IEEE Canadian Review
La revue canadienne de l'IEEE
Summer / Été 2024 — No. 96

History of Technology

Collectors and Curators

The Science of History

Radio Broadcasting and the Canadian National Railway

Cobalt-60 Radiation Therapy

Trans-Canada Telephone System

IEEE Canada

IEEE Canadian Conference on Electrical and Computer Engineering & Industry Summit

Vancouver

26-29 May 2025

SPECIAL SESSION ON THE HISTORY OF TECHNOLOGY

- the history of electrical engineering, electronics, and computing, their applications, and their impact on social and economic development
- the people, programs, places, policies, institutions, and organizations that have shaped the history of electrical engineering, electronics and computing
- efforts to preserve and promote our technological history and heritage

https://ccece2025.ieee.ca

Topics for IEEE CCECE 2025 include:

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- Power Systems and Power Electronics
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Industry theme days will offer professional development opportunities including plenary speakers, panel sessions, and hands on training on topics such as wireless communications, marine technology, and intelligent transportation.

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CSHPS/SCHPS is a Canadian forum bringing together historians, philosophers, sociologists, and a wide range of interdisciplinary scholars interested in exploring all aspects of science, past and present.

The Canadian Society for the History and Philosophy of Science (CSHPS) will hold its 2025 conference at George Brown College in Toronto as part of the annual Congress of the Humanities and Social Sciences (30 May – 6 Jun 2025).

https://cshps.ca/

IEEE Canadian Journal of Electrical and Computer Engineering

Since 1976, the IEEE Canadian Journal of Electrical and Computer Engineering (IEEE CJECE) has been publishing high-quality refereed scientific papers in all areas of electrical and computer engineering. It is indexed in both ISI and IEEE Xplore.

The IEEE CJECE invites submission of papers concerning the History of Science and Technology including:

1. Papers presenting new and original results, techniques or concepts, and,
2. Survey-style papers providing a rigorous analysis of existing results.

https://journal.ieee.ca

IEEE HISTELCON 2025

September 30 – October 2, 2025
Bonn, Germany

HIStory of ELectrotechnology CONference is the only conference in the IEEE that addresses the history of technology and its implications for modern society, industry and education.

HISTELCON is part of the R8 portfolio of conferences and was organized for the first time in France in 2008. The 2025 edition is the ninth. On March 31, 2024, an agreement among R8 and R7, R9 and R10 was signed to transform this conference into a multi-region event rotating among the four regions and always with the Technical Co-sponsorship of the IEEE History Center and IEEE History Committee.

https://www.ieee-histelcon.org

President's Message/Message du Président

Tom Murad
P.Eng., Ph.D., F.E.C., SMIEEE

2024–2025 IEEE Canada President and Region 7 Director
2024–2025 Président de IEEE Canada et Directeur de la Région 7

Once again, I am honored to extend a warm welcome to each and every one of you as I am communicating with you for the second time since I had the privilege of assuming the role of president of IEEE Canada and director of IEEE Region 7, and had the opportunity to work side by side with many of you in the last several months and enjoy our collective growth and success.

In my previous article, I mentioned that "positive change" is the one expression that should mostly mark my term (2024–2025) as I believe that positive transition within organizations like IEEE Canada are instrumental for our operational success, our membership growth, enhancement, and personal development as well as making us more efficient for creating positive outcomes for our Canadian engineering and technology community.

As challenging as the several past months were, while we were focusing on transitioning into a new organizational structure

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Encore une fois, je tiens à souhaiter la bienvenue à chacun d'entre vous, alors que je communique avec vous pour la deuxième fois depuis ma nomination en tant que président d'IEEE Canada et de directeur de la région 7 de l'IEEE et J'ai eu l'occasion de travailler aux côtés de bon nombre d'entre vous au cours des derniers mois, et de profiter de notre croissance collective et de notre succès.

Dans mon article précédent, j'ai souligné que l'expression « changement positif » est essentielle pour mon mandat (2024-2025), car je suis convaincu que la transition positive au sein d'organisations comme IEEE Canada est essentielle à notre succès opérationnel, à la croissance de nos effectifs, la consolidation du développement personnel, ainsi que la création de résultats positifs pour notre communauté canadienne du génie et de la technologie.

Même si les derniers mois ont été éprouvants, nous avons mis l'accent sur la transition vers une nouvelle structure organisationnelle

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History of Technology

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President's Message/Message du Président

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and enhancing a professional and dynamic organizational relationship and, more importantly, a new culture of openness, respect, caring, and collaboration in conducting our business, and encouraging active participation, sharing diverse perspectives, and fostering a sense of ownership and accountability. One of the main challenges has been enhancing effective and open communication to create trust, collaboration, stable operations, and proper engagement on all levels. I have to say that many of us kept enjoying their classical comfort zone and insisting on their traditional way of communication, but with time, I am confident that harmony will take place.

By engaging students, we can broaden our influence within academic institutions and among young professionals and help shape the future of the profession.

Nevertheless, I can mention with pride our collective achievements so far during 2024:

- Students' membership growth and enhancement is at the helm of our strategic plans. I sincerely believe that IEEE's future and vitality is crucially dependent on how successful and efficient we are in attracting, training, mentoring, and retaining students and young professionals to join our livelong IEEE professional journey. Students bring fresh perspectives, creativity, and innovative ideas that can invigorate our IEEE. Their input can help to address emerging challenges and adapt to changes within the industry. Younger generations are typically more adept with new technologies, which can help us to adopt modern tools and methods for communication, research, and collaboration. Also, students can become passionate advocates for the profession, spreading awareness and supporting IEEE Canada's mission. Their involvement can amplify the IEEE's impact in educational settings and beyond. By engaging students, we can broaden our influence within academic institutions and among young professionals and help shape the future of the profession. Additionally, having a strong student membership can enhance the public image of our organization, showing that it is committed to nurturing the next generation of professionals.

With that, I can proudly share with you that in 2024, we have thus far established three new students branches in Canada: the Thompson Rivers University Student Branch in the Vancouver Section; Lakehead University-Barrie Hub Student Branch within the Toronto Section, and the IEEE Institut National de la Recherche Scientifique IEEE Photonics Society Student Branch Chapter in the Montreal Section. We also appointed an IEEE Power & Energy Society Student Chapter Committee representative for Canada.

- On the same frontier, in mid-September, we had another special gathering at our 2024 Students' Congress, where about 50 students from most of IEEE Canada students' branches came to a full Weekend Congress held in Winnipeg. They were joined by IEEE Canada Leadership and Executive Committee members, sharing the same venue for

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et sur l'amélioration de notre relation professionnelle et dynamique avec l'organisation et, plus important encore, une nouvelle culture d'ouverture, de respect, de bienveillance et de collaboration dans la conduite de nos activités, et l'encouragement à la participation active, au partage de diverses perspectives et à la promotion d'un sentiment d'appropriation et de responsabilité. L'un des principaux défis a été d'améliorer la communication efficace et ouverte pour créer de la confiance, de la collaboration, des opérations stables et une participation appropriée à tous les niveaux. Je dois dire que beaucoup d'entre nous ont continué à profiter de leur zone de confort classique et à insister sur leur mode traditionnel de communication, mais avec le temps, je suis convaincu que l'harmonie aura lieu. Un des défis majeurs a été d'améliorer la communication efficace et ouverte pour instaurer la confiance, la collaboration, des opérations stables et une participation appropriée à tous les niveaux. Il est clair que beaucoup d'entre nous ont persisté à profiter de leur zone de confort habituelle et à maintenir leur mode traditionnel de communication. Cependant, avec le temps, je suis convaincu que l'harmonie sera concrétisée.

En impliquant les étudiants, nous avons la possibilité d'étendre notre influence au sein des établissements d'enseignement et auprès des jeunes professionnels, et de contribuer à façonner l'avenir de la profession.

Néanmoins, je peux mentionner avec fierté nos réalisations collectives jusqu'à présent en 2024 :

- La croissance et l'amélioration de l'effectif des étudiants sont à la tête de nos plans stratégiques. Il est indéniable que l'avenir et la vitalité de l'IEEE dépendent en grande partie du succès et de l'efficacité de notre capacité à attirer, former, encadrer et retenir des étudiants et des jeunes professionnels pour rejoindre notre parcours professionnel. Les étudiants apportent de nouvelles idées novatrices, de nouvelles perspectives, de la créativité et peuvent contribuer à la revitalisation de notre IEEE. Leur implication peut être précieuse pour relever les défis émergents et s'adapter aux changements au sein de l'industrie. Les jeunes générations ont une meilleure maîtrise des nouvelles technologies, ce qui peut nous aider à utiliser des outils et des méthodes modernes pour la communication, la recherche et la collaboration. Les étudiants peuvent aussi jouer un rôle actif en tant que défenseurs passionnés de la profession, en faisant connaître et en soutenant la mission d'IEEE Canada. Leur implication peut renforcer l'impact de l'IEEE dans les sphères éducatives et au-delà. En impliquant les étudiants, nous avons la possibilité d'étendre notre influence au sein des établissements d'enseignement et auprès des jeunes professionnels, et de contribuer à façonner l'avenir de la profession. De plus, une forte adhésion des étudiants peut contribuer à améliorer l'image publique de notre organisation, ce qui témoigne de sa détermination à former la prochaine génération de professionnels.

Sur ce, je peux vous dire avec fierté qu'en 2024, nous avons établi trois nouvelles succursales au Canada : la succursale

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networking, mentorship, leadership training, and exchanging ideas and experiences.

The Students' Congress, in addition to being a perfect training workshop, provides a formal platform for students to voice their opinions, concerns, and suggestions. It ensures that students have a say in decisions that affect their academic and social lives. Additionally, participating in a Students' Congress teaches students about democratic processes, including voting, debating, and consensus building. It mirrors the functioning of a larger IEEE Board, committees, and other operational unit (OU) platforms that help students to understand their role in such a structured professional association.

The Students' Congress, in addition to being a perfect training workshop, provides a formal platform for students to voice their opinions, concerns, and suggestions.

- During the Students' Congress weekend, we also celebrated a global achievement of one of our Life Members in a ceremony that gave a good flavor of IEEE's and IEEE Canada's new culture and identity as a "multigenerational" organization where student members join long-term Life Members in a unique celebration and recognition of achievement and pave the road for continuous future innovative achievements.
- On the recognition and awards front, I can say with full confidence that we have practically made great progress in reshaping our nomination processes, evaluation resources, and most importantly, an enhanced culture with new initiatives implemented in transparent, fair, systematic, and meaningful evaluation ways, which should definitely regain the involvement of as many of our membership, specifically our Region's active volunteers and teams from industry, academia, and government backgrounds equally, recognizing their dedication, ingenuity, and contributions to their respective fields and the community.

With that, last August, IEEE Canada hosted a fantastic and well-attended gala night at Queens University Campus in Kingston, Ontario, where it recognized and celebrated our 2024 IEEE Canada Distinguished Awards recipients from all backgrounds and experiences.

- The IEEE Canada Gala ceremony was, in fact, the jewel of our "crown" this year.

What I mean by the crown is the 2024 IEEE Canadian Conference on Electrical and Computer Engineering (CCECE 2024)—what a successful event.

This August, IEEE Canada's CCECE conference committee organized the most successful event since we emerged from pandemic-limiting circumstances. Hundreds of scholars, researchers, academics, industry leaders, students, and young professionals from all over the world had a fabulous gathering at Queens University in Kingston, a unique festival of posters, presentations, tutorials, industry and academic debating and discussion panels on various topics of state of the art technologies,

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étudiante de l'Université Thompson Rivers dans la section de Vancouver; la succursale étudiante de l'Université Lakehead et du Carrefour de Barrie dans la section de Toronto ainsi que la branche étudiante d'IEEE Photonics Society de l'Institut National de la Recherche Scientifique dans la section de Montréal. Nous avons également nommé un représentant du comité des étudiants de l'IEEE Power & Energy Society pour le Canada.

- Dans le même cadre, à la mi-septembre, nous avons eu un autre rassemblement spécial de notre Congrès des étudiants 2024, où environ 50 étudiants de la plupart des branches des étudiants de l'IEEE Canada sont venus à un Congrès complet du week-end tenu à Winnipeg. Les membres du Comité exécutif et de leadership de l'IEEE Canada se sont joints à eux et ont partagé le même lieu pour le réseautage, le mentorat, la formation en leadership et l'échange d'idées et d'expériences.

En plus d'être un atelier de formation parfait, le congrès des étudiants offre aux étudiants la possibilité d'exprimer leurs opinions, préoccupations et suggestions de manière officielle. Il veille à ce que les étudiants aient leur mot à dire dans les décisions qui ont un impact sur leur vie académique et sociale. En outre, participer à un congrès d'étudiants permet aux étudiants de développer leurs connaissances sur les processus démocratiques, notamment le vote, le débat et la formation de consensus. Il montre comment fonctionne un conseil d'administration IEEE, des comités et d'autres plateformes d'unités opérationnelles (OU) qui aident les étudiants à saisir leur rôle dans une association professionnelle structurée.

- Pendant le week-end du Congrès des étudiants, nous avons également célébré une réalisation mondiale d'un de nos membres à vie dans une cérémonie qui a donné une bonne idée de la nouvelle culture et identité de l'IEEE et de l'IEEE Canada en tant qu'organisation « multigénérationnelle » où les membres étudiants se joignent à nos membres à long terme, membres à vie, dans une célébration unique et la reconnaissance des réalisations, afin de préparer le terrain pour les réalisations innovantes futures continues.
- En ce qui concerne la reconnaissance et les prix, je peux affirmer avec confiance que nous avons réalisé d'importants progrès dans la refonte de nos processus de nomination, des ressources d'évaluation et surtout, une culture améliorée grâce à de nouvelles initiatives mises en œuvre de manière transparente, des méthodes d'évaluation justes, systématiques et significatives qui devraient absolument rallier à nouveau un grand nombre de nos membres, plus particulièrement les bénévoles actifs de notre région et les équipes provenant de l'industrie, du milieu universitaire et du gouvernement, en reconnaissance de leur dévouement, l'ingéniosité et les contributions à leurs domaines respectifs et à la communauté.

En août dernier, IEEE Canada a tenu un gala fantastique et très apprécié sur le campus de l'Université Queens à Kingston, en Ontario, où il a récompensé et honoré les lauréats des prix d'excellence IEEE Canada 2024 de toutes origines et expériences.

- La cérémonie du gala de l'IEEE Canada a été, en fait, le joyau de notre « couronne » cette année.

Par la Couronne, j'entends la Conférence canadienne de 2024 sur le génie électrique et informatique (CCECE 2024) de l'IEEE, qui a été un événement réussi.

En août dernier, le comité de la conférence CCECE d'IEEE Canada a mis en place l'événement le plus réussi depuis que nous avons réussi à nous défaire des circonstances limitantes de la pandémie.

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President's Message/Message du Président

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with a variety of robots moving around the conference halls in the university campus. My sincere thanks and appreciation to the Organizing Committee and all the volunteers who made this event a uniquely successful achievement.

We are looking forward to CCECE 2025 in Vancouver, and I am proud to announce that the preparations are already on schedule for a super successful Canadian conference in May 2025. The Montreal Section cannot wait to start preparation for CCECE 2026, followed by the Toronto Section for CCECE 2027.

- In June this year, the IEEE Board meeting series was held in Toronto, where all of the IEEE Board members and other operational boards, committees, and OUs' Global Leadership spent almost a week in our Region 7. The IEEE Toronto Section took the initiative and invited the IEEE Board members, senior staff, and other guests for a fantastic Canadian casual dinner night, where we all gathered at the Toronto lakefront area.

The Montreal Section cannot wait to start preparation for CCECE 2026, followed by the Toronto Section for CCECE 2027.

I would like personally to thank our Toronto Section leaders and attending members as well as Toronto tourism and the Toronto Leaders Circle for their hospitality and generosity and for making Region 7 so proud of this exciting initiative. The feedback from our Global IEEE attendees was unanimously fantastic and appreciative. The next day, the Toronto Section leaders and I were the IEEE president's guests, sharing his table during the IEEE President's Dinner, were they had the opportunity to mingle and share their ideas in a unique, one-on-one opportunity with the president.

- During my term as the IEEE Canada president (2024–2025), I have keen plans to enrich our relationships with other IEEE Regions, and we are putting these plans in action. Collaboration among multiple Regions of a global organization such as IEEE is not just beneficial but essential for achieving long-term success. It helps in harnessing the full potential of a diverse membership, ensuring strategic alignment, optimizing resource use, and ultimately driving innovation and growth. This becomes a vital move in our strategic journey towards enhancing our membership levels.

Different Regions bring unique cultural perspectives that can enhance creativity and innovation, leading to more comprehensive and innovative solutions. Collaboration allows Regions to share resources such as technology, knowledge, and human capital. This pooling of resources can lead to cost efficiencies and better resource management. Effective collaboration facilitates the sharing of information and knowledge across Regions, with opportunities to learn from their counterparts in other parts of the world, enhancing their skills and career development.

For all these reasons and more, we took many steps in this direction, where I attended other Regions' general meetings, such the joint Region 1 and 2 earlier this year as well as Region 8, working on these kinds of relationships. We have established many joint Sections' initiatives and events such as collaboration

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Des centaines de chercheurs, universitaires, leaders de l'industrie, étudiants et jeunes professionnels du monde entier ont eu une fabuleuse rencontre à l'Université Queens à Kingston, un festival unique d'affiches, présentations, tutoriels, des débats et des discussions sur divers sujets concernant les technologies de pointe, avec une variété de robots se déplaçant dans les salles de conférence du campus universitaire. Je tiens à exprimer ma gratitude et ma reconnaissance envers le comité d'organisation et tous les bénévoles qui ont contribué à faire de cet événement une réussite exceptionnelle.

Nous sommes impatients de prendre part au CCECE 2025 à Vancouver, et je suis fier de vous informer que tout est prêt pour une conférence canadienne très réussie qui aura lieu en mai 2025. La section de Montréal attend avec impatience le début des préparatifs du CCECE 2026, suivi par la section de Toronto pour le CCECE 2027.

En juin de cette année, le conseil d'administration de l'IEEE a tenu une série de réunions à Toronto, où tous les membres du conseil d'administration et d'autres conseils opérationnels, ainsi que les comités et le leadership mondial des UO, ont séjourné pendant près d'une semaine. La section de l'IEEE à Toronto a pris l'initiative et invité les membres du conseil d'administration, les cadres supérieurs et d'autres invités à un dîner fantastique au Canada, où nous nous sommes tous réunis dans la zone riveraine de Toronto.

Je voudrais adresser mes remerciements personnels aux dirigeants de la section de Toronto et aux membres présents, ainsi qu'au Toronto Tourisme et au Leaders Circle de Toronto, pour leur hospitalité et leur générosité, et pour avoir rendu la région 7 si fière de cette initiative passionnante. Les commentaires de nos participants à l'IEEE Global ont été unanimement fantastiques et appréciés. Le lendemain, les dirigeants de la section de Toronto et moi-même étions invités par le président de l'IEEE, partageant sa table lors du dîner du président de l'IEEE. Ils ont eu l'occasion de se rencontrer et de partager leurs idées dans une occasion unique, en face à face avec le président.

- Pendant la période de mon mandat en tant que président de l'IEEE Canada (2024–2025), je suis engagé dans des projets ambitieux visant à améliorer nos relations avec d'autres régions de l'IEEE, et nous les mettons en œuvre. La collaboration entre les multiples régions d'une organisation mondiale telle que l'IEEE est non seulement bénéfique mais essentielle pour atteindre le succès à long terme. Elle contribue à exploiter pleinement le potentiel d'une composition diversifiée, à garantir l'alignement stratégique, à optimiser l'utilisation des ressources et, finalement, à encourager l'innovation et la croissance. C'est devenu une étape cruciale dans notre évolution stratégique vers l'amélioration de nos niveaux d'adhésion.

La créativité et l'innovation peuvent être stimulées par les perspectives culturelles uniques offertes par les différentes régions, ce qui conduit à des solutions plus complètes et innovantes. La collaboration permet aux régions de partager des ressources telles que la technologie, le savoir et le capital humain. La mise en commun des ressources peut favoriser l'amélioration de la rentabilité et de la gestion des ressources. Une collaboration efficace facilite le partage de l'information et des connaissances entre les régions, en leur offrant des opportunités d'apprendre de leurs homologues dans d'autres parties du monde, ce qui contribue à l'amélioration de leurs compétences et à leur perfectionnement professionnel.

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between Region 1 Maine Section and our New Brunswick Section and also the Hamilton Section with Region 1 and the Buffalo Section soon. Our Vancouver Section also established collaboration with IEEE New Era World Leaders Summit/AI Enablement workshops and job fairs 2024 in Seattle.

"As we embark on this journey together, let us remain guided by the spirit of collaboration, caring, courtesy, and cooperation."

I should also mention our partnerships in cross-Regions' international conferences like the IEEE International Humanitarian Technologies Conference (2024 in Bari, Italy, and 2025 in Edmonton, Canada) and also the IEEE History of Electrotechnology Conference. Many other similar collaboration initiatives are under development, and we will keep you posted.

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Pour toutes ces raisons et plus encore, nous avons pris de nombreuses mesures dans ce sens. J'ai assisté à d'autres réunions générales des régions, comme celles des régions 1 et 2 plus tôt cette année, ainsi que la région 8, en travaillant sur ce genre de relations. Nous avons instauré de nombreuses initiatives et activités des sections conjointes, comme la collaboration entre la section du Maine de la région 1 et notre section du Nouveau-Brunswick, et la section de Hamilton avec la région 1 et la section de Buffalo dans un futur proche. Notre section de Vancouver a également établi une collaboration avec les ateliers et salons de l'emploi IEEE New Era World AI Leaders Summit 2024 à Seattle.

Je mentionnerai également nos partenariats dans le cadre de conférences internationales interrégionales, telles que la conférence internationale sur les technologies humanitaires de l'IEEE (2024 à Bari, en Italie, et 2025 à Edmonton, au Canada), ainsi que la conférence IEEE History of Electrotechnology. Nous sommes en train de mettre en place de nombreuses autres initiatives de collaboration similaires, et nous vous tiendrons au courant.

- Finalement, Enfin, je peux vous dire avec enthousiasme que les travaux de développement sur la nouvelle version du site Web

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IEEE Canadian Review

La revue canadienne de l'IEEE

IEEE Canadian Review is published three times per year: Spring, Summer, and Fall.

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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

(President's Message cont'd from p. 5)

- Finally, I can share with excitement that development work on IEEE Canada website's new version is almost concluding and is expected to be officially launched before the end of 2024. I am hoping that the new website will meet your expectations as the IEEE Website Committee has thankfully been investing an extensive amount of its time in the development, implementation, and final touches, including uploading all the content and IEEE documentations and archive to serve our members and volunteers in the best possible way and reflect a new and bright image of the IEEE Canada organization.

Let me conclude with the same words I finished my previous edition's article:

> "As we embark on this journey together, let us remain guided by the spirit of collaboration, caring, courtesy, and cooperation. Let us embrace diversity and celebrate the unique perspectives that each of us brings to the table. Let us never lose sight of the profound impact that we can make when we unite for a common purpose. Together, we will continue to build upon the rich legacy of our organization and leave an indelible mark on the world around us. Together, there is no limit to what we can achieve."

Thank you all for your trust, professionalism, and support. ■

Tom Murad, P.Eng., Ph.D., F.E.C., SMIEEE
2024–2025 IEEE Canada President
2024–2025 Region 7 Director

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d'IEEE Canada sont presque terminés et qu'on s'attend à ce qu'elle soit officiellement lancée avant la fin de 2024. J'espère que le nouveau site Web répondra à vos attentes, car le comité du site Web de l'IEEE a investi beaucoup de son temps dans le développement, la mise en œuvre et les touches finales, y compris le téléchargement de tout le contenu et des documents et archives IEEE pour servir nos membres et bénévoles de la meilleure façon possible et refléter une image nouvelle et lumineuse de l'organisation IEEE Canada.

Je souhaite conclure en utilisant les mêmes mots que j'ai utilisés pour conclure mon article précédent :

> « Alors que nous entreprenons ce voyage ensemble, restons guidés par l'esprit de collaboration, d'attention, de courtoisie et de coopération. Embrassons la diversité et célébrons les perspectives uniques que chacun d'entre nous apporte à la table. Ne perdons jamais de vue l'impact profond que nous pouvons avoir en nous unissant pour un but commun. Ensemble, nous continuerons de bâtir sur le riche héritage de notre organisation et de laisser une marque indélébile sur le monde qui nous entoure. Ensemble, il n'y a pas de limite à ce que nous pouvons accomplir »

Merci à tous pour votre confiance, votre professionnalisme et votre soutien. ■

Tom Murad, P.Eng., Ph.D., F.E.C., SMIEEE
2024–2025 IEEE Canada President
2024–2025 Region 7 Director

A Few Words From the Guest Editor / Quelques mots de l'éditeur invité

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History of Technology in Canada

The study of the history of technology and the preservation of technological artifacts help us to understand why things are the way they are today, better appreciate the human element in technological innovation, and help us to make better-informed decisions concerning the future. Ultimately, these activities are team efforts that involve historians, museums, private collectors, government, industry, and

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Histoire de la technologie au Canada

Comprendre l'histoire de la technologie et préserver les artefacts technologiques nous aide à comprendre pourquoi les choses sont telles qu'elles le sont aujourd'hui, à mieux comprendre le facteur humain dans l'innovation technologique et à prendre des décisions plus éclairées concernant l'avenir. En fin de compte, ces activités sont des efforts d'équipe qui impliquent les historiens, les musées, les

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A Few Words From the Guest Editor / Quelques mots de l'éditeur invité

(A Few Words From the Guest Editor cont'd from p. 7)

the engineering community. Each contributes and each benefits from these efforts in unique ways.

A scan of faculties of applied science or schools of engineering across Canada shows that over the past few decades, the vast majority have established strong links with the business schools in their institutions. Many of them offer joint courses and degree programs in entrepreneurship, innovation, and/or business at both the undergraduate and graduate levels. Such initiatives are designed to develop highly qualified personnel who can take on significant leadership roles in industry and help Canada to achieve its goals for economic growth through technical innovation and market development.

A similar scan fails to show many examples of faculties of applied science or schools of engineering across Canada establishing similar links with the faculties of arts or schools of humanities in their institutions. This is unfortunate, considering that many universities in Canada host interdisciplinary programs such as science and technology studies that bring together historians, philosophers, economists, and others to examine the creation, development, and consequences of science and technology in their historical, cultural, and social contexts. The participation of faculty, graduate students, and undergraduates

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(Quelques mots de l'éditeur invité suite de p. 7)

collectionneurs privés, le gouvernement, l'industrie et la communauté du génie. Chacun contribue et tire avantage de ses efforts d'une manière unique.

Un examen des facultés de sciences appliquées ou des écoles d'ingénieurs à travers le Canada montre que, au cours des dernières décennies, la grande majorité a établi des liens solides avec les écoles de commerce dans leurs établissements. Bon nombre d'entre eux offrent des cours et des programmes menant à un diplôme en entrepreneuriat, en innovation ou en affaires aux niveaux de premier cycle et de troisième cycle. L'objectif de ces initiatives est de former des employés hautement qualifiés qui peuvent occuper des postes de leadership importants dans l'industrie, et de soutenir la croissance économique du Canada grâce à l'innovation technique et au développement du marché.

Une analyse similaire ne montre pas de nombreux exemples de facultés de sciences appliquées ou d'écoles de génie au Canada établissant des liens similaires avec les facultés des arts ou les écoles des sciences humaines dans leurs établissements. Ceci est regrettable, étant donné que de nombreuses universités au Canada accueillent des programmes interdisciplinaires tels que les études scientifiques et technologiques qui réunissent des historiens, des philosophes, des économistes et d'autres pour examiner la

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(A Few Words From the Guest Editor cont'd from p. 8)

from applied science or engineering in such programs, if it was more common, would help to develop highly qualified personnel who can take on significant roles in policy making and government and, importantly, strengthen the ties between academia and government.

Since it was formed in 1963, IEEE has taken a keen interest in the collection, writing, and dissemination of historical information concerning the fields covered by IEEE technical and professional activities, and IEEE and its predecessor organizations. Such activities are designed to promote pride in the profession and awareness of past efforts to advance technology for the benefit of humanity and align with IEEE's strategic goal to enhance public understanding of engineering and technology. IEEE's long experience in matters related to the history of technology can likely play a supporting role in any initiative to build stronger links between faculties of applied science or schools of engineering and faculties of arts or schools of humanities.

This special issue of *IEEE Canadian Review* on the history of technology in Canada is intended to raise awareness of activities and opportunities related to the history of technology in Canada and builds on a very successful Special Session on History that was held on 7 August 2024 as part of the *IEEE Canadian Conference on Electrical and Computer Engineering* (CCECE) in Kingston, ON. Some of the articles in this special issue summarize presentations that were given at that session. The remaining papers from that session are part of the CCECE 2025 conference proceedings and can be found on IEEE *Xplore*.

In This Issue

In our regular "History Matters" column [A1], we preview some upcoming activities in the field, including the first-ever IEEE History Week (30 September–4 October 2024); the Special Session on the History of Technology, to be held at CCECE 2025 from 26–29 May 2025 in Vancouver; and the new History of Science and Technology track that has recently been added to the *IEEE Canadian Journal of Electrical and Computer Engineering*.

In [A2], David Bart, president of the Radio Club of America and vice president of the Antique Wireless Association, explores the important relationship between museum curators and private collectors in preserving historical artifacts.

In [A3], we consider the scientific aspects of history, including both the manner in which history is formally studied and the technical aspects of historical study and preservation to which engineers are uniquely qualified to contribute.

In [A4], Andrew Elliott, an archivist with Library and Archives Canada, reviews the development of North America's first national radio network by Canadian National Railways in the 1920s and the archival records that are held by Library and Archives Canada.

In [A5], long-time IEEE volunteers Murray MacDonald and Denard Lynch review the development of the Cobalt-60 cancer treatment machines that were developed during the early 1950s independently, but cooperatively, by teams in London, Ontario, and Saskatoon, Saskatchewan. Since then, many millions of lives have been extended by this revolutionary approach to cancer treatment.

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(Quelques mots de l'éditeur invité suite de p. 8)

création, le développement et les conséquences de la science et de la technologie dans leur contexte historique, culturel et social. La participation de professeurs, d'étudiants des cycles supérieurs et de diplômés en sciences appliquées ou en génie à ces programmes, si elle était plus courante, contribuerait à former du personnel hautement qualifié qui pourrait jouer un rôle important dans l'élaboration des politiques et le gouvernement, renforçant ainsi les liens entre le monde universitaire et le gouvernement.

Depuis sa fondation en 1963, l'IEEE a accordé une grande importance à la collecte, à la rédaction et à la diffusion d'informations historiques sur les domaines couverts par ses activités techniques et professionnelles, ainsi que par les organisations qui l'ont précédé. Ces activités visent à promouvoir la fierté de la profession et à sensibiliser aux efforts antérieurs visant à faire progresser la technologie au profit de l'humanité, et à s'aligner sur l'objectif stratégique de l'IEEE qui est d'améliorer la compréhension du public en matière d'ingénierie et de technologie. La longue expérience de l'IEEE en histoire de la technologie pourrait certainement aider à établir des liens plus étroits entre les facultés de sciences appliquées ou les écoles d'ingénierie et les facultés des arts ou les écoles de sciences humaines.

Ce numéro spécial de *l'IEEE Canadian Review* sur l'histoire de la technologie au Canada vise à sensibiliser les gens aux activités et aux possibilités liées à l'histoire de la technologie au Canada, en s'appuyant sur une session spéciale très réussie sur l'histoire qui a eu lieu le 7 août 2024 sous le nom de partie de la *Conférence canadienne sur l'ingénierie électrique et informatique de l'IEEE* (CCECE) à Kingston, en Ontario. Certains des articles de ce numéro spécial résument les présentations qui ont été faites durant cette session. Les autres communications de cette session sont incluses dans les actes de la conférence CCECE 2025 et sont accessibles sur IEEE *Xplore*.

Dans ce numéro

Dans notre colonne « l'histoire compte » [A1], nous prévoyons certaines activités à venir dans le domaine, y compris la toute première semaine d'histoire de l'IEEE (du 30 septembre au 4 octobre 2024); la session spéciale sur l'histoire de la technologie, qui se tiendra au CCECE 2025 les 26 et 29 mai 2025 à Vancouver ; et Le nouveau volet "Histoire des sciences et de la technologie" qui a récemment été ajouté au *Journal Canadien de Génie Électrique et Informatique*.

Dans [A2], David Bart, président du Radio Club of America et vice-président de l'Antique Wireless Association, explore les liens importants qui existent entre les conservateurs des musées et les collectionneurs privés en matière de préservation d'objets historiques.

Dans [A3], nous explorons les aspects scientifiques de l'histoire, en particulier la façon dont l'histoire est officiellement étudiée, ainsi que les aspects techniques de l'étude historique et de la préservation auxquels les ingénieurs sont particulièrement qualifiés pour apporter leur contribution.

Dans [A4], Andrew Elliott, archiviste à la Bibliothèque et Archives du Canada, examine l'élaboration du premier réseau radio national en Amérique du Nord par les Chemins de fer nationaux du Canada dans les années 1920, ainsi que les dossiers archivés de Bibliothèque et Archives du Canada.

(Suite p. 10)

A Few Words From the Guest Editor / Quelques mots de l'éditeur invité

(A Few Words From the Guest Editor cont'd from p. 9)

In [A6], Barry MacDonald, a retired microwave technician, describes his efforts to launch and manage a Facebook group dedicated to preserving photographs and documents concerning the vast network of microwave sites that formed the backbone of the Canadian telephone and television network from the 1950s until the late 1990s.

In [A7], Scott Campbell, Director of the Centre for Society, Technology and Values at the University of Waterloo, describes the successes and challenges associated with establishing the University of Waterloo Computer Museum, an effort that has yielded more than 4,000 artifacts, including many that come from the period of personal microcomputing during the 1970s–1990s.

In our regular "Radio Science in Canada" column [A8], we review how Canadian contributions to radar during the Second World War, long a source of national pride, has been reported and documented in the historical literature. We conclude that much remains to be done to ensure that these efforts are not forgotten.

In [A9], [A10], [A11], and [A12], we review four books concerning the history of technology in Canada that will be of interest to readers:

- John Swettenham's *McNaughton* [A9], a three-volume biography of one of Canada's most accomplished electrical engineers, reviews his early life and education, his roles with the Canadian Army in the First World War, the National Research Council, with the Canadian Army during the Second World War, and his later roles as a politician and diplomat.
- Jean-Guy Rens' *The Invisible Empire: A History of the Telecommunications Industry in Canada, 1846–1956* [A10] is the first overview of Canadian telecommunications, from the laying of the first telegraph line between Toronto and Hamilton in 1846 to the separation between Nortel—then known as *Northern Electric*—and the American Bell System in 1956.
- David Nevius's *The History of the North American Electric Reliability Corporation*, 2nd ed. [A11], is a review of how the North American Electric Reliability Council, a voluntary international organization that was formed by electric utilities across North America in 1968, evolved into today's North American Electric Reliability Corporation, which was formed in 2006.
- Edward Jones-Imhotep and Tina Adcock's *Made Modern: Science and Technology in Canadian History* [A12] is an exploration of the complex interconnections between science, technology, and modernity in Canada.

The balance of this issue includes our regular "Engineering Management" column by Terrance Malkinson [A13]. ■

Appendix: Related Articles

[A1] D. G. Michelson, "Sharing History [History Matters]," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 12–13, Summer/Été 2024, doi: 10.1109/MICR.2024.3447328.

[A2] D. Bart, "Curators and collectors: Partners in historical preservation," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 14–16, Summer/Été 2024, doi: 10.1109/MICR.2024.3447268.

[A3] D. G. Michelson, "The science of history," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 17–19, Summer/Été 2024, doi: 10.1109/MICR.2024.3447358.

(Continued on p. 11)

(Quelques mots de l'éditeur invité suite de p. 9)

Dans [A5], Murray MacDonald et Denard Lynch, des bénévoles de longue date de l'IEEE, se penchent sur l'avancement des machines de traitement du cancer Cobalt-60 qui ont été développées de manière indépendante, mais en collaboration, par des équipes à London (Ontario) et à Saskatoon (Saskatchewan). Depuis lors, cette méthode révolutionnaire pour traiter le cancer a permis à plusieurs millions de personnes de vivre plus longtemps.

Dans [A6], Barry MacDonald, technicien en micro-ondes à la retraite, décrit ses efforts pour créer et gérer un groupe Facebook dédié à la préservation des photographies et des documents concernant le vaste réseau de sites micro-ondes qui a constitué l'épine dorsale du réseau téléphonique et télévisuel canadien des années 1950 jusqu'à la fin des années 1990.

Dans [A7], Scott Campbell, directeur du Centre for Society, Technology and Values de l'Université de Waterloo, discute des succès et des défis qui ont été rencontrés lors de la création du Musée de l'informatique de l'Université de Waterloo. Plus de 4 000 artefacts ont été obtenus grâce à cet effort, dont beaucoup sont issus de la période du microcalcul personnel dans les années 1970–1990.

Dans notre chronique habituelle intitulée « Radio Science in Canada » [A8], nous analysons comment les contributions canadiennes au radar pendant la Seconde Guerre mondiale, longtemps une source de fierté nationale, ont été rapportées et enregistrées dans la littérature historique. Nous constatons qu'il reste encore beaucoup à faire pour que ces efforts ne soient pas négligés.

Dans [A9], [A10], [A11], et [A12], Nous passons en revue quatre livres sur l'histoire de la technologie au Canada qui intéresseront les lecteurs:

- Swettenham's *McNaughton* [A9], une biographie en trois volumes qui met en lumière l'un des ingénieurs électriciens les plus remarquables du Canada, examine sa jeunesse et son éducation, ses emplois dans l'armée canadienne pendant la Première Guerre mondiale, au Conseil national de recherches, dans l'armée canadienne pendant la Seconde Guerre mondiale, et plus tard, ses responsabilités en tant que politicien et diplomate.
- Jean-Guy Rens, dans son livre *L'Empire invisible : une histoire de l'industrie des télécommunications au Canada, 1846–1956* [A10], offre une vision d'ensemble des télécommunications au Canada, depuis le début de la première ligne télégraphique de Toronto à Hamilton en 1846 jusqu'à ce que Nortel, devenue Northern Electric, se sépare du système américain de Bell en 1956.
- David Nevius, dans *The History of the North American Electric Reliability Corporation, 2e édition* [A11], examine comment le North American Electric Reliability Council, un organisme international bénévole créé en 1968 par les entreprises d'électricité de l'Amérique du Nord, s'est transformé en la North American Electric Reliability Corporation en 2006.
- *Made Modern : Science and Technology in Canadian History* [A12] de Edward Jones-Imhotep et Tina Adcock, est une exploration des liens complexes entre la science, la technologie et la modernité au Canada.

Pour compléter ce numéro, il y a notre chronique régulière de Terrance Malkinson [A13] intitulée « gestion de l'ingénierie ». ■

Appendix: Related Articles

[A1] D. G. Michelson, "Sharing History [History Matters]," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 12–13, Summer/Été 2024, doi: 10.1109/MICR.2024.3447328.

(Suite p. 11)

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[A4] A. Elliott, "The development of radio technology by Canadian National Railways in the 1920s (and the Archival Records, Available at Library and Archives Canada)," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 20–21, Summer/Été 2024, doi: 10.1109/MICR.2024.3447288.

[A5] M. MacDonald and D. Lynch, "The development of Cobalt-60 radiation therapy for cancer [Commentary/Comentario]," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 22–23, Summer/Été 2024, doi: 10.1109/MICR.2024.3447269.

[A6] B. MacDonald, "Preserving the history of the Trans-Canada telephone system," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 24–25, Summer/Été 2024, doi: 10.1109/MICR.2024.3447359.

[A7] S. M. Campbell, "Bootstrapping a university-based museum of computing: From unsanctioned and unrecognized to a stateful home [Histboots]," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 26–27, Summer/Été 2024, doi: 10.1109/MICR.2024.3447360.

[A8] D. G. Michelson, "Radio Science in Canada," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 28–29, Summer/Été 2024, doi: 10.1109/MICR.2024.3447408.

[A9] J. Swettenham, "McNaughton [Book Review]," *IEEE Canadian Rev.*, vol. 36, no. 2, p. 30, Summer/Été 2024, doi: 10.1109/MICR.2024.3447409.

[A10] J.-G. Rens, "The invisible empire: A history of the telecommunications industry in Canada, 1846–1956 [Book Review]," *IEEE Canadian Rev.*, vol. 36, no. 2, p. 30, Summer/Été 2024, doi: 10.1109/MICR.2024.3456268.

[A11] D. Nevius, "The history of the North American Electric Reliability Corporation [Book Review]," *IEEE Canadian Rev.*, vol. 36, no. 2, p. 31, Summer/Été 2024, doi: 10.1109/MICR.2024.3456270.

[A12] E. Jones-Imhotep and T. Adcock, "Made modern: Science and technology in Canadian history, *Second Edition* [Book Review]," *IEEE Canadian Rev.*, vol. 36, no. 2, p. 31, Summer/Été 2024, doi: 10.1109/MICR.2024.3456269.

[A13] T. Malkinson, "Biz tech report [Engineering Management/Gestion du génie]," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 35–36, Summer/Été 2024, doi: 10.1109/MICR.2024.3455528.

(Quelques mots de l'éditeur invité suite de p. 10)

[A2] D. Bart, "Curators and collectors: Partners in historical preservation," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 14–16, Summer/Été 2024, doi: 10.1109/MICR.2024.3447268.

[A3] D. G. Michelson, "The science of history," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 17–19, Summer/Été 2024, doi: 10.1109/MICR.2024.3447358.

[A4] A. Elliott, "The development of radio technology by Canadian National Railways in the 1920s (and the Archival Records, Available at Library and Archives Canada)," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 20–21, Summer/Été 2024, doi: 10.1109/MICR.2024.3447288.

[A5] M. MacDonald and D. Lynch, "The development of Cobalt-60 radiation therapy for cancer [Commentary/Comentario]," *IEEE Canadian Rev.*, vol. 36, no. 2, pp. 22–23, Summer/Été 2024, doi: 10.1109/MICR.2024.3447269.

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IMPORTANT UPDATES

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

What does this mean?

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

History Matters

Sharing History

by David G. Michelson
IEEE Canada Historian

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

While historical fact is immutable, historical evidence is inherently fragile and often irreplaceable. Accordingly, efforts to preserve and interpret the past are among the most valuable of legacies.

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This fall, we will celebrate the first-ever IEEE History Week (30 September–4 October 2024) and showcase the efforts of the IEEE History Center and its partners to preserve and promote the history of our profession. The event will be held in conjunction with IEEE Day, the annual commemoration of the first technical meeting that our predecessor organization, the American Institute of Electrical Engineers, organized at the Franklin Institute in Philadelphia in October 1884.

The focal point for IEEE History Week activities will be the landing page at https://historyweek.ieee.org. From there, visitors can find links to more information about History Week webinars and history activities organized by other IEEE organization units (OUs). A web form will allow IEEE OUs including Regions, Sections, Societies, and Chapters to submit activities for inclusion in the History Week event calendar. The site will also contain links to history-themed webinars and events and information concerning the History Center's various public history programs, including

- the IEEE Oral History program, which, since 1968, has conducted more than 900 oral history interviews with leaders and innovators within IEEE's fields of interest.
- the IEEE Milestones program, which, since the first Milestone was dedicated in 1977, has recognized almost 250 significant achievements within IEEE's fields of interest through placement of commemorative plaques.
- the IEEE History Awards program, which oversees the annual selection of recipients of the William and Joyce Middleton book prize, the IEEE Life Members' Fellowship in Electrical History, and the Elizabeth and Emerson Pugh Young Scholar in Residence.
- the Engineering and Technology History Wiki, a MediaWiki-powered website that hosts thousands of articles, first-hand accounts, oral histories, milestones, archival documents, and lesson plans pertaining to the history of technology.
- the REACH educational program, which provides teachers and students with educational resources that explore the relationship between technology and engineering history, and the complex relationships they have with society, politics, economics, and culture.
- IEEE History Center publications, which include both *IEEE History Center Newsletter* and books published by IEEE History Press, and editorial support for history content for *Proceedings of the IEEE*, *IEEE Spectrum*, and *IEEE-USA InSight*.

IEEE History Week is intended to 1) dramatically increase the membership's, the profession's, and the general public's awareness of History activities across IEEE; 2) increase both participation in and support for such activities; and 3) contribute to the public visibility goals of the IEEE Strategic Plan.

Upcoming History of Technology Conferences

There are quite a few history of technology conferences coming up during the next year. See the inside front cover of this issue of *IEEE Canadian Review* for additional details.

- The XLIII Scientific Instrument Symposium (SIC 2024) will be held from 16 to 20 September 2024 in Ottawa. Hosted by Ingenium, Canada's Museums of Science and Innovation, SIC 2024 will explore the cultures of precision as they apply to the history of scientific instruments. Participants have been encouraged to probe this topic through materiality, scientific and workshop practices, conservation and digital techniques, education, and museology. The conference will include side trips to view scientific instrument collections at the University of Toronto and McGill University immediately before and after the main program, respectively. More details can be found at https://sic2024.ca/.
- The IEEE Canadian Conference on Electrical and Computer Engineering (CCECE) 2025 will be held from 26 to 29 May 2025 in Vancouver. Building on the success of the 2024 event, the conference will once again feature a half-day special session on the History of Technology. Both abstracts (up to 250 words) and full papers (5–7 pages) concerning the following topics are welcome: 1) the history of electrical engineering, electronics, and computing, their applications, and their impact on social and economic development; 2) the people, programs, places, policies, institutions, and organizations that have shaped the history of electrical engineering, electronics, and computing; and 3) efforts to preserve and promote our technological history and heritage. Contributions from academia, government, industry, nonprofit organizations, and IEEE members and OUs are all encouraged. More details can be found at https://ccece2025.ieee.ca/.
- The Canadian Society for the History and Philosophy of Science (CSHPS) will hold its 2025 conference at George Brown College in Toronto as part of the annual Congress of the Humanities and Social Sciences (30 May–6 Jun 2025). CSHPS is a Canadian forum that brings together historians, philosophers, sociologists, and a wide range of interdisciplinary scholars interested in exploring all aspects of

science, past and present. More details can be found at http://cshps.ca/.

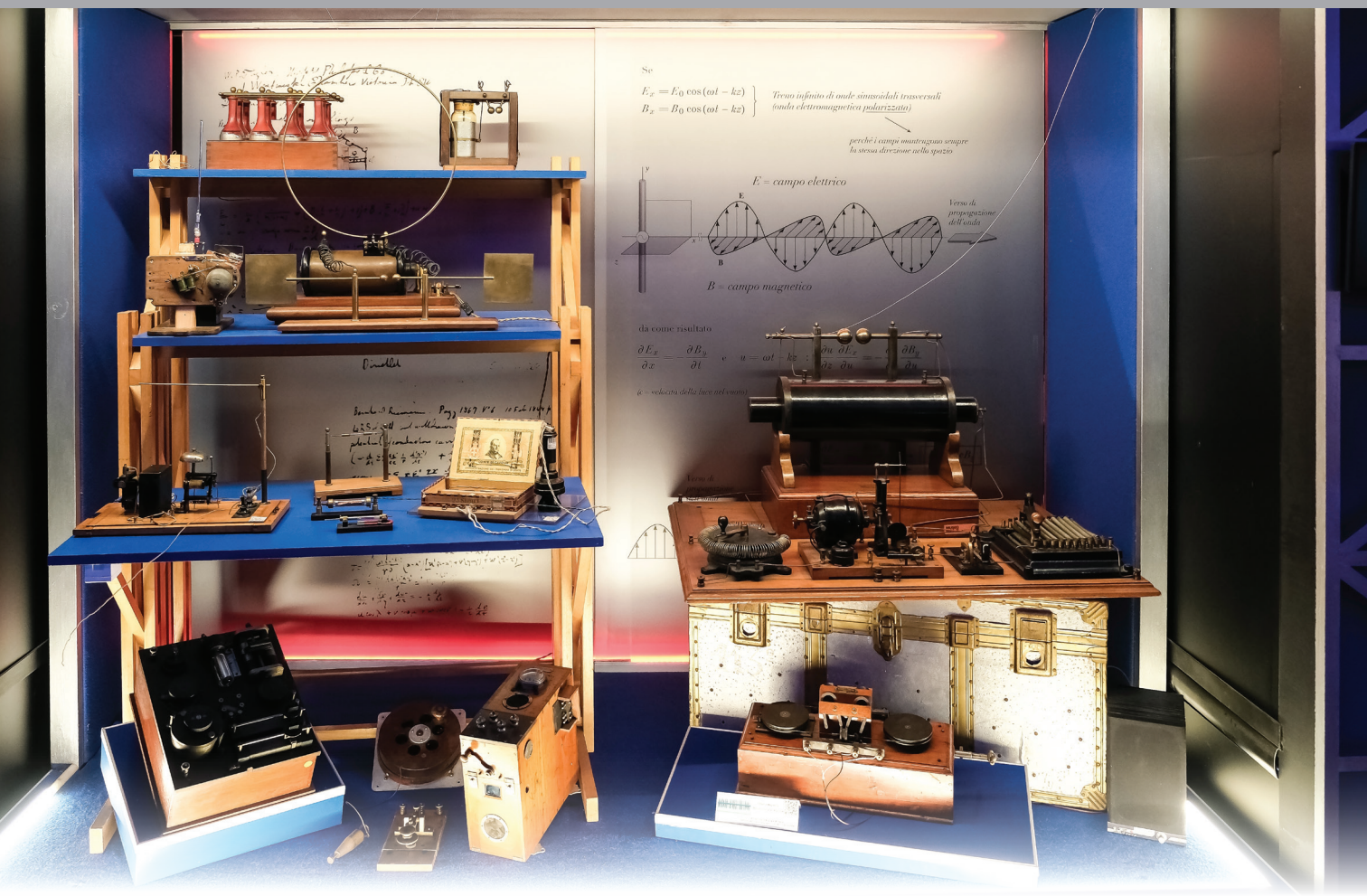
- The IEEE AP-S International Symposium and North American Radio Science Meeting will be held in Ottawa from 13 to 18 July 2025. The conference will feature a half-day special session on the history of antennas and propagation. Contributions from academia, government, industry, nonprofit organizations, and IEEE members and OUs are all encouraged. More details can be found at https://2025.apsursi.org/.
- The IEEE History of Electrotechnology Conference will be held in Bonn, Germany, from 30 September–2 October 2025. Contributions from academia, government, industry, nonprofit organizations, and IEEE members and OUs are all encouraged. More details can be found at https://www.ieee-histelcon.org/.

IEEE Canadian Journal of Electrical and Computer Engineering

Since 1976, *IEEE Canadian Journal of Electrical and Computer Engineering* (*CJECE*) has been publishing high-quality refereed scientific articles in all areas of electrical and computer engineering. It is indexed in both ISI and IEEE *Xplore*. *IEEE CJECE* has recently introduced a new track on the history of science and technology and invites submission of articles that present new and original results, techniques or concepts, and survey-style articles that provide a rigorous analysis of existing results. Manuscripts should be between six and 12 pages. More details can be found at https://journal.ieee.ca. ■

About the Author

David G. Michelson is the IEEE Canada historian and chair of the IEEE History Committee. An active contributor to the history of technology for more than two decades, he has been a member or corresponding member of the IEEE History Committee since 2012 and is responsible for one quarter of the 18 IEEE Milestones that recognize Canadian technology achievements. He is also a member of the Society for the History of Technology, the Canadian Society for the History and Philosophy of Science, the HISTELCON 2025 Steering Committee, and the History and Archives Committee of the Engineering Institute of Canada. His research interests in this area include the historiography of contemporary science and technology, the development and impact of Canadian science and technology since the First World War, and the development and impact of both wireless technology and space technology since the First World War. He can be contacted at dmichelson@ieee.org or historian@ieee.ca.



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Curators and Collectors: Partners in Historical Preservation

by David Bart

Since modern public museums emerged during the 19th century, they have played a key role in preserving our heritage. In addition to researching, collecting, conserving, interpreting, and exhibiting tangible and intangible heritage, they offer varied experiences for education, enjoyment, reflection, and knowledge sharing. Like other public institutions, museums have evolved over time in response to a combination of social pressures, challenges, and opportunities.

Although the curators who manage museum collections and historic sites play a highly visible role in efforts to preserve historical artifacts and make them available for viewing by the public, private collectors also play an important, and often underappreciated, role. During my long association with the Radio Club of America (which I currently serve as president), the Antique Wireless Association (which I currently serve as vice president), and the IEEE History Committee (which I currently serve as treasurer), I have learned much about the relationship between museum curators and private collectors. Here, I share these insights and, importantly, suggest ways that IEEE members can play a supporting role.

The Role of Private Collectors

Private collectors operate under different constraints and with different priorities than museum curators. However, they help shape museums and our cultural identities, whether their collections are given to existing institutions or used to help create new ones [1]. Many museum collections were derived from donations sourced over dozens of years from numerous private collectors. Curatorial staff and volunteers may be employed to archive the collection's specimens and artifacts. Here, trained nonmuseum researchers and volunteers form a core resource, often providing hundreds of hours of labor, personal passion,

and insights developed from close study. Those not affiliated with a museum may often donate the core starting point of a museum's collection or provide important additions to an archive, making them publicly available to others [2]. Private loans from amateurs and collectors may also be a source of artifacts and information to fill in or fill out exhibit content.

For example, the core of the early telegraph collection at the Smithsonian Institution began with an early volunteer curator, George Maynard. Maynard once served in President Lincoln's White House as a telegrapher during the American Civil War. Postwar, he sold equipment and installed telegraph lines around Washington, DC. Eventually becoming president of the Old Time Telegrapher's Association, later named the *Telegraph Historical Society of North America*, he led the group in assembling a significant collection of early instruments that were ultimately donated to the Smithsonian. Maynard became an honorary custodian of electrical collections and expanded greatly the breadth of the Smithsonian's collection of early electrical instruments. He ended his career as the professional staff curator of the technology collections, having greatly shaped the scope of the instrument archive [1].

In another more modern example, Roderick and Marjorie Webster dedicated more than 30 years to developing the scientific instrument collection at the Adler Planetarium in Chicago. Adler opened in 1930 as the first planetarium in the Western Hemisphere and the new home of the A. W. Mensing collection of antique scientific instruments from Amsterdam, The Netherlands. The Websters served the Adler as volunteer caretakers and cocurators, members of the board, and members of the collections committee. Their private donations, research, and networking with scholars, curators, and rare books and antique instrument dealers developed their expertise in the history of astronomy and its instruments. Their connections and knowledge allowed them to acquire a substantial number of instruments and books for Adler's collections, many of them very rare or one-of-a-kind items [3]. Today, Adler's scientific instrument collections are world renowned.

The strengths of private collectors come to the fore when they come together to form a community. For example, consider the evolution of telegraph collecting. Establishing private social networks; salvaging, buying, and selling old equipment; restoring items; and compiling documentation to educate the collector were all common activities before the advent of the Internet. Telegraph collectors moved online in the early 1990s, establishing the first online encyclopedic resources with categorized identification, dates, photos, descriptions, biographies of inventors, stories about companies, histories of governmental involvement, and other information related to telegraphy. Among the early websites are the W1TP Telegraph & Scientific Instrument Museums [4] and the History of the Atlantic Cable & Undersea Communications [5] websites.

Many museum collections were derived from donations sourced over dozens of years from numerous private collectors.

These innovations broadened the audience, increased general knowledge about the subject, stimulated the search for rarer items, and spurred other collectors and historians to action, resulting in the creation of other websites. They became resources utilized by professional historians and amateurs alike. These and other amateur successes require intense dedication and commitment over decades.

Trends and Fads

Both museums and private collections share the risks associated with fads or changes in preferences over time. What is popular, available in an active marketplace, and obtainable at a period in time may or may not be historically important, and the definitions of historical importance themselves evolve. Wealth, collecting booms, and preferences change. Some have suggested that collecting fads tend to follow the youthful desires of 16–26 year olds who, when old enough to possess disposable income to buy those desires in midlife, drive the collecting interests and collectible markets. This leads to the rise and eventual decline of demand and monetary value as the bubble comes and goes in favour of a new fad from another generation's former youth. This cycle can have implications for institutions working with private collectors.

Changes in demand affect value. Increased value can spur a hunt for rare items, but over time, widescale knowledge about the artifacts will peak and then recede as the bubble fades and the people pass away. Those who developed encyclopedic reference materials pass on, and their collections disperse. This is a problem today with electronic communications and radio collectors. After reaching a peak in the late 1990s and early 2000s, these collectors and the in-depth knowledge associated with them are dying off, and their collections are being disbursed or donated in such large volumes that they cannot be absorbed.

Differences between the underlying philosophies and motives of museums and private collectors can raise concerns in both sectors about the future of the objects they hold. Who will be passionate about these items to study and preserve them in the future? Can the private collection transition to the museum? Does the museum place historical value on the private collection, warranting its acquisition? Will the museum itself survive, maintaining the integrity of the collection for preservation and study? Is it true that "collectors collect objects, and museums collect collectors," and are private collections and collectors still providing an important underpinning of museums as archives and as educational institutions?

Although private collectors may be driven by different incentives and motives than museums, there is a role for the private collector. Shortcomings in documenting the provenance of artifacts remain a central issue; yet, notwithstanding the resultant difficulties in cataloging, private collections donated or sold to museums offer a rich source for building museum holdings. The private collection can preserve rare items over time and across periods of political and economic instability.

Private Versus Public

Rights of ownership and changing institutional missions further obscure the gaps that separate knowledge about and uses of private and public collections. Private collectors may avoid the public and any public debate. By contrast, public institutions are increasingly held to account for the origins and provenance of their artifacts. Public awareness of the issues surrounding native peoples, Holocaust victims, survivors of war, and other social concerns has increased. Public museums

are reevaluating the rights of ownership [6], the interpretations of displays that portray the historical contexts of their collections [7], or responding to political concerns [8]. Vast collections are being reevaluated across regional or even global networks of institutions [9]. These global trends and issues may or may not have ramifications for private collectors, but they are likely to impact their interactions with institutional historians and museums.

Museums and other institutions involved in preserving history can be viewed as businesses, which may be succeeding or failing to fulfill their missions, some of which can be quite broad or very idiosyncratic. The employees (curators and administrators) are not permanent; they may change jobs multiple times in a career. The public's preferences and the institution's mission may change over time. Boards and direction-setting priorities evolve. Staffing and funding change over time. Decisions can be dominated by current and strong viewpoints about mission, perceptions, and measures of changing visitor expectations; evolving internal staff and management motivations; financial considerations; and other factors. Decisions are made and relationships are managed in real time, and longer-term implications may not be fully understood or easily anticipated.

Increased value can spur a hunt for rare items, but over time, widescale knowledge about the artifacts will peak and then recede as the bubble fades and the people pass away.

Conclusions

Collectors who enter a field in their 20s or 30s may build and maintain a collection for 50 years. The collection may be imbued with a deep personal commitment and meaning, almost like a child or member of the family. Collectors' social networks can carry memories of experiences that may span a half-century, which can affect collectors' willingness or refusal to be involved with named institutions. Heirs to large collections may not understand them, may have inadequate knowledge to manage them, and may face conflicting issues, both personally and financially, regarding the disposal of these collections.

Complicating matters, the role of the museum, library, or other historical institution is shifting as they become much more multifunctional. The type of organization (e.g., large governmental institutions, local authority museums, or specialty trustee-governed institutions) can have dramatic implications for any relationships with amateurs and collectors [10].

Both institutions and collectors need to be aware of who they are talking to. These are personal conversations between people, not organizational or bureaucratic correspondences. Professionals and collectors need to be sensitive to the memories and experiences of the people with whom they are interacting, addressing them—or correcting misperceptions—to satisfy everyone's goals and purposes in working together. ■

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The Science of History

by David G Michelson

"Man is a history-making creature who can neither repeat his past nor leave it behind."

—W. H. Auden (1907–1973), British-American poet

Identity is who we are, the way we think about ourselves, the way we are viewed by the world, and the characteristics that define us. Tradition is the handing down of the information, beliefs, and customs that define our identity from one generation to another. History, the systematic study of how our identity and traditions have evolved based on events and evidence from the past, helps us to satisfy the very human need to understand where we came from and why things are the way they are today.

There is more to studying the history of technology than simply remembering names and dates, collecting documents and photographs, or reminiscing about past events. Historical evidence is key, but historical context and historical imagination are also required to usefully reconstruct or interpret historical events and thereby allow us to better explain why things are as they are. Such understanding is essential if we wish to make better decisions about tomorrow.

History: Art or Science?

R. G. Collingwood, a British philosopher and historian who was active in the first half of the twentieth century, took particular interest in the similarities and differences between the work of the natural scientist and the work of the historian. His goal was to understand how historians could and should use historical evidence to understand and interpret the past [1]. Many of his insights and observations help us to understand how the history of technology can be most usefully pursued as a scholarly activity.

Collingwood believed that history could be considered a science because its goal is to create and interpret an organized body of knowledge. However, he noted that a key difference between history and natural science is that natural scientists can generally observe the object of their study directly and repeatedly, while historians are generally limited to studying whatever evidence remains after the event occurred. If there are gaps or omissions in the evidence, the historian generally has no alternative but to either search for additional evidence or use their best judgment to fill in or reconstruct the missing details.

Collingwood further argued that historical events have both an "external" or observable component and "internal" or experiential component. The observable component is concerned with what occurred, is often assembled from on multiple observations from multiple perspectives, and is only fully knowable after the event. This is sometimes referred to as *explicit knowledge*. By contrast, the experiential component is concerned with how the event was perceived or experienced by individual participants. This is sometimes referred to as *tacit knowledge*.

Collingwood's belief that both perspectives are essential for reconstructing and interpreting historical events provides vital clues regarding the nature, and especially the diversity, of the historical evidence that we should seek to preserve. Tacit knowledge is particularly difficult to capture and relies greatly on the

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historical imagination of the author to fill in missing details.

Conventional histories tend to accurately capture the interactions that took place, the decisions that were made, and the actions that were taken. However, they often omit discussion of the engineering reasoning that drove the actors at the time and the engineering significance or implications of the outcomes. If the historian is able to draw upon similar or at least relevant experiences, drawing out such understanding is easier and more reliable.

It is unfortunate that publishers sometimes admonish writers of technical histories that every equation they include will significantly reduce sales, e.g., Stephen Hawking and *A Brief History of Time* [2] or David Salsburg and *The Lady Tasting Tea* [3]. In many cases, the authors later regret accepting such advice after they discover that the vast majority of their readers were technical experts who would have benefited greatly from the additional insights that equations provide. It is fortunate that Abraham Pais ignored such advice and included equations in his critically acclaimed biographies of Albert Einstein [3] and Niels Bohr [4]. *The New York Times* later reported that

> "Though hardly easy to read with its mixture of scientific equations and biographical narrative, the book won critical acclaim and became an instant classic among scientists, who said they felt that it captured the essence of their intellectual culture." [5]

Historical Evidence: Fragile and Irreplaceable

Historical study is dependent on evidence that is inherently fragile and often irreplaceable. A number of related practices, including historic preservation, museum curatorship, archival science, records management, and oral history, have evolved to preserve such evidence for both academic study and the public good. As events recede ever further into the past, the effort required to locate and preserve these "shadows of the past" increases dramatically. Accordingly, efforts to preserve the past should ideally begin in the present.

Primary or original sources are generated as the historical event unfolds or afterward by those who experienced the event. They may take the form of plans and drawings, orders and schedules, diaries and first-hand accounts, recordings (including photographs, video recordings, and audio recordings), internal reports (including technical reports, conference presentations and journal papers), external reports (including news accounts), artifacts (including devices and engineering prototypes), and landmarks (including structures and buildings). Secondary sources are interpretations of primary sources produced by those who didn't directly experience or witness the event.

Both primary and secondary sources need to be interpreted with care due to the limitations of those who produced them. The authors may be influenced by bias, have limited perspective, or not be able to correctly interpret what they have observed or experienced. Part of the task of the historian is to make appropriate judgements based upon their own knowledge and experience.

Collingwood believed that history could be considered a science because its goal is to create and interpret an organized body of knowledge.

The amount of primary source material that is generated depends greatly on the nature of the event and the organization involved. In many cases, the historical significance of an event may not be recognized until long after the event has taken place. Once primary source material is generated, it must be preserved and made accessible for future use. This doesn't happen automatically and a great deal of historical evidence is lost as individuals and organizations discard records and evidence that are no longer required for their original purpose.

Many historians simply accept the loss of primary source material as inevitable and resign themselves to making do with what remains. Perhaps there is a role for IEEE in helping industry and government develop a better appreciation of the long-term value of such material and to adopt best practices for the retention of materials of use to historians of technology.

Categorizing and Preserving Historical Evidence

Historical evidence tends to falls into four categories, which we may denote as types 1, 2, 3, and 4. Type 1 evidence is the living memory of those who experienced the event and who can both share information and respond to requests for clarification or additional information. Type 2 evidence includes records, reports, and media of various types including oral and first-hand histories. It is the most easily stored, shared, and interpreted of the three types. Type 3 evidence includes artifacts, prototypes, and other hardware. Type 4 evidence includes the large structures and landmarks associated with the event. Type 3 and 4 evidence help to provide both context and continuity but may be difficult to interpret in the absence of type 1 or 2 evidence.

Degradation of Historical Evidence

All historical evidence degrades with time, albeit at different rates and for different reasons. Type 1 evidence, living memory, is among the most valuable, but memory fades with time and the human lifespan is finite. Moreover, recollections may become biased or inaccurate for many reasons. Type 2 evidence, records and reports, may be lost as documents and records deteriorate, can no longer be read (possibly due to technical obsolescence), or are no longer required for their original purpose and discarded. Type 3 evidence, artifacts, may be lost as the materials from which artifacts are constructed deteriorate or are the artifacts are no longer required for its original purpose and discarded. Type 4 evidence, structures and landmarks, may be lost as properties deteriorate, are upgraded, are redeveloped, or are no longer required for their original purpose and demolished.

What is frequently overlooked (and underappreciated) is the vital role that individual scientists and engineers play in preserving historical evidence relevant to the history of science and technology. It's obvious that such individuals are a valuable repository of type 1 evidence: living memory.

Although the most visible repositories of type 2 and 3 evidence are corporate archives, public archives, and public museums, where they are highly accessible to professional historians and the public, an astonishing amount of such evidence is in the hands of private individuals, private collectors, and private museums.

Conservation involves intervention to stabilize and restore objects, often through invasive techniques. Preservation involves minimizing deterioration and preventing future damage to objects

and is usually characterized as noninvasive. Technical artifacts often present a particular challenge because many were designed under the assumption that their useful lifespan would be fairly short.

Many materials deteriorate over time, but plastics and similar organic materials can be particularly difficult. The chemical and physical damage associated with such deterioration is not just unattractive, it can be highly corrosive, irreversible, and often untreatable.

Engineers can contribute to conservation and preservation efforts by working with curators and collectors to 1) understand the deterioration process, including better tests for assessing deterioration; 2) develop better techniques for storing artifacts; and 3) develop better techniques for restoring artifacts.

The Recent and Distant Past

As a historical event recedes ever farther into the past, we may identify four different "pasts."

In the *recent past*, which may either be exceedingly brief or last for up to several years after an event, the people, places, artifacts, and records associated with the event are still intact and the context for the event easily discerned.

Preservation involves minimizing deterioration and preventing future damage to objects and is usually characterized as noninvasive.

In the *living past*, which may either be exceedingly brief or last for up to few decades, relevant landmarks, artifacts, and records may be lost over time, but witnesses are still able to offer first-hand accounts and answer questions.

In the *historical past*, no one with living memory of the event remains, but a fairly diverse set of records, artifacts, and landmarks are still available (although many have been lost).

In the *distant past*, records, artifacts, and landmarks become increasingly rare, context becomes less clear, and the task of interpretation and reconstruction becomes very difficult.

Until the latter part of the 20th century, the study of contemporary science and technology, i.e., events and achievements that occurred during the previous 50 years (or during the recent and living pasts), was mostly limited to personal biographies, project histories (sometimes referred to as management histories), science and technology journalism, and survey papers.

At an International Workshop on the Historiography of Contemporary Science, Technology and Medicine that was held from 16 to 17 September 1994 at the University of Gothenburg in Sweden, historians grappled with the challenges associated with the historical study of contemporary science and technology [6]. They concluded that

> "Historians of science (including related areas of history of technology and history of medicine) are confronted with a paradox: more than 90 percent of all science in history has been produced during the last half century, but so far only a small fraction of historical scholarship deals with this period. One reason for this glaring discrepancy may be that historians who approach the recent and contemporary technoscientific scene are confronted with new and unfamiliar methodological and theoretical problems. How shall we handle the huge amounts of published and unpublished sources? Is it possible to write a synthetic history of recent science? What level of scientific training is necessary to understand recent and contemporary science? Does the lack of historical distance prevent good scholarship? Can (and will) historians of recent science share the turf with other professional groups, such as active scientists, scholars of science and technology studies, and science journalists? How shall we deal with scientists' and technocrats' constant interference with our work? Whose history are we writing? Whose science?"

Thirty years later, we are still grappling with these questions.

Conclusions

History is both an art and a science to which engineers can usefully contribute. Ultimately, history is a team effort that involve historians, museum curators, private collectors, government, industry, and the engineering community. We must work together to ensure that historical evidence is not lost and that history is accurately told. ■

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The Development of Radio Technology by Canadian National Railways in the 1920s (and the Archival Records, Available at Library and Archives Canada)

by Andrew Elliott

Between 1923 and 1932, the Canadian National Railways Radio Department (CNR Radio or CN Radio) operated the first national radio network in North America. It was established at the behest of Sir Henry Thornton, the president and chairman of CNR, who believed that radio broadcasting was a unique way to reach both prospective and existing passengers. CNR Radio broadcast information and entertainment to both train passengers and anyone living in the coverage area of the transmitters that it operated in major cities across Canada. The existing network of telegraph lines along the rail line was used to connect the stations and conduct coast-to-coast network programming.

The position of director of radio was established, and during the 1920s the radio department was located under various incarnations of the Department of Insurance, Lands, Express, Telegraphs, Colonization, Development and General Matters. The 1923 CN Annual Report states that a Radio Department was organized in the latter part of the year (officially it was 1 July 1923) under the control of a radio engineer and assistant. The work undertaken was largely

LIBRARY AND ARCHIVES CANADA

Figure 1: Canadian National Railways radio promotional booklets. (Source: Library and Archives Canada, used with permission.)

Figure 3: Canadian National Railways radio facilities. (Source: Library and Archives Canada, used with permission.)

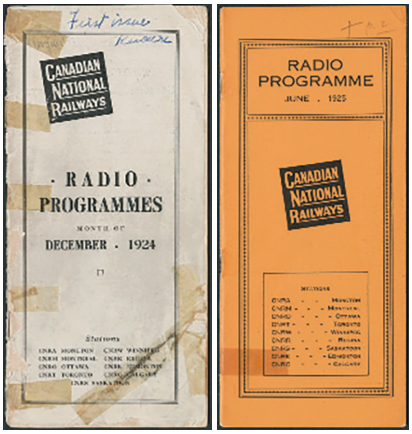

Figure 2: Canadian National Railways radio program booklets. (Source: Library and Archives Canada, used with permission.)

experimental the begin with, with the first experimental broadcast occurring in December 1923.

The official inauguration of the radio service occurred in early January 1924. Although availability was limited at first, the system expanded quickly. Low-profile antennas that could pass through railroad tunnels were installed on parlour and lounge cars, as shown in Figure 1. The CNR equipped all of its transcontinental trains with radio receiving sets (headphones and loud speakers), which passengers used to keep in touch with the events of the day and provide them with entertainment. The early radios were known as *tuned radio-frequency* (*RF*) receivers and had three tuning dials to tune each of three RF stages in succession. These had only been patented not long before this period in 1916, and console radio sets were placed in prominent interior locations.

On trains and elsewhere, broadcasting equipment was initially very basic, and some of it was battery operated. Broadcasts tended to include classical music, speeches by the CN president, and radio dramas. Some programming (broadcast out of Montréal) was bilingual as an early nod to the large number of rail travellers and employees who lived in the province of Quebec. In March 1924, CN inaugurated the program known as *Hockey Night in Canada*. Radio programme booklets were produced monthly, starting in December 1924. Examples are shown in Figure 2. CN's Public Relations Department also promoted the radio service extensively, sometimes in colourful booklets that emphasized the service as a way of bringing Canadians together, as shown in Figure 3.

(Continued on p. 25)

The Development of Cobalt-60 Radiation Therapy for Cancer

by Murray MacDonald and Denard Lynch

The development of cobalt-60 cancer treatment machines by Canadian researchers and their subsequent use worldwide have been a significant and positive contribution to global health care. Although X-rays had been used for cancer treatment since the 1920s, their energy was not sufficiently high to achieve adequate penetration to deep-seated lesions in the body. Radium sources had been used with some success but were very expensive. With the advent of nuclear reactors, numerous other radioactive isotopes became available. Dr. Harold Johns, a Canadian medical physicist, recognized that radioactive cobalt-60, which can be produced by neutron activation of cobalt-59 within a nuclear reactor, had a long-enough half-life and emissions of sufficient strength to potentially replace radium and provide effective treatment of deep-seated tumours.

Johns provided the guidance that led to development of the elements that were required for the concept to be applied in a practical setting: a suitable source, a machine to contain it, and a methodology and data to control it. In 1951, two teams of medical physicists, engineers, and radiation oncologists in London, ON, and Saskatoon, SK, independently, yet cooperatively, designed the first cobalt-60 radiation treatment machines or "cobalt bombs." Photos of the treatment machines developed by the teams in London and Saskatoon are shown in Figures 1 and 2, respectively. Both of these machines directed collimated beams of gamma radiation onto cancerous tumours. The first use of a cobalt-60 treatment machine was at Victoria Hospital, London, on 27 October 1951, followed by the University of Saskatchewan in Saskatoon on 8 November 1951. Decades of effective worldwide use since then and the many millions of lives extended have proven the efficacy of this technology.

Background

The pursuit of the "cure" for human ailments has likely been the goal of sentient beings since the Stone Age. Although various herbs, potions, and prayers prevailed for millennia, advances in modern medical technology within the last 200 years have accelerated exponentially. Modern chemistry (pharmaceuticals) has made a significant contribution to

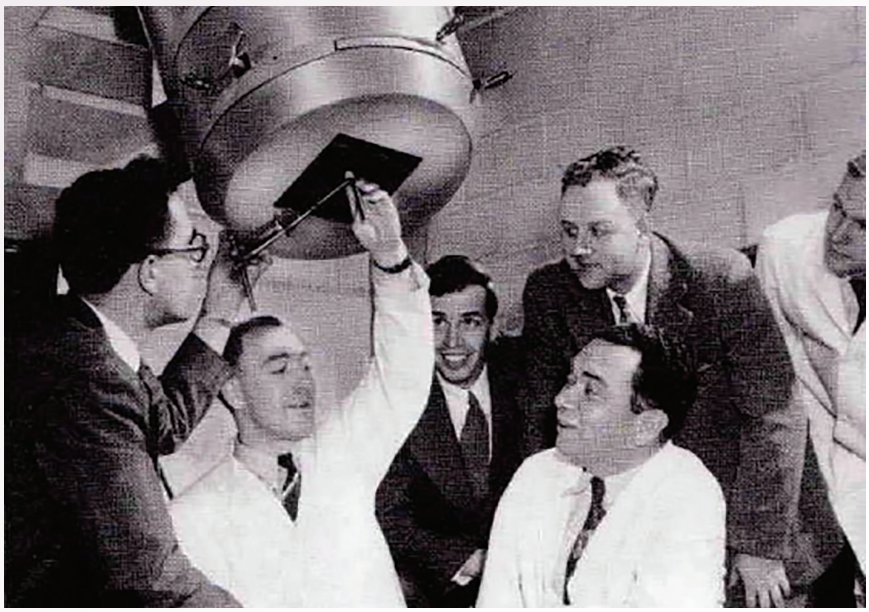

Figure 1: The Eldorado A at Victoria Hospital in London, ON, in 1951. The first patient treatment was given on 27 October 1951. Don Green (far left) was an engineering physicist involved in its design. Roy Errington (second from right) became the founder of MDS Nordion and was heavily involved in the initial development and sales of cobalt teletherapy. Dr. Ivan Smith (right foreground) was a surgeon-pathologist and head of the London cancer clinic. Dr. Frank Bately (with arm up below the Eldorado unit) was the radiation oncologist. From [1].

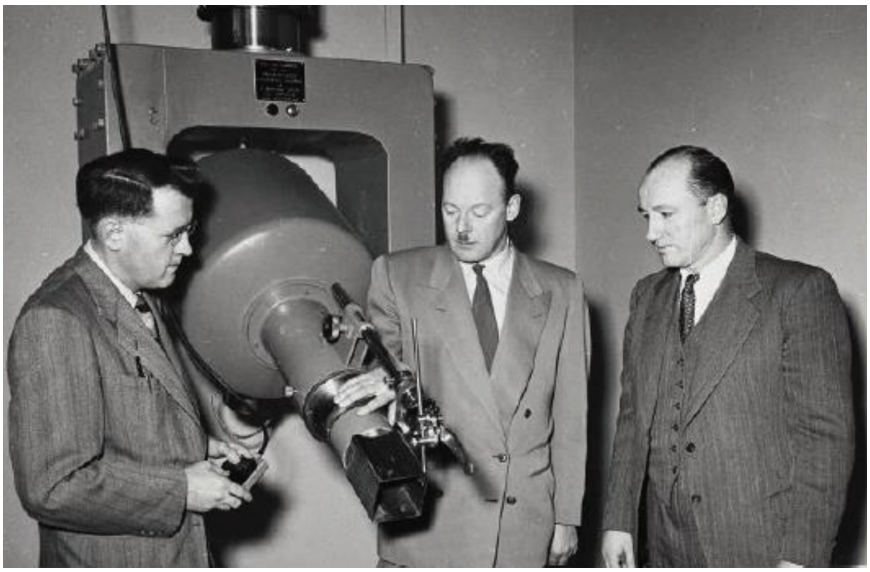

Figure 2: The Saskatchewan cobalt-60 radiation treatment unit in 1951 with the initial lead plug collimator system. (Left to right): Dr. Harold Johns, John MacKay, and Dr. T. A. Watson. From [1].

our arsenal of modern weapons against disease, but for ailments such as cancer, more tools were needed.

Röntgen's discovery of X-rays in 1895 and Becquerel's discovery of radioactivity the next year were followed in 1898 by the isolation of radioactive isotopes suitable for medical applications by Becquerel and the Curies. By the 1920s, the use of radiation in treatment of cancer, also known as *radiotherapy*, was well known to be effective at killing cancerous cells. Unfortunately, such radiation is equally effective at killing normal, healthy cells. To be a practical and effective tool for cancer treatment, it is necessary to direct the radiation, as much as possible, on the cancerous cells. For tumors deep inside the body, it is also necessary for the radiation to penetrate sufficiently to reach its target.

The development of cobalt-60 radiotherapy provided much improved penetration control, reduced complications, and much lower skin reactions at a relatively low cost.

Early radiotherapy had challenges with penetration, directivity, intensity control, safety (for both operators and patients), and cost. Prior to the development of artificial radioisotopes, radiotherapy was largely limited to low-energy sources (kilovoltage X-ray tubes) with limited penetration capabilities. Megavoltage machines (such as a betatron and the Van de Graaff generator) that produced megavoltage X-rays were already available during the 1940s and 1950s, however, they were very complex as well as costly and therefore not widely available.

Cobalt-60 and the "cobalt bomb" radiotherapy that was developed and first used in London and Saskatoon, Canada, were the foundation of a new era in radiotherapy technology. The development of cobalt-60 radiotherapy provided much improved penetration control, reduced complications, and much lower skin reactions at a relatively low cost.

Probing Further

A comprehensive review of the chain of events that led to the introduction of cobalt-60 radiotherapy was presented by Van Dyk [1]. The essential aspects of cobalt-60 radiotherapy are described in a Wikipedia article [2]. Professional guidance concerning external beam radiotherapy, including cobalt-60 radiotherapy, are presented in [3], [4], and [5]. Contemporary accounts of the introduction of cobalt-60 radiotherapy include [6], [7], and [8]. Retrospective accounts of the development of cobalt-60 radiotherapy that have appeared in various professional journals include [9], [10], [11], and [12]. ■

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Preserving the History of the Trans-Canada Telephone System

by Barry MacDonald

Since coast-to-coast long-distance communication became a reality in 1932, the telecommunications industry has seen much technological change. The first "all-Canadian" Trans-Canada circuits were a combination of open wire and twisted pair that were assisted by line repeaters. In 1958, these were replaced by the Trans-Canada Microwave System, which provided not only high-capacity voice communication but coast-to-coast TV service as well. Microwave systems incorporated digital radio in the early 1980s. As high-capacity fibre-optic systems became available in the late 1980s and 1990s, they replaced long-distance microwave links.

As microwave towers disappear from the Canadian landscape or are repurposed as cellular sites, it is time to find a way to preserve the legacy of this system that was once hailed as a "miracle of modern engineering." Many who worked in the industry and are now retired look back fondly on their time and have stories, photos, and documents to share. Facebook has provided us with a convenient way to achieve this. The Trans-Canada Telephone System – System-Téléphonique-Transcanadien group was started in 2021 and presently has 146 members. One of the goals of the group is to have members from every province and territory in Canada. To date, this has not been achieved but it is our hope that word will spread and people who have worked in the industry, directly or by association, will join us in preserving the legacy.

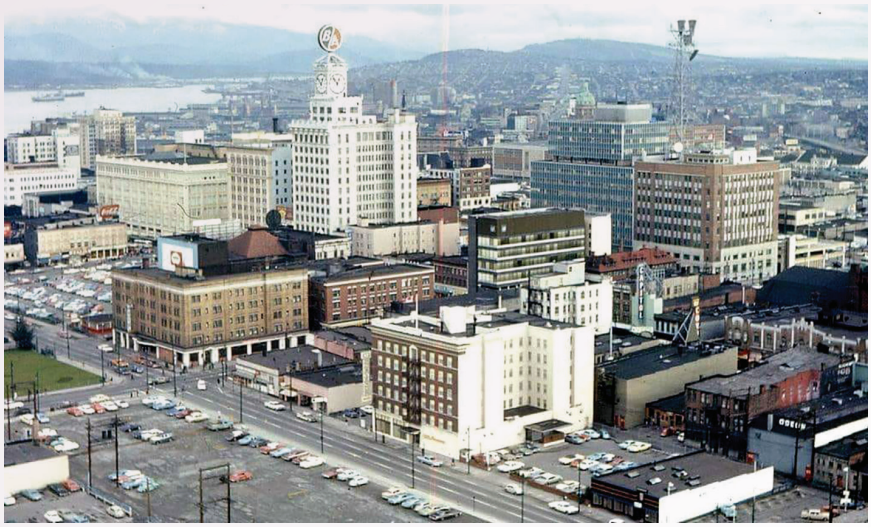

Figure 1: A 1966 photo of the Trans-Canada Microwave System tower atop the BC Tel building at the corner of Robson and Seymour in Vancouver.

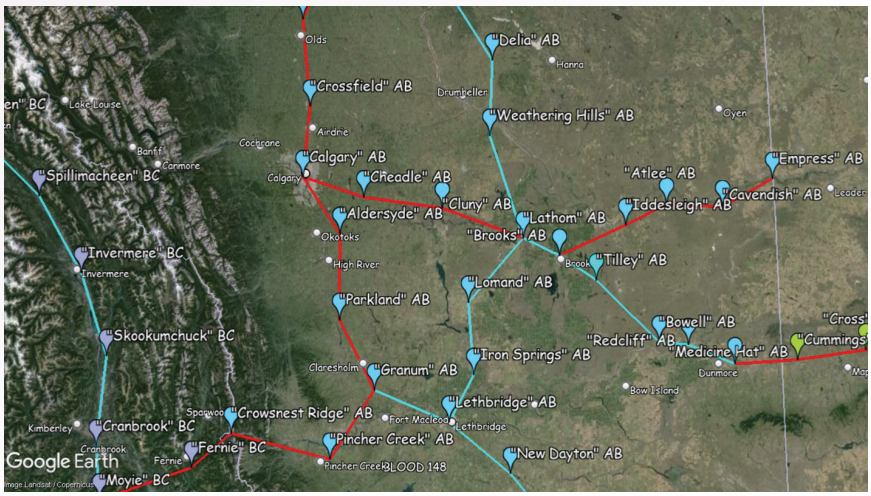

Figure 2: A map of former microwave routes in southern Alberta.

Members of the group have contributed historical and current photos of former microwave sites and historical documents, some of which include 1) a 1966 photo of the Trans-Canada Microwave System tower atop the BC Tel building at the corner of Robson and Seymour in Vancouver (Figure 1), 2) a map of former microwave routes in southern Alberta (Figure 2), and 3) a recent photo of a former microwave site near Saint-André, NB, that now hosts cellular base stations (Figure 3).

The Trans-Canada Telephone System – System-Téléphonique-Transcanadien group was started in 2021 and presently has 146 members.

On a personal note, my interest in microwaves was kindled when I visited a microwave repeater site as part of a school trip in 1961. It was a CN Telecommunications site located in northern Cape Breton. After studying electronics, I joined Maritime Tel & Tel in 1971. It took a few years to get the job I wanted, but in January of 1975, I joined the Toll Radio group in Sydney, NS. The job involved microwave, broadcast television operation centre, and multiplex, plus digital and analog carrier systems. After pulling the plug on several microwave systems that I helped to maintain over the years, I transferred to Business Services in 1993 and retired in 2005. One memory I have is working at our radio relay site outside Baddeck, NS. It overlooked Baddeck Bay and Beinn Bhreagh, which was the summer home of Alexander Graham Bell. That view always gave me pause to remember the man who started it all. ■

Figure 3: A recent photo of a former microwave site near Saint-André, NB, that now hosts cellular base stations.

About the Author

Barry MacDonald (3fathom@ns.sympatico.ca) is a retired microwave technician and the current administrator and moderator of the Trans-Canada Telephone System – System-Téléphonique-Transcanadien group on Facebook. To join the Trans-Canada Telephone System – System-Téléphonique-Transcanadien group, please visit https://www.facebook.com/groups/234595542115092/.

The Development of Radio Technology

(Continued from p. 21)

By the end of 1924, CN possessed three broadcasting stations and 11 outlets. By 1925, CN had set up or leased broadcast facilities and transmitters in major Canadian cities, including CNRV (Vancouver), CNRC (Calgary), CNRE (Edmonton), CNRR (Regina), CNRS (Saskatoon), CNRW (Winnipeg), CNRT (Toronto), CNRO (Ottawa), CNRM (Montréal), and CNRA (Moncton). Many of these locations had their own orchestras, radio play actors, and announcers, and employed people with diverse backgrounds.

The two people who were instrumental in making the radio service a success were Alexander Roy MacEwan and E. Austin Weir. From his appointment as assistant radio engineer in 1923 to his directorship in 1926 until his death in 1929, McEwan (an American by birth) was the main person who shepherded the network from experimental service to a well-established cross-country network.

E. Austin Weir (born in Ontario) joined the Colonization Department of Canadian National Railways in London, U.K., in 1924 and he was responsible for publicity in Britain and later, Europe. In 1929, he returned to Canada as director of radio for CN and was involved in a number of broadcasting successes. This included a diverse lineup of musical talent that ranged from an acclaimed British contralto to a Mohawk singer as well as the Romance of Canada, a series of 25 radio plays broadcast over many months during 1931. Some booklets published during his tenure help indicate how CN promoted its radio programming in the early 1930s.

In a 1929 short piece in *Canadian National Railways Magazine*, Weir wrote that "chain broadcasting on a national network can establish an intimate contact between all geographical and political discussions, permitting the grouping of a great nation in one vast assemblage for interchange of thought." He concluded by saying that only good could come from such a network that was constructive in building up a "stronger national consciousness and a broader mutual understanding." CN Radio was disbanded when the Canadian Broadcasting Corporation (CBC) was created in the early 1930s, Weir went on to work for the CBC, and much of the network technology that CN had developed was taken over and used by the CBC.

Various archival collections at Library and Archives Canada contain records that relate to the establishment of radio broadcasting in Canada. Although the primary records that relate to radio broadcasting pioneering can be found in the Canadian National Railways fonds (specifically in the Public Relations and Radio Department series), there are also some excellent archival records in the E. Austin Weir fonds. Additionally, researchers can find material in both the Department of Railways and Canals fonds and the CBC fonds. ■

About the Author

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Bootstrapping a University-Based Museum of Computing: From Unsanctioned and Unrecognized to a Stateful Home

by Scott M. Campbell

Computer scientists describe a system as stateful if it is designed to remember its own history by storing information about previous interactions. Here, I briefly describe the activities and challenges of the University of Waterloo Computer Museum, particularly those relevant to bringing it to its current stateful abilities.

The museum is a university-based collection of computing-related artifacts that has been housed administratively within the David R. Cheriton School of Computer Science since 2022. Visitors can see and interact with dozens of artifacts in our welcome center, which is located in a high-traffic area across from the School's main office and close to the engineering, science, and mathematics library. Featured artifacts include the diagnostic panel from the IBM System/360 Model 75 that occupied the computing centre in the late 1960s (Figure 1), a diorama of that same computing centre, a Commodore SuperPET originally developed by Waterloo researchers as a teaching-related computer (Figure 2), several "classic" personal microcomputers in working order, and other rare artifacts linked to computing-related spin-offs from the university and the region. There are also two physical exhibits on campus. One explores the history and use of slide rules, the other recognizes the 40th anniversary of the Apple Macintosh computer.

The Computer Museum was founded in 2010 by Lawrence Folland, a senior manager of research computing in the School of Computer Science, and Scott

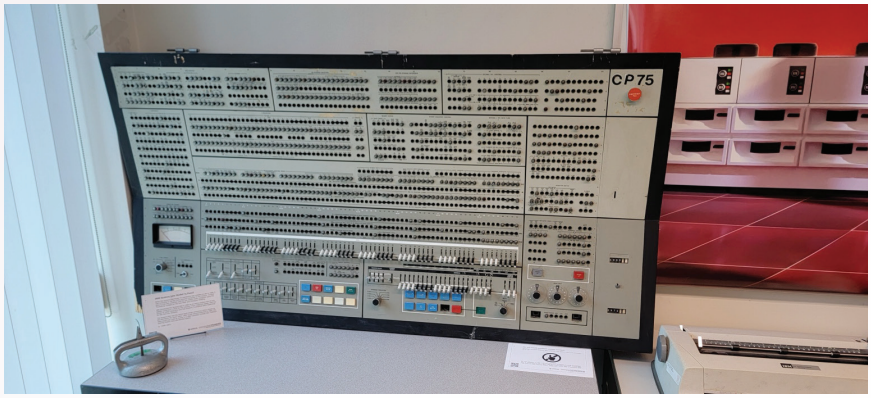

Figure 1: The diagnostic panel of the IBM System/360 Model 75 on display in the museum. It was installed at the University of Waterloo (UW) in 1967 and was thought to be the most powerful computer in Canada for a brief time.

Campbell, a historian of computing faculty member from the Faculty of Engineering. Independently, both had approached senior university administrators about establishing a museum before meeting (Figure 3). Their shared interest in preserving and promoting the university's technological heritage has gained broad support over time, because as it turns out, many current and past students, staff and faculty, and external community members have artifacts and stories to share. To prevent the loss of these treasures, the museum has been given a mandate to collect, preserve, and interpret the history of computing at the University of Waterloo and related organizations of the geographic region.

As with most museums, storage is a constant concern because the majority of the collected artifacts cannot be displayed. And as with most universities, campus space is at a premium. Operating unofficially for many years has meant borrowing temporarily empty offices and unused corners in controlled access areas to store and catalogue artifacts. Despite these challenges, more than 4,000 artifacts have been catalogued by staff and volunteers over the last 14 years. The collection covers primarily the period of personal microcomputing from the 1970s to the 1990s and includes hardware, peripherals, manuals, and software of many popular and several not-so-popular computers.

As with most museums, storage is a constant concern because the majority of the collected artifacts cannot be displayed.

More broadly, our collection includes artifacts as far back as the 19th century, such as a cylindrical slide rule once owned by a prominent local civil engineer, and several dozen mechanical calculators and related office machinery from the early to mid-20th century. Although not directly related to the university, these artifacts are relevant to the broader pre-electronic history of computing. They are often featured in single-day pop-up exhibits, and many are part of the teaching collection used in a history of computing course taught by the author.

Figure 2: A collection of working microcomputers on display in our welcome centre, featuring Commodore, Apple, and Tandy systems from the late 1970s to early 1980s.

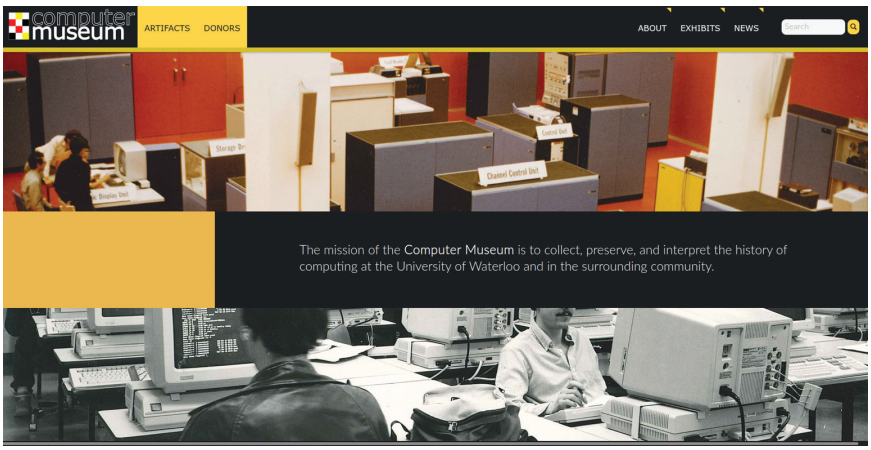

Figure 3: The homepage of the UW Computer Museum catalogue system, featuring our mission and photos of the Red Room computing centre and a teaching lab.

We have also recently launched a software preservation effort to recover data from media during these periods. Our primary goal is to recover software and languages produced at Waterloo for higher education, such as WATFOR the student-oriented FORTRAN compiler first developed in 1965 for IBM mainframes, or the many WATCOM computer language and database products of the 1980s, which were often spun-off from academic research.

Until 2023, the museum had no annual budget for supplies or to hire staff, and depended on a handful of one-off project proposals and repurposed budget surpluses to fund small exhibits and storage-related purchases such as shelves and boxes. We also employed student interns to assist with cataloguing and exhibit development.

Official standing within the School of Computer Science and a permanent display area and office has come with increased promotional and outreach opportunities. The existence of the museum has become a pleasant surprise for many alumni and visitors as well as staff and students. As a result, donation offers have increased to their highest levels, requiring more deliberate acquisition policies. Community volunteers have also helped drive governance and policy development. Looking forward, our plans include exhibit development, research related to computing history and historical teaching, and outreach and community development working with local computing heritage enthusiasts and regional museum networks. ■

About the Author

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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 historiography of Canadian contributions to microwave radar during the Second World War.

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It has been said that, while the atomic bomb may have ended the Second World War, it was radar that won it. Canada's formal involvement with radar began in March 1939, when the Air Ministry briefed it and the other Dominions on British developments. The contributions of the National Research Council (NRC) and its industry and academic collaborators to the radar effort, especially in the wake of the Tizard mission in 1940, have long been a source of national pride [1], [2]. These contributions generally fall into three categories: 1) the development and production of radar components, 2) the introduction of new radar concepts and innovations, and 3) the development and production of radar systems.

An immediate result of Canada's decision to participate in microwave radar development was the expansion of Research Enterprises Ltd. (REL)—a crown corporation originally formed to manufacture technically sophisticated

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equipment, such as optical devices and, later, radio-frequency radars—to include the manufacture of microwave radars [3]. At the same time, Northern Electric Ltd. was subcontracted to manufacture copies of the Tizard magnetron in volume with part number REL-3D and had them in full production within six months.

NRC developed the first plan position indicator radar display using fixed deflection coils based upon its earlier work with cathode ray direction finding. Collaborations between NRC and several Canadian universities also led to significant outcomes. At McGill University, for example, W. H. Watson et al. introduced the slotted waveguide antenna, which greatly simplified the design of radar antennas used in mobile and shipboard environments and which is still used by many radars today. Also at McGill, J. S. Marshall and his doctoral student W. Palmer conducted pioneering work on the raindrop size distribution in midlatitude rain that led to the rain rate-to-radar reflectivity (Z–R) relation that laid the foundation for radar meteorology.

NRC developed the first plan position indicator radar display using fixed deflection coils based upon its earlier work with cathode ray direction finding.

During 1941, Canada developed two microwave radars based on the REL-3D magnetron before it was superseded: the GL IIIC antiaircraft (AA) early-warning (EW) and gun-laying (GL) radar for the Canadian Army and the RX/C

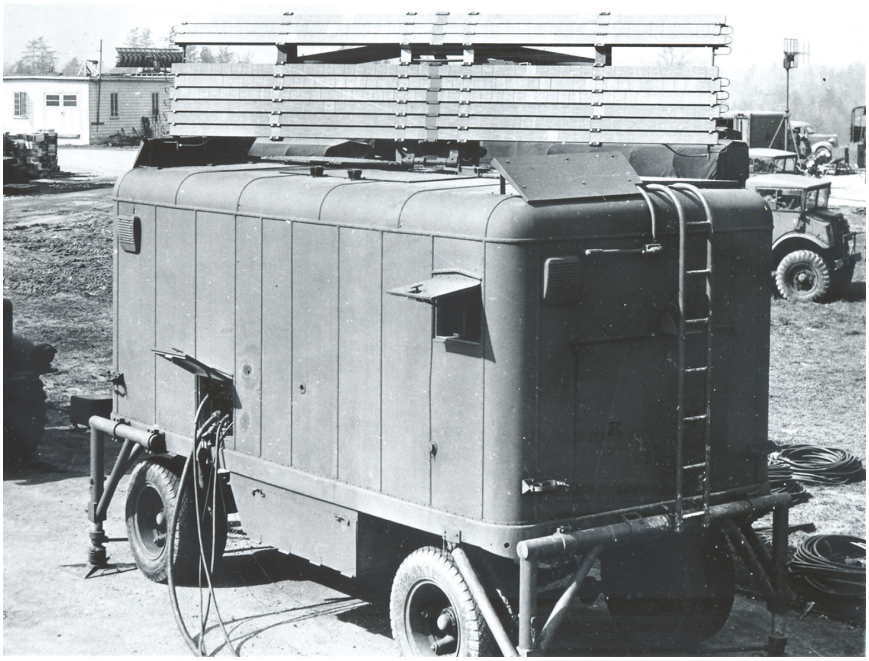

Figure 1: An MZPI sweep search radar (also known as *Anti-Aircraft Radar No. 4 Mk. 6*). (Source: National Research Council Canada archives; used with permission.)

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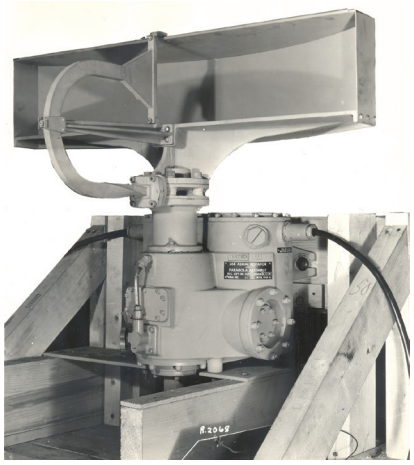

Figure 2: A Type 268 shipboard radar antenna. (Source: National Research Council Canada archives; used with permission.)

microwave shipborne radar for the Royal Canadian Navy. While both radars encountered issues during development and early deployment, they also enjoyed major successes. In particular, the GL IIIC elicited strong praise from W. L. Bragg after a demonstration in mid-1941 and led to important follow-on models, such as the MZPI radar shown in Figure 1 that was widely adopted by Allied partners [4]. The experience gained during the development of the GL IIIC and RX/C also informed the Canadian development of a microwave EW radar for the Royal Canadian Air Force later in the war.

Canada was the first to mass produce a microwave fire-control radar; more than 400 AA No. 4s were produced and served in virtually every war zone. At the request of the Admiralty, Canada designed and built more than 2,000 Type 268 3-cm marine radars that served in the North Atlantic until 1945. A Type 268 shipborne radar antenna is shown in Figure 2. Altogether, Canada produced more than 8,800 radar sets during the course of the war.

In the literature, however, Canadian contributions to radar are often lost against the background of the British and American efforts. For example, in 1996, Buderi [5] presented a history of radar with a strong focus on U.S. contributions and especially those of the Massachusetts Institute of Technology Radiation Lab, but some reviewers expressed concern that his treatment fails to fully acknowledge the contributions of the other allies, including Britain and Canada. In 1999, Brown [6] published what has been described by some as radar's first comprehensive history, but, while Britain's role is clearly described, Canadian contributions get short shrift.

The sources concerning Canadian contributions to radar are quite dispersed, with many elements either unpublished or only informally published. Only a few works treat Canadian contributions to microwave radar during the Second World War in any depth. In 1981, Middleton [7] presented a slim volume that provides details of the projects conducted by the National Research Council's Radio Section and Radio Branch for the Canadian military. In 1990, Lindsey [8] edited a series of recollections of Canadian science during the war that included eight contributions concerning the Canadian radar effort. In 1998, Avery [9] devoted a 28-page section to radar in his summary of Canadian and Allied technology during the war.

In the literature, however, Canadian contributions to radar are often lost against the background of the British and American efforts.

In recent years, a dedicated group of enthusiasts has begun to post some of the missing details to privately run websites. The lack of a guide or review of that literature or a monograph that pulls the details concerning published and unpublished sources together into a single document is a major obstacle to those who wish to 1) learn more about or contribute to the story or 2) use it as a case study concerning technical innovation. A transition from what some describe as political or management histories to full engineering histories would also be welcome. We clearly have a great deal of work to do to ensure that Canadian radar efforts are not forgotten. ■

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/.

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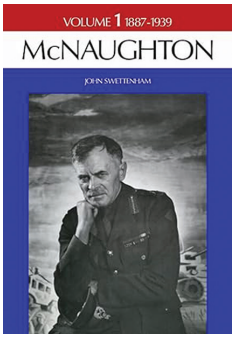
David G. Michelson is president of the Canadian National Committee of the International Union of Radio Science (2018–2026). He has led the Radio Science Lab at the University of British Columbia, Department of Electrical and Computer Engineering, since 2003. His current research focuses on short-range/low-power wireless networks for industrial vertical and transportation applications, millimetre-wave channels and systems, and satellite networks for communications and remote sensing. Prof. Michelson currently serves as a member of the Board of Governors of the IEEE Vehicular Technology Society, as general chair of the IEEE AP-S/URSI 2025 and IEEE CCECE 2025 conferences, 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.

Book Review

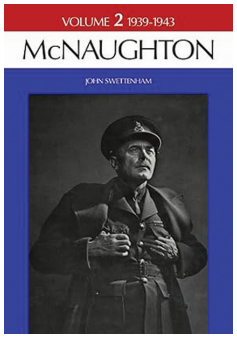
McNaughton

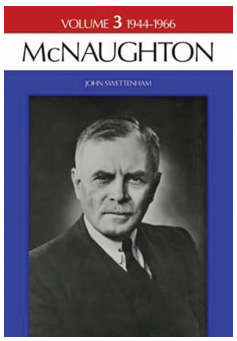


Author: John Swettenham
Publisher: Ryerson Press
Date: 1968
Reprinted by IEEE Canada Press, 2022

Andrew G. L. McNaughton (25 February 1887–11 July 1966) was a Canadian electrical engineer, scientist, army officer, cabinet minister, and diplomat. In 1969, IEEE Region 7 (Canada) elected to honour the memory of General McNaughton's contributions to the engineering profession in Canada by establishing the Andrew G. L. McNaughton Gold Medal as its highest award and honour. The McNaughton medal recognizes outstanding Canadian engineers for their exemplary contributions to the engineering profession.

Swettenham's three-volume biography tells the complete story of the life and times of General McNaughton. The first volume covers his early life and education; his military career during the First World War; his roles as deputy chief and, later, chief of the general staff; and his role as president of the National Research Council during the critical prewar years. The second volume covers his return to the Army and deployment to the United Kingdom as commander of the 1st Canadian Infantry Division; Canadian Corps; and, ultimately, First Canadian Army. The third volume covers his return to Canada and subsequent career as a politician and diplomat.



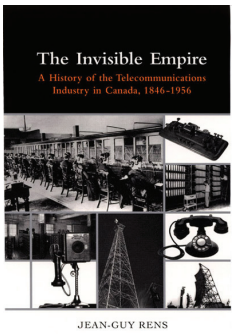


The biography makes clear why McNaughton is held in such high regard by IEEE Canada and its members. McNaughton combined, in a single person, the military leadership skill of someone like Omar Bradley with the scientific and administration skills of someone like Vannevar Bush. Easily the best known Canadian general at the start of the war, the news media in Canada, the United Kingdom, and even the neutral United States hailed McNaughton as the great "soldier–scientist." *Life* magazine featured McNaughton on the cover of its 18 December 1939 issue and predicted that he was the Allied general most likely to take Berlin. While serving as commander of the First Canadian Army, his contribution to the development of new techniques has been described as outstanding, especially in the field of detection and weaponry. While some have complained that this biography is not critical enough of McNaughton, all acknowledge that he was a truly exceptional individual.

Available from Amazon.ca:

- *Volume 1*: ISBN 0969231636 (https://www.amazon.ca/McNaughton-1-John-Swettenham/dp/0969231636)
- *Volume 2*: ISBN 0969231644 (https://www.amazon.ca/McNaughton-2-John-Swettenham/dp/0969231644)
- *Volume 3*: ISBN 0969231652 (https://www.amazon.ca/McNaughton-3-John-Swettenham/dp/0969231652). ■

The Invisible Empire: A History of the Telecommunications Industry in Canada, 1846–1956



Author: Jean-Guy Rens
Publisher: McGill–Queen's University Press
Date: 2001
Number of pages: 320

As a large and sparsely populated nation, Canada has long been dependent on advances in telecommunications to establish national sovereignty and shape its national identity. The latter part of the 20th century witnessed remarkable advances. In 1958, completion of the Trans Canada microwave system made possible direct-dialled long distance service and coast-to-coast network television. In 1972, the first of the Anik series of communication satellites brought direct-dialled long distance service and network television to the north. In 1978, the Communications Technology Satellite was the first to demonstrate direct-to-home satellite television broadcast. In the 1980s, the introduction of fibre-optic networks began to transform the Canadian telecommunications infrastructure, while the introduction of cellular telephony began to transform personal communications. What set the stage for all this?

The Invisible Empire tells the story of Canadian telecommunications from the laying of the first telegraph line between Toronto and Hamilton in 1846 to the separation of Northern Electric (later to become known as *Nortel*) from the American Bell System in 1956. Through the book, Rens pursues four main themes: 1) the extent to which advances in and the expansion of the telecommunications infrastructure were enabled by social or economic events, 2) the degree to which improvements in the telecommunications infrastructure affected the course of key historical events, 3) lost opportunities as projects with great potential failed, and 4) the challenge of maintaining Canadian ownership and control of its telecommunications infrastructure in the face of American domination.

The book is divided into two parts: 1846–1915 and 1915–1956. The book has received praise for the depth and quality of the underlying research. The only significant criticism has been that part two is very focused on the role of Bell Canada. Originally written in French and published in 1993 as *L'Empire invisible*: *histoire des télécommunications au Canada de 1846 à 1956*, the book was translated into English and published in 2001 as *The Invisible Empire: A History of the Telecommunications Industry in Canada, 1846–1956*. The book will be of interest to those who work in the telecommunications industry and anyone curious about what set the stage for the telecommunications revolution that began in the late 1950s.

Available from McGill-Queen's University Press at https://www.mqup.ca/invisible-empire--the-products-9780773520523.php (hardcover: ISBN 9780773520523). ■

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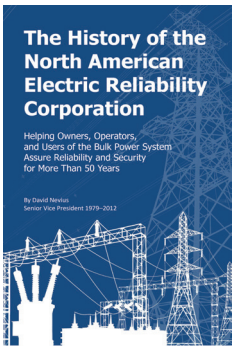
The History of the North American Electric Reliability Corporation, *Second Edition*



Author: David Nevius
Publisher: North American Electric Reliability Corporation
Date: March 2020
Number of pages: 165

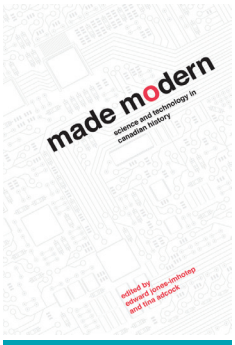
The Great Northeast Blackout of 1965 was one of the biggest power failures in history. At the height of rush hour on 9 November 1965, 30 million people living in parts of Ontario, Quebec, and eight U.S. states were plunged into darkness. Although power was restored by the next morning, the scale of the event attracted political attention. The electric power industry had already recognized the challenges associated with the growing mutual dependence of interconnected power systems and, in January 1963, had established the North American Power Systems Interconnection Committee. Following the blackout, the Federal Power Commission was charged by President Johnson with investigating the cause and recommending appropriate actions. This ultimately led to the formation of the National Electric Reliability Council (NERC) in 1968 and would include, essentially, all of the electric power systems in the United States as well as parts of Ontario, British Columbia, and Manitoba. In 1981, the name was changed to the North American Electric Reliability Council to recognize both Canada's participation and the broader scope of NERC's footprint.

The work strikes the right balance between a purely technical document and a history book that explains why things are the way they are today.

The 50th anniversary of the formation of NERC was the motivation for preparing this volume. The project was undertaken to recognize the individuals responsible for NERC's many accomplishments during this period and to ensure that the history of NERC's first half century would not be forgotten. David Nevius, a former senior vice president of NERC, was the lead writer and researcher. At the outset, Nevius suggests that the history of NERC is best considered in three stages: 1) NERC's original formation and the manner in which electric power utilities came together to voluntarily accept responsibility for ensuring the reliability of the bulk power system; 2) the advent of competition, open access, and the entry of new nonutility generators and marketers; and 3) the results of the Energy Policy Act of 2005, which led to NERC being recast and rebranded as the North American Electric Reliability Corporation. The work strikes the right balance between a purely technical document and a history book that explains why things are the way they are today. It will be of interest to both those working in the electric power industry and those who are just curious about the organization that ensures the reliability of North America's bulk power system.

Available as a free download from the North American Electric Reliability Corporation at https://www.nerc.com/news/Documents/NERCHistoryBook.pdf. ■

Made Modern: Science and Technology in Canadian History



Editors: Edward Jones-Imhotep and Tina Adcock
Publisher: UBC Press
Date: 2019

Canadians have always considered themselves to be modern, but what does *modernity* really mean, and what role have advances in science and technology over the years played in shaping their perceptions of what it means to be modern? *Made Modern: Science and Technology in Canadian History* is based on presentations given at the Science, Technology, and the Modern in Canada conference at York University in 2015 in memory of Richard Jarrell. The book is organized around three themes—bodies, technologies, and environments—and considers topics as varied as exploration, scientific rationality, the occult, medical instruments, patents, communication, and infrastructure.

What does *modernity* really mean, and what role have advances in science and technology over the years played in shaping their perceptions of what it means to be modern?

There is no shortage of books that focus on the role that people play in shaping and advancing science and technology over the years. Relatively few take the opposite stance and focus on the role that advances in science and technology have played in shaping people, their perceptions, and their aspirations over the years. The first major collection of its kind in 30 years, *Made Modern* includes contributions from Stephen Bocking, Dorotea Gucciardo, Jan Hadlaw, James Hull, Dolly Jørgensen, Eda Kranakis, Daniel Macfarlane, Beth A. Robertson, Efram Sera-Shriar, Blair Stein, Andrew Stuhl, and David Theodore.

This book will be of interest to students and scholars of the history of science and technology, Canadian history, and environmental history.

Available from UBC Press at https://www.ubcpress.ca/made-modern:

- *Paperback*: ISBN 9780774837248
- *Hardcover*: ISBN 9780774837231
- *PDF*: ISBN 9780774837255
- *E-pub*: ISBN 9780774837262. ■

IEEE Canadian Foundation
Dr. John William Bandler Graduate Scholarship in Engineering Design

The IEEE Canadian Foundation is pleased to announce a prestigious new scholarship for Ph.D. students and postdoctoral fellows doing research at a Canadian university, which has been established to honour the memory of John Bandler, one of Canada's most illustrious engineering pioneers.

The IEEE Canadian Foundation Dr. John William Bandler Graduate Scholarship in Engineering Design is funded by John's wife Beth Budd Bandler to annually provide one worthy recipient a CAD$5,000 grant to further his or her education and research. The inaugural award will be in 2025.

A world-renowned engineer, teacher, researcher, and innovator, Bandler was a professor, former dean, and professor emeritus of the Faculty of Engineering at McMaster University, Ontario, Canada, from 1969 until his death on 28 September 2023.

He is internationally known for pioneering "space mapping" technology, a mathematical encapsulation of old-fashioned common sense, which is now used across the entire spectrum of engineering. Bandler's award-winning research revolutionized the engineering and CAD of microwave circuitry, and his practical application of space mapping, device modeling, and optimization theories resulted in more than 500 publications and significant reductions in the development costs of a wide variety of electronic systems.

Bandler wrote, produced, and directed plays and a short film. He gave workshops on entrepreneurship, ethics, awareness, creativity, and creative thinking, and across all disciplines and internationally. He coached students and young professionals in communicating their research to general audiences. Bandler believed that the lessons and tips about presentations and knowledge translation he shared would make a lasting impact on their careers. He was particularly proud of the hundreds of students he mentored over his career, many of whom have had or now hold prestigious industry positions or teaching and research positions at companies or academic institutions around the world.

Bandler believed that the lessons and tips about presentations and knowledge translation he shared would make a lasting impact on their careers.

His commitment to personal and professional growth is demonstrated by his many international scientific collaborators and the hours he spent mentoring students on ethics and presentation skills. He spearheaded competitions for the Three Minute Thesis (3MT), a program created by Queensland University in Australia; in the IEEE Microwave Theory and Technology Society (MTT-S) for the IEEE MTT-S International Microwave Symposium; and also at McMaster University for graduate students in engineering and other disciplines. 3MT recognizes the importance of communicating research to nontechnical audiences. Students learn, practice, and compete to present their research in under 3 min, using only one static slide.

John William Bandler O.C., Ph.D., D.Sc. (engineering), ACGI, DIC, FRSC, FCAE, LFIEEE, FEIC, P.Eng. Medals (left): Officer of the Order of Canada and (right) the Queen's Diamond Jubilee. (Source: Beth Bandler.)

Bandler was a fellow of numerous engineering societies and the Royal Society of Canada. He was the recipient of multiple awards for his contributions to the field of microwave theory and techniques. These awards include the IEEE Canada McNaughton Gold Medal, 2023 IEEE Electromagnetics Award, and Queen Elizabeth II Diamond Jubilee Medal. He was also honoured as an Officer of the Order of Canada for his scientific contributions that have helped position Canada at the forefront of microwave engineering.

The scholarship that bears his name will be awarded annually to either a graduate student in the second or subsequent year of a Ph.D. program or a postdoctoral fellow in the Department of Electrical and Computer Engineering at a Canadian university. The recipient must also be conducting research in one of the areas of Bandler's scientific interests, have an outstanding academic record, and a commendable publication record.

Further details about the scholarship and the eligibility requirements are posted on the IEEE Canadian Foundation website at www.ieeecanadianfoundation.org/EN/bandler_scholarship.php.

Nominations for the inaugural award will be due 15 March 2025.

Reflections and Testimonials

"John's guidance during my graduate studies not only helped me become a competent engineer but also a stronger communicator and better mentor. He cared deeply about his students, and I hope that I can have the same impact on others as he had on me."

—Daniel Tajik, electrical engineer, MDA Space

"John's mentorship was instrumental in my transformation as a science communicator. His guidance taught me how to captivate audiences and convey complex ideas with clarity. John emanated all the qualities of an exemplary mentor: [he was] knowledgeable, inspiring, and kind. It was a privilege to learn from his wisdom. I am once again reminded how grateful I am for John's coaching; the importance of communication skills seems to prevail time and time again!"

—Megan Vierhout, M.Sc., H.B.Sc., Ph.D. candidate, medical sciences, McMaster University

"John Bandler's research legacy has left an indelible imprint on engineering science, marked by originality, talent, and exceptional vision. But his legacy also lives through us, his students, and researchers, whom he shaped into professionals and better people. Looking back to 25 years of professional interaction, I feel privileged and lucky."

—Natalia K. Nikolova, professor, McMaster University

"John Bandler's departure leaves a profound void, not only within his family but also in the microwave community. He will be remembered as a brilliant and distinguished academic and engineer with a unique personality and exceptional multifaceted talents. His scientific and engineering achievements garnered highest national and international honors and acclaim. His legacy comprises disruptive innovations in microwave design and optimization, and he is known as *the godfather of space mapping*. Beyond his technical and scientific accomplishments, he left his mark in education, literature, theater, and the fine arts. His creativity lives on through the accomplished individuals he mentored, all of whom remain profoundly grateful for his inspiration, unwavering support, collaborative spirit, and enduring friendship."

"John's mentorship was instrumental in my transformation as a science communicator."

—Wolfgang J.R. Hoefer, professor emeritus, Department of Electrical and Computer Engineering, University of Victoria

"I was a privileged by having John as my Ph.D. supervisor at McMaster University (1997–2001). He was a great mentor, very demanding but also very wise and patient. We developed a very strong friendship that extended until his death. John has been the most influential figure in my professional career."

—José E. Rayas-Sánchez, director, CAECAS Research Group, ITESO–The Jesuit University of Guadalajara

"John Bandler's relentless pursuit of innovation transformed ideas into realities. His work and mentorship have inspired countless researchers, profoundly shaping the field and leaving a lasting legacy for future generations. As a Canadian icon, his absence leaves a void in the Canadian microwave engineering community."

—Raafat Mansour, professor, Canada Research Chair Electrical and Computer Engineering Department, University of Waterloo

IEEE Canadian Foundation—A 30-Year Partnership With IEEE Canada

The year 2024 marks the 30th year of the IEEE Canadian Foundation (ICF) operating as a public foundation and charity.

The Foundation's story predates this, going back to 1955, when an electronics trade show and event began in Toronto, supporting the Institute of Radio Engineers, a predecessor of IEEE. That prospered and was able to disburse funds to local student activities. Years later, the market for general-interest trade shows faded, so the organizers determined, along with other Canadian IEEE members, to transform itself into a structure that would support the ongoing educational and scientific aims of IEEE in Canada. One of the goals was to allows tax-deductible donations for Canadians, similar to what exists for U.S. donors to the IEEE Foundation, a U.S. registered charity. Following approval by the Canada Revenue Agency as to charitable purposes, that transformation was completed in 1994.

Some 10 years later, the Foundation welcomed the addition of surplus from a similar event in Montréal and, at the same time, broadened to become a national organization with benefit to all Sections.

Today, through the generosity of donors, our annual program of scholarships, McNaughton Learning Resource Centre grants, special grants, and awards encourages educational growth, new and innovative initiatives. and recognition of achievement and excellence. Together, we deliver opportunity, innovation, and impact across Canada.

I am impressed with the deep competence and the quiet dignity that its members and directors have shown in carrying out the mission of the Foundation.

Your gift as annual, monthly, appreciated assets, endowment, or bequest sustains and advances our support to the IEEE community in Canada. For additional details, visit www.ieeecanadianfoundation.org. ■

"I have closely followed the work of the Foundation over the decades since its inception. I am impressed with the deep competence and the quiet dignity that its members and directors have shown in carrying out the mission of the Foundation. The IEEE and the ICF have contributed substantially to the growth and success of electrical and electronic engineering in all parts of Canada. I certainly expect this will continue far into the bright future of our chosen profession."

—Miro Forest, Life Senior Member, P.Eng.,
Founding President,
IEEE Canadian Foundation

(Right) Founding Foundation President Miro Forest receives IEEE Canada's highest award for service, the W.S. Read Outstanding Service Award from (left) Wally Read at the 22 October 2005 IEEE Toronto Section Annual General Meeting. The citation reads, "for significant and sustained leadership over two decades as director and president of the IEEE Canadian Foundation and its predecessor organization, IEEC Inc."

Biz Tech Report

by Terrance Malkinson

This summer the impact of climate change has become evident to everyone. No region of our planet was immune. Predictions (often ignored) made by scientists and engineers over the decades are now occurring. Global warming has now reached the point where, this summer, we experienced the hottest days in recorded history, (www.cnn.com/2024/07/23/climate/hottest-day-global-record/index.html). This is the second consecutive year that the average global temperature has set new records. Based on scientific data extracted from ice cores and coral reefs, these temperature records represent the warmest period the planet has seen in at least 100,000 years. Without immediate and substantial change, we are likely to see continuing record temperatures, which will in time make our planet uninhabitable.

Based on scientific data extracted from ice cores and coral reefs, these temperature records represent the warmest period the planet has seen in at least 100,000 years.

Global temperatures fluctuate based on natural factors: seasons, large-scale climate patterns and solar activity, and on unnatural human caused factors, primarily the burning of fossil fuels and loss of vegetation. Climate change and extreme weather events are facilitating an increasing rate of colossal disasters such as wildfires, hurricanes, both flooding and drought, increased pestilence, and the loss of agricultural-based food products, which are unable to adapt to a changing environment. Outdoor activities have become a challenge as witnessed by the athletes experience in Paris and previous Summer Olympic Games. Many summer sporting events have been cancelled, including those traditionally offered in the British Columbia Interior for many years, such as the Penticton Ironman Triathlon. This is in part because of the high-risk conditions of high temperatures, intense solar radiation, and wildfires.

Solutions will be complex and expensive and will require innovative engineering solutions and changes in human behavior. An increasing global population is placing what many believe are unsustainable demands upon the ecosystem of our plant. Vast areas of fertile agricultural land are being destroyed by conversion into homes and for industrial purposes. As we know, photosynthesis is the process through which plants use sunlight to convert carbon dioxide and water into glucose and oxygen. Potable water is now in short supply, not just in the undeveloped world but increasingly in the developed world. Urban infrastructure, as exemplified by the breakage of the main water feeder line in Calgary, is deteriorating and is subject to catastrophic failure (www.cbc.ca/news/canada/calgary/calgary-water-feeder-main-bearspaw-south-wire-snaps-1.7288378). We must all accept the scientific reality of climate change and take well-crafted actions to address it:

The Gordie Howe International Bridge project is a massive, US$6.4 billion, 84-month project that delivers transportation improvements between Canada and the United States (www.gordiehoweinternationalbridge.com/en). It connects Detroit, Michigan, and Windsor, Ontario. It is being built through a public–private partnership where the private sector assumes a major share of the financing and construction risks from design and planning as well as long-term maintenance. With a total length of 2.5 km and its cable-stayed design, this six-lane bridge and its multiuse pedestrian and cycling pathway is aesthetically attractive. It is the longest cable-stayed bridge in North America and the 10th longest in the world. The crossing will be publicly owned, between Canada and Michigan. Completion of construction is planned for September 2025 and the first vehicles are expected to travel across the bridge shortly thereafter.

On 5 July 2023, Abbott announced that the U.S. Food and Drug Administration has approved its AVEIR dual-chamber leadless pacemaker system. (www.cardiovascular.abbott/us/en/hcp/products/cardiac-rhythm-management/pacemakers/aveir-dr-dual-chamber-leadless-pacemaker-system.html). Used in patients with abnormal or slow heart rhythms, it is the world's first dual-chamber leadless pacing system. It has two pieces that are placed into different parts of the heart. Each piece is smaller than a triple-A battery, one-tenth the size of a traditional pacemaker. The device is less invasive, with a lower risk for infection. Abbott's proprietary implant-to-implant communication technology provides synchronized or coordinated cardiac pacing between the two leadless pacemakers based on the patient's medical needs. The pacing system is implanted directly into the heart through a leg vein. In Canada, the device is available at Foothills Medical Centre in Calgary and the Montreal Heart Institute (www.cbc.ca/news/canada/calgary/dual-chamber-pacemaker-1.7292543). Currently, it is limited to specially selected patients. In time, more cardiac patients will be able to access this important medical technology.

Although concrete has the strength for building skyscrapers and heavy infrastructure, the reality is that it cannot compete with the endurance of concrete used by builders thousands of years ago. Concrete used in current construction generally has a lifespan of 50–100 years. Ancient builders created structures that remain, thousands of years later. (www.sciencealert.com/why-2-000-year-old-roman-concrete-is-so-much-better-than-what-we-produce-today). Scientists have been studying materials from long ago in a quest to discover how the ancients accomplished this longevity. If we could discover their recipe, cement construction would be more sustainable, reducing global O_2 emissions.

Today's builders do not wish to simply copy the ancient recipes. Ancient concrete lasted a long time, but it does not hold up to heavy loads. Studies have found all kinds of natural materials mixed into structures from long ago. Additionally, scientists have found that the recipe often contains materials unique to the region. These materials often have an unusual ability to repair the cement itself and adapts over time to changing conditions. Initial results showed that they would put many different things into the cement that created structures that have survived the ages.

Studies have found all kinds of natural materials mixed into structures from long ago.

The James Webb Space Telescope, for which Canada was a major design and construction contributor, continues to function well, providing new information on every phase in the history of our universe (www.science.nasa.gov/mission/webb/). Thousands of astronomers worldwide are involved in Webb investigations. Small exoplanets are common in our galaxy, and some even orbit in the so-called habitable zone of their star. NASA's James Webb Space Telescope has been busy observing a few of these small, potentially habitable planets, and astronomers are now hard at work analyzing Webb data. Its infrared vision that is peering back more than 13.5 billion years to see the first stars and galaxies forming out of the darkness of the early universe. This is helping us to understand how galaxies assemble over billions of years. Webb is able to see right through and into massive clouds of dust that are opaque to visible-light observatories like Hubble, where stars and planetary systems are being born.

Canada has some of the world's most specialized and important science infrastructure, which serve to provide opportunities for our country's top scientists, and is respected worldwide. As reported in the *Globe and Mail* by Ivan Semeniuk (www.theglobeandmail.com/canada/article-science-facilities-federal-funding), research advocates suggest that if the government fails to act, it will be hard for us to make the most of the billions of dollars it has invested in its research resources or to plan for the future. Research resources such as SNOLAB, the Amundsen research icebreaker, CGEn (a national platform for genomic analysis), Ocean Networks, and the Polar Continental Shelf Program, to name but a few of these incredible facilities. The Canadian Science Policy Centre has held a public discussion about how these facilities could be supported through a new, dedicated federal body. Stakeholders have issued a call for a new framework to support our big science facilities They have also recommended that the government conduct a "road-mapping exercise" to make informed decisions about what new kinds of facilities Canada will need to optimize its research efforts going forward.

On 5 March 2024, the Canadian Space Agency announced the closure of Ottawa's space technology laboratory, the David Florida Laboratory, by the end of March 2025. (www.spaceimpulse.com/2024/03/05/ottawas-space-technology-laboratory-to-close-doors-after-52-years). This decision is the result of a strategic review of operations, marking the end of a 52-year journey. The laboratory has played a pivotal role in advancing space technology. From contributing to the development of the iconic Canadarm, to supporting U.S. Space Shuttle missions for three decades, the lab has been a cornerstone of Canadian achievements in space exploration. Private companies are increasingly becoming involved in the space industry, prioritizing their own infrastructural investments over facilities like the David Florida Laboratory. Work is expected to wind down gradually over the coming months for the 34 employees at the facility. The closure marks a new beginning, where private enterprise and technological advancements drive the next wave of space exploration. Canada must play for this transition and capitalize on emerging opportunities to maintain its presence in the global space arena.■

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; 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, Massachusetts Institute of Technology, and the University of Colorado. During his long career, he has advanced both basic and applied medical, health and wellness, scientific, and engineering knowledge. He has trained and mentored undergraduate, graduate, and postdoctoral students as well as staff in the business sector and government. He is a 45-year, Life Senior Member of IEEE. He has served in many professional public and private governance and publication roles. He is the recipient of several peer-selected earned awards, including induction into the Order of the University of Calgary, IEEE achievement medals, and APEX awards for publication excellence. In retirement, he vigorously continues basic and applied research with an extensive portfolio of projects. 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. His profile can be found on Academia.

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- Nano-electromagnetics
- EBG/Metamaterial Structures
- Frequency Selective Surfaces

Important Dates

- Full Paper Submission: **Jan. 17, 2025**
- Notification of Acceptance: **Mar. 1, 2025**
- Final Paper Submission: **Apr. 1, 2025**
- Early Bird Registration Deadline: **May 1, 2025**
- Conference Date: **Jul. 20-23, 2025**

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