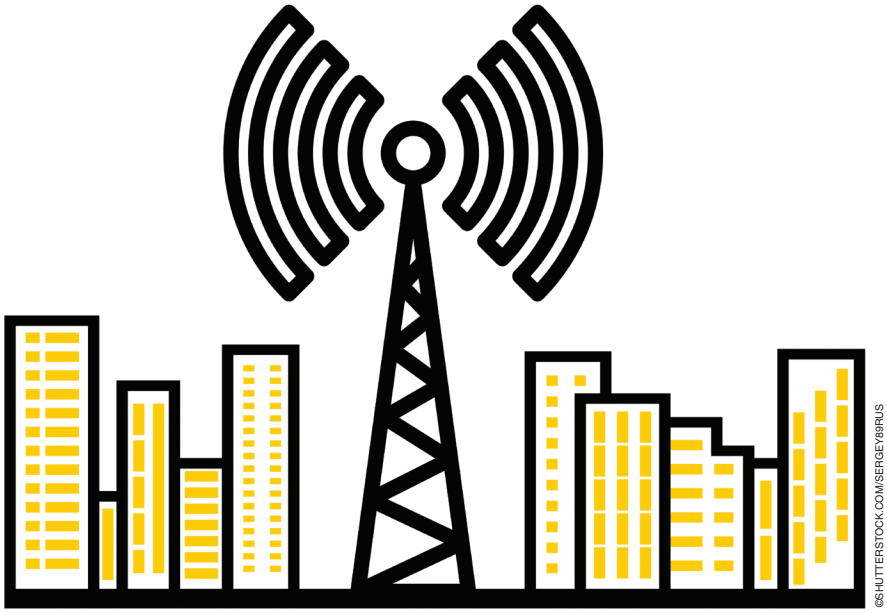
Visibility and recognition can be further enhanced by hosting a booth and possibly giving a presentation or demonstration in the exhibits area, hosting a workshop (onsite) or corporate tour (offsite), and becoming a conference patron and possibly giving a plenary presentation. During the next few months, the 2025 organizing committee will be reaching out to potential industry and government participants with the aim of clarifying and strengthening the value proposition associated with their involvement.

CITIZEN RADIO SCIENCE

HamSCI (https://www.hamsci.org/) was started by researchers who study upper atmospheric and space physics and who are also radio amateurs. They recognized that amateur radio projects, such as the Reverse Beacon Network, WSPRNet, PSKReporter, DX Cluster, ClubLog, and more, are generating big datasets that could provide useful observations of Earth's ionosphere and related systems.

HamSCI is currently pursuing three projects of potential interest to both individual radio amateurs and those affiliated with universities:

1) Concurrent with the 14 October 2023 and 8 April 2024 annular and total North American eclipses, the worldwide amateur radio community will be transmitting, receiving, and recording signals across the high-frequency (HF) radio spectrum to provide data for space physics research. The operating format will be a series of friendly ham radio competitions and researcher-led experiments. Key science questions include the following:
   - How does the ionosphere couple with the neutral atmosphere and with space?
   - How do solar eclipses impact ionospheric structure and dynamics?
2) The Personal Space Weather Station project ultimately aims to create a small, multi-instrument system that can make ground-based measurements of the space environment. The PSWS network has proven to be useful in the study of short-term (lasting hours to days) geophysical and solar events, such as traveling ionospheric disturbances (TIDs), solar flares, solar eclipses, and geomagnetic storms. It does so by observing the bottom side of the ionosphere. Data from PSWS member stations, often combined with observations from other scientific instruments, yields clues as to how and why those events impact HF (3–30-MHz) radio wave propagation. The data can also be used to improve mathematical models of the ionosphere, which should result in more accurate predictions of HF propagation (such as maps of the MUF and critical frequencies). Key science questions include the following:
   - How does the ionosphere respond to inputs from space and from the neutral atmosphere?
   - How does the ionosphere couple with the neutral atmosphere and with space?
3) TIDs are variations in the ionosphere that can impact medium-frequency and HF radio communications through fading (QSB) and by causing variations in communications distance. In this project, we use data from large-scale amateur radio networks, such as the Reverse Beacon Network, WSPRnet, and PSKReporter, to study the sources, characteristics, and dynamics of TIDs. Key science questions include the following:
   - How does energy move from the lower atmosphere to the upper atmosphere to generate TIDs?
   - What percentage of observed TIDs are correlated with geomagnetic activity, and what percentage are not?
   - What is the TID longitudinal dependence on the 2D stratospheric polar vortex configuration?



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IEEE CANADA, CNC-URSI, AND AMATEUR RADIO

Do IEEE Canada and CNC-URSI have a role to play in bringing together members of the engineering community with an interest in amateur radio and supporting the use of amateur radio in teaching and research in universities across Canada? If you would be interested in joining an IEEE Canada/CNC-URSI Affinity Group on Amateur Radio, please let me know. ■

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 http://www.ursi.org/. For more information about URSI Canada, please visit http://www.ursi.ca/.

About the Author

David G. Michelson is president of the Canadian National Committee of the International Union of Radio Science (2018–2026). He has led the Radio Science Lab at the University of British Columbia, Department of Electrical and Computer Engineering, since 2003. His current research focuses on short-range/low-power wireless networks for industrial vertical and transportation applications, millimeter-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. He is licensed in Canada (basic, advanced, and digital) as VA7DM and in the United States as NC7V (extra class). He is an ISED-accredited amateur radio examiner.

IEEE Canadian Atlantic Section Holds Annual Life Member Recognition Event

The IEEE Canadian Atlantic Section held its Annual Life Member Recognition Event on 13 June 2023 on the patio at the Celtic Corner Pub in Dartmouth, Nova Scotia. This was the first time this event was held since the pandemic began. There were 23 people, including nine Life Members, in attendance.

Recent Life Members were presented with a Life Member pin in recognition of their contributions to IEEE. These Life Members represent more than 200 years of engineering experience. A great time was had by all as old friends and colleagues reconnected.

Jim MacKenzie receives a Senior Life Member pin from Dr. Mae Seto.

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