IEEE Canadian Review

La revue canadienne de l'IEEE

Summer/Été 2021 — No. 87

Summer of Reopening





Data Governance Roadmap

Driving Into the Future

Virtues of Good Supervisors



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The Institute of Electrical and Electronic Engineers Inc.

34Th IEEE Canadian Conference of Electrical and Computer Engineering

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Paper submission deadline	May 1st , 2021
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Camera ready registration	August 1st, 2021
Program online	August 30th, 2021
Tutorial/Special session submission	May 30TH, 2021
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Jason Gu
Ph.D., P.Eng., FEIC, FCAE

2020–2021 IEEE Canada President and Region 7 Director
Président de l'IEEE Canada et directeur de la région 7, 2020–2021

Dear Friends and IEEE Canada members,

In the Spring 2021 issue of *IEEE Canadian Review*, I covered the newly restructured regional committee and training of new volunteers. I also talked about the impacts of the COVID-19 pandemic, which brought us numerous challenges and some unique opportunities. In this issue, I will focus on these challenges and opportunities. I will also take the opportunity to announce several upcoming IEEE Canada events.

IEEE Canada had its "Spring 2" 2021 Caucus and Board Meeting on 29 May 2021, during which the recommendations from the Nominations and Appointment Committee (NAC) and the Steering Committee (SteerCom) of regional leadership positions for 2022 were approved. During the summer, NAC and SteerCom will also fill in the committee vice chair and member positions for 2022. Training sessions for the new volunteer leaders will be arranged near the end of the year or early next year. IEEE Canada is also looking to expand relationships with industries and professional organizations. The executive director of the Canadian Academy of Engineering was invited to address the board

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Chers Amis et Membres de l'IEEE Canada,

Dans le numéro du printemps 2021 de la Revue Canadienne de l'IEEE, j'ai couvert le comité régional nouvellement restructuré et la formation de nouveaux bénévoles. J'ai également parlé des impacts de la pandémie de COVID-19, qui nous a apporté de nombreux défis et des opportunités uniques. Dans ce numéro, je me concentrerai sur ces défis et opportunités. Je profiterai également de l'occasion pour annoncer plusieurs événements à venir de l'IEEE Canada.

L'IEEE Canada a tenu sa réunion du caucus et du conseil d'administration « Spring 2 » ou « Printemps 2» 2021 le 29 Mai 2021, au cours de laquelle les recommandations du Comité des Nominations et des Délégations (CND) et du comité directeur (SteerCom) des postes de direction régionaux pour 2022 ont été approuvées. Au cours de l'été, le CND et SteerCom combleront également les postes de vice-président et de membre du comité pour 2022. Des séances de formation pour les nouveaux dirigeants bénévoles seront organisées vers la fin de l'année ou au début de l'année prochaine. L' IEEE Canada cherche également à

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during the May board meeting. We had fruitful discussions on opportunities for future collaboration and cooperation.

Not surprisingly, compared with 2020, Region 7 membership in 2021 has decreased in all categories. In particular, undergraduate student membership has seen the highest decrease, as most students are at home, and their face-to-face interactions are very limited. Many international students have returned to their home countries and are not physically present in Canada. In addition, due to the COVID-19 pandemic, many students have lost their internships or job opportunities. Understandably, this also has increased their financial burden. To mitigate this, IEEE is offering students and graduate students a 50% discount on their IEEE membership dues. Please use the coupon code FUTURE50 on renewals and new memberships.

The technical societies have also begun offering companion promotions. I encourage all of the Section chairs to inform their student branches of this discount so that students can take advantage of this to join/renew their membership.

Both IEEE Member and Geographic Activities (MGA) and IEEE Canada have decided to use the available funds from 2020 to fund new and innovative projects to promote memberships. All Sections, affinity groups, and committees are encouraged to take this opportunity to leverage these project funds for various promotional activities as well as attract and retain our membership.

Both IEEE Member and Geographic Activities and IEEE Canada have decided to use the available funds from 2020 to fund new and innovative projects to promote memberships.

The health and safety of our members and volunteers remain our top priority. Therefore, we are closely monitoring the COVID-19 pandemic and will plan to have a face-to-face IEEE Canada fall board meeting only if it is safe to do so.

I would like to draw your attention to several signature events that are being rescheduled or postponed due to the COVID-19 pandemic:

- *2021 IEEE Canada Conference on Electrical and Computer Engineering (CCECE'2021)*: This conference has been transformed into an online conference organized by IEEE Canada/Region 7 and will be held 12–17 September 2021. Please visit https://ccece2021.ieee.ca/.
- *2021 IEEE Canada Electric Power and Energy Conference (EPEC'2021)*: This conference is now moved to a virtual platform and will be held 30–31 October 2021. IEEE EPEC is IEEE Canada's premier power and energy conference focusing on innovations in the electric power sector. Please visit https://epec2021.ieee.ca/.

IEEE Canada also sponsors the following three conferences:

- *IEEE International Symposium on Antenna Technology and Applied Electromagnetics (ANTEM) 2021*: 8–11 August 2021 (https://antem2021.ieee.ca/)

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élargir ses relations avec les industries et les organisations professionnelles. Le directeur général de l'Académie Canadienne du Génie a été invité à s'adresser au conseil lors de la réunion du conseil de Mai. Nous avons eu des discussions fructueuses sur les possibilités de collaboration et de coopération futures.

Sans surprise, par rapport à 2020, le nombre de membres de la Région 7 en 2021 a diminué dans toutes les catégories. En particulier, l'adhésion des étudiants de premier cycle a connu la plus forte baisse, car la plupart des étudiants sont à la maison et leurs interactions en face à face sont très limitées. De nombreux étudiants internationaux sont retournés dans leur pays d'origine et ne sont pas physiquement présents au Canada. De plus, en raison de la pandémie de COVID-19, de nombreux étudiants ont perdu leurs stages ou leurs opportunités d'emploi. Naturellement, cela a également augmenté leur fardeau financier. Pour atténuer cela, l'IEEE a proposé des abonnements étudiants à des tarifs réduits de 50 %.

Les sociétés techniques ont également commencé à offrir des promotions pour les membres. J'encourage tous les présidents de section à informer leurs branches étudiantes de ce rabais afin que les étudiants puissent en profiter pour adhérer/renouveler leur adhésion.

Les membres de l'IEEE et les activités géographiques (MGA) et l'IEEE Canada ont décidé d'utiliser les fonds excédentaires de 2020 pour financer de nouveaux projets innovants afin de promouvoir les adhésions. Toutes les sections, groupes d'affinité et comités sont encouragés à profiter de cette occasion pour tirer parti de ces fonds excédentaires pour diverses activités promotionnelles ainsi que pour attirer et retenir nos membres.

La santé et la sécurité de nos membres et bénévoles restent notre priorité absolue. Par conséquent, nous surveillons de près la pandémie de COVID-19 et nous prévoyons d'organiser une réunion d'automne en personne du conseil d'administration uniquement si cela est sécuritaire.

Je voudrais attirer votre attention sur plusieurs événements phares qui sont reprogrammés ou reportés en raison de la pandémie de COVID-19 :

- *La Conférence 2021 de l'IEEE Canada sur le génie électrique et informatique (CCECE2021): cette conférence est devenue une conférence virtuelle régionale et se tiendra du 12 au 17 septembre 2021. Veuillez visiter* https://ccece2021.ieee.ca/.
- *La Conférence de l'IEEE Canada sur l'Électricité et l'Énergie 2021 (EPEC2021): cette conférence est maintenant déplacée vers une plate-forme virtuelle et se tiendra du 30 au 31 Octobre 2021. L'IEEE EPEC est la première conférence de l'IEEE Canada sur l'énergie et l'électricité axée sur les innovations dans le secteur. Veuillez visiter* https://epec2021.ieee.ca/.

L'IEEE Canada parraine également les trois conférences suivantes :

- *le Symposium International de l'IEEE sur la technologie des antennes et l'électromagnétisme appliqué (ANTEM) 2021: 8-11 août 2021* (https://antem2021.ieee.ca/)
- *La Conférence Internationale L'IEEE sur le sans fil pour l'espace et les environnements extrêmes (WiSEE) 2021: 12-14 octobre 2021* (https://attend.ieee.org/wisee-2021/)
- *La Conférence Internationale de l'IEEE sur les technologies humanitaires (IHTC) 2021: 2 au 4 décembre 2021*

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- *IEEE International Conference on Wireless for Space and Extreme Environments (WiSEE) 2021*: 12–14 October 2021 (https://attend.ieee.org/wisee-2021/)
- *IEEE International Humanitarian Technology Conference (IHTC) 2021*: 2–4 December 2021 (hosted by Regions 7, 8, and 9 in rotation; to be hosted by Region 8 in 2021) (https://www.ihtc21.org.uk/ihtc-2021-committee/).

I am sorry to end this message on a sad note. Dr. Ferial El-Hawary passed away on Thursday, 6 May 2021. An IEEE Life Fellow, Dr. El-Hawary served as the Region 7 director on the IEEE Board of Directors in 2008 and 2009. In addition to serving as president of IEEE Canada, Ferial had been heavily involved with IEEE both technically and administratively, especially as a current member of the IEEE Oceanic Engineering Society Administrative Committee. Dr. Ferial El-Hawary will be deeply missed. She was remembered with a moment of silence at the 20 May 2021 IEEE Board meeting and 29 May 2021 IEEE Canada Board meeting.

Stay safe, healthy, and have a wonderful summer. ■

Jason Gu, Ph.D., P.Eng., FEIC, FCAE
2020–2021 IEEE Canada President
2020–2021 IEEE Region 7 Director

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(organisée par les régions 7, 8 et 9 en rotation; sera hébergée par la région 8 en 2021) (https://www.ihtc21.org.uk/ihtc-2021-comité/).

Je suis désolé de terminer ce message sur une note triste. Madame Ferial El-Hawary est décédée le jeudi 6 Mai 2021. Membre de l'IEEE Life Fellow, Madame El-Hawary a été directrice de la région 7 au Conseil d'Administration de l'IEEE en 2008 et 2009. En plus d'être présidente de l'IEEE Canada, Ferial avait été fortement impliquée avec l'IEEE à la fois techniquement et administrativement, en particulier en tant que membre actuel du comité administratif de l'IEEE Société d'Ingénierie Océanique. Madame Ferial El-Hawary nous manquera profondément. On se souvient d'elle avec une minute de silence lors de la réunion du conseil d'administration de l'IEEE du 20 mai 2021 et de la réunion du conseil d'administration de l'IEEE Canada du 29 mai 2021.

Restez en sécurité, en bonne santé et passez un bel été. ■

Jason Gu, Ph.D., P.Eng., FEIC, FACG
Président de l'IEEE Canada 2020–2021
Directeur de la Région 7 de l'IEEE 2020–2021

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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As the battle of vaccine and variant continues, we wonder what reopening will feel like. There appears to be a huge pent-up demand for travel, tourism, entertainment, and general socializing. Beyond that, there is a true opportunity to create a fundamentally different normal where technology and humanity can live in harmony. From redesigning

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Alors que la bataille du vaccin et de la variante se poursuit, nous nous demandons à quoi ressemblera la réouverture. Il semble y avoir une énorme demande de voyages, de tourisme, de divertissement et de socialisation en général. Au-delà de cela, il existe une véritable opportunité de créer une normalité fondamentalement différente où la technologie

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(A Few Words From the Editor-in-Chief cont'd from p. 4)

our cities and workplaces to fostering a greener economy, the dialogue must continue.

One of our most prolific columnists, Terrance Malkinson, wrote a series of articles throughout the pandemic years. Often, I reflect on Terrance's Summer 2020 article titled "Reflections on the New Normal." In doing so, it is natural to wonder where the electrical and electronic engineering community falls.

With cybersecurity breaches hitting ever closer to home, data governance and privacy issues continue to be at the heart.

The Spring 2021 edition of *IEEE Canadian Review* featured data analytics and cybersecurity. From that discussion have sprung more conversations on many fronts. With cybersecurity breaches hitting ever closer to home, data governance and privacy issues continue to be at the heart. Christine Pelletier's question-and-answer article on Canada's Data Governance Roadmap sheds more light on this topic. In addition, the regular columns by Terrance Malkinson, Dario Schor, Dave Michelson, Mathew Wilder, and Daryoush Shiri discuss a wide variety of contemporary issues.

IEEE Canada's signature conferences, the 2021 IEEE Canadian Conference On Electrical and Computer Engineering (CCECE), Antenna Technology and Applied Electromagnetics (ANTEM), and 2021 IEEE Electric Power and Energy Conference (EPEC), are moving ahead as planned. These events, albeit virtual for now, provide a platform for IEEE Members, affiliates, academicians, students, and practitioners to discuss issues of common interest.

Our prayers are for all of the friends and families who were affected by the recent bloody conflict in the Middle East. As we know by now, hundreds of children's remains were discovered at a former British Columbia residential school burial ground. This saddens us to the core, as historians are suggesting there could be many more such sites. It is about time we recognize this tragedy to the fullest scope and aim to move forward.

With this edition of *IEEE Canadian Review*, I wish everybody a sunny, safe, COVID-free Canadian summer. If you have any comments and questions, please send a note to me at mjakhan@ieee.org. ■

(Quelques mots du rédacteur en chef suite de p. 4)

et l'humanité peuvent vivre en harmonie. De la refonte de nos villes et de nos lieux de travail à la promotion d'une économie plus verte, le dialogue doit se poursuivre.

L'un de nos chroniqueurs les plus prolifiques, Terrance Malkinson, a écrit une série d'articles tout au long des années de pandémie. Souvent, je réfléchis à l'article de Terrance pour l'été 2020 intitulé « Réflexions sur la nouvelle normalité ». Ce faisant, il est naturel de se demander où se situe la communauté du génie électrique et électronique.

L'édition du printemps 2021 de la revue canadienne de l'IEEE portait sur l'analyse des données et la cybersécurité. De cette discussion ont surgi plus de conversations sur de nombreux fronts. Avec des failles de cybersécurité qui frappent de plus en plus près de chez nous, les problèmes de gouvernance des données et de confidentialité continuent d'être au cœur des préoccupations. L'article questions-réponses de Christine Pelletier sur la feuille de route de la gouvernance des données au Canada jette plus de lumière sur ce sujet. De plus, les chroniques régulières de Terrance Malkinson, Dario Schor, Dave Michelson, Mathew Wilder et Daryoush Shiri traitent d'une grande variété de problèmes contemporains.

Les conférences phares de l'IEEE Canada, la Conférence canadienne de l'IEEE 2021 sur le Génie Électrique et Informatique (CCECE), Technologie d'antenne et électromagnétisme appliqué (ANTEM), et la Conférence de l'IEEE 2021 sur l'Énergie Électrique et l'Énergie (EPEC), se déroulent comme prévu. Ces événements, bien que virtuels pour l'instant, offrent une plate-forme aux membres, affiliés, universitaires, étudiants et praticiens de l'IEEE pour discuter de questions d'intérêt commun.

Nos prières sont pour tous les amis et les familles qui ont été touchés par le récent conflit sanglant au Moyen-Orient. Comme nous le savons maintenant, des centaines de restes d'enfants ont été découverts dans un ancien cimetière de pensionnats de la Colombie-Britannique. Cela nous attriste au plus profond, car les historiens suggèrent qu'il pourrait y avoir beaucoup plus de tels sites. Il est temps que nous reconnaissions pleinement cette tragédie et que nous ayons l'intention d'aller de l'avant.

Avec cette édition de la Revue Canadienne de l'IEEE, je souhaite à tous un été canadien ensoleillé, sûr et sans COVID. Si vous avez des commentaires et des questions, veuillez m'envoyer une note à mjakhan@ieee.org. ■

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Anneke Olvera, Director, Programs and Operations, Standards Council of Canada

This interview investigates how the Standards Council of Canada (SCC) (see "About the Standards Council of Canada") is tackling one of the most crucial questions in our information economy: who will own, control, and benefit from the vast ocean of data it generates? Anneke Olvera is the director of programs and operations at SCC. She is also the secretary of the Canadian Data Governance Standardization Collaborative (DGSC). The DGSC Steering Committee consists of thought leaders from government, industry, civil society, Indigenous organizations, academia, and standards development organizations. Anil Arora, chief statistician of Canada, and Philip Dawson, senior policy counsel, Responsible AI Institute, are cochairs of the Steering Committee. IEEE participates on the Steering Committee.

ICR: What is the Canadian DGSC?

AO: SCC established the collaborative in 2019 as one of the first deliverables following the launch of Canada's Digital Charter. The collaborative is a group of 220 Canadian experts and stakeholders working together to accelerate the development of industrywide data governance standards.

As one can imagine, collaboratives are not new. They are used in other countries, as they offer a neutral forum to coordinate and identify standardization needs and priorities; however, this is the first time this approach is taken in Canada. Our members come from across government, industry, civil society, Indigenous organizations, academia, and standards development organizations. Over the past two years, we've taken a hard look at Canada's data governance frameworks—the current state and challenges as well as the ideal future state.



ICR: How would you describe the current state of data governance in Canada?

AO: Data are being generated, analyzed, and applied in every aspect of our lives—faster than ever before. The handling and management of data impact everything from finance to health care, education to recreation, and manufacturing to retailing. Like countries around the world, Canada is trying to develop data strategies to address the tension between data as a national "resource" and the ethical and privacy concerns of people, organizations, and communities. While we have been lauded as rich in innovators and innovation, from a data-driven economical point of view, we are lagging in a world that is increasingly driven by data.

The good news is that we have the tools to become a leader and influencer internationally in data governance and big data. It is a matter of understanding the tools we already have in our tool box and how we can make use of existing best practices—both within Canada and on the international stage. Fortunately, Canada's standardization system has the tools we need. Standardization will help us build a safer and more secure digital infrastructure founded on quality, trust, and ethics. Without clear and cohesive data governance standards, the privacy of our citizens and competitiveness of our economy are at risk.

ICR: Surely, Canada's data infrastructure is already governed by standards—is it not the case?

AO: Interestingly, standardization is a tool that more traditional sectors are familiar with. For example, standards

About the Standards Council of Canada

The Standards Council of Canada (SCC) is Canada's voice on standards and accreditation on the national and international stages. SCC works closely with a vast network of partners to promote the development of effective and efficient standards that protect the health, safety, and well-being of Canadians while helping businesses prosper.

As Canada's leading accreditation organization, SCC creates market confidence at home and abroad by ensuring that conformity assessment bodies meet the highest national and international standards. SCC advances Canada's interest on the international scene as a member of the International Organization for Standardization and International Electrotechnical Commission by connecting thousands of people to global networks and resources, opening a world of possibilities for Canadians and businesses. For further information, please contact Anneke Olvera, Canadian Data Governance Standardization Collaborative secretary, at aolvera@scc.ca.

are embedded in our building codes and regulations, and they work like an invisible shield. When I enter a building, I don't worry that the roof is going to come down or the floor will cave in. We take comfort in knowing that our infrastructure is safe and resilient, and we don't tend to think about "why" we feel safe.

This innate sense of safety and security does not extend to intangible digital infrastructure, like the Internet. Rules governing digital technology—your data privacy and safety—are still in their infancy. Understandably, Canada has a patchwork standardization system for data governance. The sheer volume of standards being developed is cause for concern. As such, we can't effectively and safely harness the benefits of data without coherent standards and complementary conformity assessment programs.



Figure 1: The Canadian Governance Standardization Collaborative Roadmap. (Source: SCC, https://www.scc.ca/en/about-scc/publications/general/canadian-data-governance-standardization-roadmap)

ICR: How is the Canadian DGSC tackling data governance issues?

AO: The collaborative has spent the past two years working together to build a standardization roadmap. The Canadian DGSC Roadmap (Figure 1) (https://www.scc.ca/en/flagships/data-governance) tackles the challenging questions we face when we talk about standardization and data governance. The roadmap describes the current and desired Canadian standardization landscape, including recommendations to address gaps and new areas where Canada can be a standards setter and influencer internationally in the sphere of data governance/big data.

We scoped priority areas to 35 key issues with the understanding that the roadmap would not be able to deal with all issues related to the complexities of data governance. Understanding the relevance of standards to data governance was a major undertaking, given the breadth of the topics and magnitude of the challenges posed by new technologies along the data supply chain and governance lifecycle. The document cuts through the noise around what is happening in the standardization and data governance world to make sense of key issues.

The working groups explored case studies that serve as pragmatic examples of the key issues facing data governance today. One study examined data weaknesses in our health-care system. A second took on consumer-directed finance, or open banking as it's commonly known. A third looked at how our food gets to our tables as the global food supply chain undergoes a digital transformation. The working groups described and scoped the chosen issues, inventoried existing standards, and conducted the necessary gap analyses. Each working group followed five steps to map the landscape of published standards relevant to each issue (Figure 2).

Key highlights of the work completed to date are as follows:

- The working groups identified 12,000 standards across the 35 issues—with more than 1,900 of those standards deemed directly relevant to the 35 key issues addressed in the roadmap.
- More than 159 IEEE standards are referenced in the roadmap. These standards are potential tools to meet data governance needs, evidence that IEEE is an active player in areas including digital trust, inclusion, agency, cybersecurity, artificial intelligence (AI), biometrics, and cryptocurrency, to name only a few. Government and industry will do well to look to these standards as they build national data governance strategies in line with our trading partners.
- SCC will continue to welcome new members to the collaborative in phase 2 of this work and welcomes IEEE Members as well as electrical and electronics engineers to take a seat at the table.
- Three broad themes emerge from the roadmap. These themes highlight the importance of data governance standardization solutions that focus on both operative and strategic needs (see "Standardization and Data Governance"):
  1) *quality*: establishing standardization solutions for systems and controls so that high-quality data can be achieved
  2) *trust*: building the foundation of trust through standardization to know that those using data are using it properly and respecting privacy, security, and transparency regulations and frameworks
  3) *ethics*: ensuring that AI machine learning tools are ethical and that explainability (can be explained in human terms) can be achieved and supported by standardization, systems, and other forms of controls.

ICR: Who is the audience for the roadmap?

AO: The roadmap is a call to action for a several key audiences:

- For our government partners, the roadmap will help build an understanding of how participating in the development of standardization solutions ensure that the standards can be leveraged for regulatory purposes, as appropriate.
- For our standardization partners, the roadmap will support the development of new and needed standardization solutions.
- For our private-sector partners, the roadmap can cultivate an understanding of how standardization tools can help industry access new markets, scale up and be first to market, comply with emerging regulations, and provide guidance on

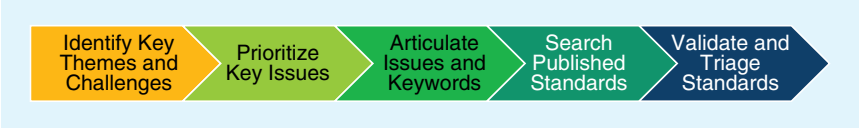


Figure 2: The development of the standardization landscape.

how to navigate the standardization system, especially for small and medium enterprises with limited resources.

- For our partners from civil society organizations, the roadmap highlights the need for stronger data governance in civil society and to lead by example by demonstrating "an alternative to the current model of unchecked, large-scale data exploitation by many big technology companies" [1].
- For Canadian citizens, the roadmap will help build an understanding of how standardization, a tool that is already seamlessly incorporated in your day-to-day life, will help build a safer and more secure digital infrastructure founded on quality, trust, and ethics as more and more services and transactions go online, and we continue to build digital infrastructures that support the health and safety of Canadians.

ICR: Canada has a roadmap. What happens next?

AO: This is not where our journey ends. This is where it really begins. It's one thing to have a roadmap; the next thing is to put it into action. SCC and the collaborative will be working hard to implement this roadmap and the 35 recommendations over the next few years, in close partnership with standards development organizations and other key partners.

We'll facilitate this work by doing what we do best: helping to solve complex issues by bringing experts and stakeholders together to collaborate and develop consensus-based solutions. In addition, we will develop an action plan for each of the 35 recommendations. With the support of Statistics Canada, we will create a dashboard to track the implementation of the recommendations and status of closing the identified gaps.

Later this year, we expect to commence work on a second version of the roadmap to address new issues that were not covered in this first version and provide an update on the work related to the implementation of recommendations. Budget 2021 proposed providing $8.4 million over five years, starting in 2021–2022, and $2.3 million ongoing to SCC to continue its work to advance industrywide data governance standards.

ICR: Any exciting up-and-coming areas that we should know about?

AO: The global movement toward the widespread use of digital credentials is quite exciting. Digital credentials are electronic representations of physical certificates and IDs held in user-controlled digital wallets. Their potential applications are almost endless; they can include electronic versions of documents like plane tickets, driver's licenses, university degrees, and even certificates of incorporation for businesses.

In Canada, there is no way for third parties to verify or certify whether digital credentials and digital trust services meet the requirements of emerging standards, including those for interoperability, privacy, and security. SCC is spearheading work (https://www.scc.ca/en/news-events/news/2021/national-technical-specification-for-digital-credentials-provide-greater-privacy-and-security-for) to develop a technical specification for digital credentials to provide greater privacy and security for Canadians.

ICR: What shifts have you seen in the role of standards as a result of the COVID-19 pandemic?

AO: We've seen remarkable examples of standards in action during the pandemic. Standards have revealed themselves to be the bridge we need to help us get to the other side of this global crisis. Standards are what enabled the unprecedented level of data sharing around the world that led scientists to develop vaccines against COVID-19 in record time.

By the same token, the pandemic has exposed some weaknesses. The COVID-19 pandemic has accelerated fundamental shifts in the way we interact with the digital world. Data are coming from more sources than ever and continuously moving in all directions. And that's why establishing a common language for data sharing is more important than ever. ■

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[1] Open Society Foundations, Civil Society Organizations and General Data Protection Regulation Compliance, 2020.

[2] Guidelines for Incorporating Standards by Reference in Regulations to Support Public Policy Objectives. https://www.scc.ca/en/system/files/publications/SCC_IBR-Guidelines-_v1_2018-09-05_EN.pdf

About Anneke Auer-Olvera

Anneke Auer-Olvera is the director at the Standards Council of Canada (SCC) responsible for Programs and Operations in the Strategy and Stakeholder Engagement branch. Anneke leads various teams in the implementing government funded programs focused on delivering standardization solutions in areas such as Infrastructure and Climate Change, Innovation and IP, Data Governance, and Artificial Intelligence. Anneke is the Secretary of the Canadian Data Governance Standardization Collaborative, which recently published its first Roadmap mapping the standardization landscape for data governance in Canada. For more information, please visit. https://www.scc.ca/en/flagships/data-governance

Standardization and Data Governance

What does standardization mean with respect to data governance?

- Standardization is about highlighting excellence and promoting it.
- Whether it's the food we eat, the products and technologies we use, or how we get around, every aspect of our lives is touched by standards.
- The standardization system is quite complex. It's more than just having a set of standards.
- Simply put, standardization is the development and application of standards.
- This includes the work of the committees that develop standards; publication of standards by standards development organizations; recognition of standards by national standards bodies such as the Standards Council of Canada; application of standards by businesses, suppliers, and customers; verification that products or services conform to applicable standards (conformity assessment); accreditation of organizations that provide conformity assessment services; and use of standards and conformity assessment as an element in public policy as well as international trade.
- A standard is a document that provides a set of agreed-upon rules, guidelines, or characteristics for activities or their results. Standards establish accepted practices, technical requirements, and terminologies for diverse fields. They can be mandatory or voluntary and are distinct from acts, regulations, and codes, although standards can be referenced in those legal instruments (see "Guidelines for Incorporating Standards by Reference in Regulations to Support Public Policy Objectives" [2]).
- Conformity assessment is the practice of determining whether a product, service, or system meets the requirements of a particular standard.

Dr. Ferial El-Hawary

Dr. Ferial (El-Bibany) El-Hawary, Life Fellow of IEEE, passed away peacefully with family at her side on Thursday, 6 May 2021, at her home in Halifax, Nova Scotia, Canada. Dr. El-Hawary received her B.Eng. from the University of Alexandria, Egypt; M.Sc. in electrical engineering from the University of Alberta, Edmonton, Canada; and Ph.D. in oceans engineering from Memorial University of Newfoundland, Canada. Prior to her Ph.D., she spent two years (1971–1973) in Brazil along with her husband, Mo, as part of the team for establishing a Higher Engineering Research Institute, which is well recognized as COPPE in Rio de Janeiro, Brazil.



Dr. Ferial El-Hawary

She was president and cofounder of BH Engineering Systems Ltd. and a former professor, Faculty of Engineering at Dalhousie University, Canada, where she established and directed the Modeling and Signal Analysis Research Laboratory. Her sustained research was devoted to control and signal processing for ocean engineering applications with a significant impact in the marine industry. She was the editor-in-chief of *The Ocean Engineering Handbook* (CRC Press, 2nd ed., 2004) and served as associate editor of *IEEE Journal of Oceanic Engineering*. As cofounder of BH Engineering Systems Ltd., she established professional development courses linking academic innovations to industrial needs.

She had been heavily involved in engineering both technically and administratively as a current member of the IEEE Oceanic Engineering Society (OES) Administrative Committee, having served as vice president–International and past chair of the Membership Development Committee. She was nominated to serve as president of the Society. Ferial was instrumental in establishing the Canadian Atlantic Chapters of the OES, and she was recognized for her leadership roles in establishing a strong IEEE/OES European

Madame Ferial El-Hawary

Madame Ferial (El-Bibany) El-Hawary, Membre à vie de l'IEEE, est décédée paisiblement avec sa famille à ses côtés le jeudi 6 mai 2021, chez elle à Halifax, en Nouvelle-Écosse, au Canada. Madame El-Hawary a reçu son B.Eng. de l'Université d'Alexandrie, Egypte; M.Sc. en génie électrique de l'Université de l'Alberta, Edmonton, Canada; et Ph.D. en génie océanique de l'Université Memorial de Terre-Neuve, Canada. Avant son doctorat, elle a passé deux ans (1971–1973) au Brésil avec son mari, Mo, dans le cadre de l'équipe de création d'un institut supérieur de recherche en ingénierie, bien connu sous le nom de COPPE à Rio de Janeiro, Brésil.

Elle a été présidente et cofondatrice de BH Engineering Systems Ltd. et ancienne professeure à la faculté de génie de l'Université Dalhousie, au Canada, où elle a créé et dirigé le laboratoire de recherche en modélisation et analyse de signaux. Ses recherches soutenues ont été consacrées au contrôle et au traitement du signal pour les applications d'ingénierie océanique avec un impact significatif dans l'industrie maritime. Elle a été rédactrice en chef de The Ocean Engineering Handbook (CRC Press, 2e éd., 2004) et a été rédactrice associée du IEEE Journal of Oceanic Engineering. En tant que cofondatrice de BH Engineering Systems Ltd., elle a mis en place des cours de développement professionnel reliant les innovations académiques aux besoins industriels.

Elle avait été fortement impliquée dans l'ingénierie à la fois techniquement et administrativement en tant que membre actuel du comité administratif de Société d'Ingénierie Océanique de l'IEEE (SIO), après avoir été vice-présidente internationale et ancienne présidente du comité de développement des membres. Elle a été nommée présidente de la Société. Ferial a joué un rôle déterminant dans la création des sections canadiennes atlantiques de la SIO et elle a été reconnue pour ses rôles de leadership dans la création d'une solide section européenne IEEE/SIO basée en

Editor's Note

IEEE Canada mourns the loss of two of our most decorated volunteers in the span of a couple of years: Mohamed (Mo) El-Hawary and Ferial El-Hawary. Mo's obituary was published in the *IEEE Canadian Review* Fall 2019/Winter 2020 issue. It is with great sadness that we bid farewell to both.



Note de l'éditeur

L'IEEE Canada pleure la perte de deux de nos bénévoles les plus décorés en l'espace de quelques années: Mohamed (Mo) El-Hawary et Ferial El-Hawary. L'avis de décès de Mo a été publié dans le numéro d'automne 2019/hiver 2020 de la Revue Canadienne de l'IEEE. C'est avec une grande tristesse que nous faisons nos adieux à tous les deux.

Chapter based in France as well as the IEEE OES Chapter based in Trondheim, Norway. Dr. El-Hawary was heavily involved in the organizing committees of the OCEANS'87 and OCEANS'97 conferences and 2000 IEEE Canadian Conference of Electrical and Computer Engineering in Halifax, Nova Scotia, Canada, as well as the OCEANS'94 and OCEANS'98 conferences in France. Dr. El-Hawary was also the chair of the Eastern Canada Council of IEEE Canada and a member of the IEEE Women in Engineering Committee.

She was a recipient of the IEEE Canada Wally Read Service Award for 2000, IEEE Third Millennium Medal in 2000, 1999 RAB Achievement Award, and 1997 IEEE Oceanic Engineering Society Distinguished Service Award. She was a Fellow of IEEE, the Engineering Institute of Canada, and the Marine Technology Society. Ferial served as president of IEEE Canada in 2008 and 2009. As a woman "ahead of her time," she served as a role model and passionate advocate for women in science, technology, engineering, and mathematics initiatives around the world.

Nanny Fifi, as she was known to her family, was a devoted wife, mother, grandmother, sister, and friend. She enjoyed spending as much time as possible with the love of her life (Grampy Mo) with whom she shared so many amazing adventures in exotic locations all around the world. ■

France ainsi que de la section IEEE SIO basée à Trondheim, en Norvège. Madame El-Hawary a été fortement impliquée dans les comités d'organisation des conférences OCEANS'87 et OCEANS'97 et 2000 Conférence canadienne du génie électrique et informatique de l'IEEE à Halifax, Nouvelle-Écosse, Canada, ainsi que les conférences OCEANS'94 et OCEANS'98 en France. Madame El-Hawary était également la présidente du Conseil de l'Est du Canada de l'IEEE Canada et membre du comité des femmes en ingénierie de l'IEEE.

Elle a reçu le prix de service Wally Read de l'IEEE Canada en 2000, la médaille du troisième millénaire de l'IEEE en 2000, le prix d'excellence RAB en 1999 et le prix de service distingué de la Société d'Ingénierie Océanique de l'IEEE en 1997. Elle était membre de l'IEEE, de l'Institut d'ingénierie du Canada et de la Société des Technologies marines. Ferial a été présidente de l'IEEE Canada en 2008 et 2009. En tant que femme « en avance sur son temps », elle a été un modèle et une défenseure passionnée des initiatives des femmes dans les domaines de la science, de la technologie, de l'ingénierie et des mathématiques à travers le monde.

Nanny Fifi, comme l'appelait sa famille, était une épouse, une mère, une grand-mère, une sœur et une amie dévouée. Elle aimait passer autant de temps que possible avec l'amour de sa vie (Grampy Mo) avec qui elle a partagé tant d'aventures incroyables dans des endroits exotiques du monde entier. ■

Canadian Journal of Electrical and Computer Engineering–an IEEE Journal

IEEE Canadian Journal of Electrical and Computer Engineering (*CJECE*), issued quarterly, has been publishing high-quality refereed scientific papers in all areas of electrical and computer engineering since 1976.

IEEE CJECE is accepting papers presenting new and original results, techniques or concepts in the following areas (inclusive, but not limited to):

- Bioengineering /biomedical engineering
- Signal processing
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- Electromagnetics
- Energy and power systems
- Microelectronics
- Artificial intelligence
- Wireless communication
- Communication systems
- Computer networks
- Software engineering
- Cybersecurity
- Computer systems
- Robotics



For more information, please visit: http://www.journal.ieee.ca/

Ways to Give: Charitable Bequests

Many Canadians choose to support important causes by naming a charity as a beneficiary in their will. A charitable bequest is a gift made through a will to support a cause that is close to your heart. Leaving a charitable gift as a part of your estate plan provides the satisfaction of knowing that you have made a truly meaningful contribution to future generations.

Planned gifts typically come from a donor's assets rather than income. These gifts can either be outright or deferred. They enable you to integrate your charitable objectives with your overall financial, tax, and estate plans to maximize benefits to both you and the IEEE Canadian Foundation.

People often make their most significant donations in their wills. Gifts come in all sizes. We're grateful for every dollar. Even 1% of your estate can make a huge difference in improving the ability of the IEEE Canadian Foundation to enhance IEEE-related activities in Canada.

Balance Family and Favourite Causes

Talk it through with your family. Share what is important to you. Many people choose to leave everything to their family and loved ones. Yet for many, a small portion of your estate left to charity leaves enough for you to support your loved ones.

Simple

A gift in your will is easy to arrange. Ask your lawyer to include a gift to the IEEE Canadian Foundation in your will. Your lawyer will guide you when a will is prepared. If you already have a will, a small add-on (a codicil) can be prepared by your lawyer to add a gift to charity.

Peace of Mind

Your gift plan will stand until realized. Should you wish to change course at any time, just advise your lawyer.

Purpose

An undirected gift will be allocated by the Board of Directors of the IEEE Canadian Foundation to the area of greatest need. The gifts directed to a current—or new—program are also welcome; it would be best to discuss first so that your specific vision can be fully established.



Your gift will cultivate well-rounded engineers—Grant to University of British Columbia AgroBot Team.



UBC AgroBot Team in action.

Recognition

If you decide to leave a bequest to the IEEE Canadian Foundation in your will, we hope you will share the good news with us so that we can express our gratitude and recognize your gift. Public acknowledgement of your commitment may inspire others to take the same important step.

Our annual Honour Roll of Donors recognizes planned givers by donor name, not amount, as soon as we are informed of completed arrangements. You have the option to be anonymous, upon request.

How to Make a Gift in Your Will

It may be that some lawyers confirm a charity beneficiary is in good standing at the time of preparation; they will want to know the following:

- our legal name and the proper beneficiary for your gift: the IEEE Canadian Foundation
- our mailing address: the IEEE Canadian Foundation, 456 Rogers Street, Peterborough, Ontario K9H 1W9
- our Canada Revenue Agency charitable business number: 102450376 RR 0001.

Immediacy

Your legacy gift may be well off in the future. Recurring monthly giving or annual giving in manageable amounts will support the year-by-year activities of the IEEE Canadian Foundation.

Advice

We strongly recommend that you consult with your lawyer or financial advisor for more information on maximizing your charitable gift and to determine the best options or you.

Information

Inquiries may be made to info.ieeecanadianfoundation@ieee.ca. Of course, we will respect your privacy and confidentiality.

Planned gifts are a powerful way for you to ensure that the IEEE Canadian Foundation has the future resources it needs to support the next generation of engineers. Thank you in advance for your support. ■

We Just Couldn't Resist ...

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

Harold was a hardworking mathematics schoolteacher in Scotland. He was very frugal his whole life, and hence he managed to retire early. He decides to fill the time—and supplement his retirement income—with a hobby. As it turns out, Harold has a rather sizeable backyard that adjoins an orchard. So he starts taking the steps toward starting an apiary so that he could produce and sell honey.



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After a long several months of constructing platforms for the hives, building structures to provide shade, digging ponds to provide water, and planting attractive flowers, Harold's hard work is rewarded: the honeybees start appearing! After about a week, he has around two dozen hives. At the end of that summer, he was able to harvest and sell nearly 500 lb of honey.

As luck would have it, his neighbour is the brilliant physicist James Clerk Maxwell: surely he could figure this out!

The next summer, Harold finds that running the apiary is a much smoother process. Everything is practically on autopilot. He finds that the bees are largely healthy and that there are no predators around. Harold had anticipated that beekeeping would be a much more labour-intensive hobby, so he finds himself with much more extra time. He decides to try to count all the bees in his apiary, figuring it is probably a good practice to keep track of the numbers. And as a longtime mathematics teacher, the tallying is second nature to him.

In the first week of June, he counts 628,319 drones. In the second week, he counts again and finds that he has once again exactly 628,319 drones. He figures it must have been a coincidence. However, in the third week of June, he counts once again, and finds that he arrives at the same number: 628,319.

Harold wonders how this could be the case; all these drones leave throughout the day to go to the orchard. Surely some would get lost or die and not come back. Unless the new baby bees hatch at exactly the same rate. That seemed improbable. But, for the rest of the summer, he counts every couple of days, and every time he arrives at the same number: 628,319.

Finally, Harold decides that he has to ask someone about this. As luck would have it, his neighbour is the brilliant physicist James Clerk Maxwell: surely he could figure this out! Harold explains the situation to him. Maxwell mulls it over and takes out one of his notebooks and shows it to Harold. "There's actually an equation about this. Right here, see? The divergence of the bee field is always zero." ■



History and IEEE Canada

by David G. Michelson

Our sense of who we are, what we should do, and where we should go is guided, in part, by our recollection and understanding of our past. Our sense of professional identity is, in turn, shaped by the stories and anecdotes concerning both ourselves and those who came before us that we share with each other. According to D. P. McAdams, storytelling "may be *the* way through which human beings make sense of their lives and the lives of others." 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.



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This is the first installment of what will be a regular feature in *IEEE Canadian Review*. Its purpose is to inform the IEEE Canada community of history activities conducted by IEEE as a whole as well as by IEEE Canada in particular and to encourage members at all levels to both contribute to and benefit from these activities. While historical fact is immutable, the historical record is fragile and tends to degrade with time. Efforts to preserve the past are among the most valuable of legacies.

History and IEEE

While publications and conferences have been described as the twin pillars of IEEE, history has always played a vital role in the Institute. When IEEE was formed in 1963, it established a History Committee to directly advise the IEEE Board of Directors about the heritage and legacy of IEEE, its Members, and their related professions and fields of interest while carrying out promotional and outreach activities in these areas. As the IEEE centennial celebration in 1984 approached, there was strong motivation to strengthen the Institute's history efforts and properly showcase the achievements of the Century of Giants who had established both the profession and technologies represented by IEEE.

In 1980, IEEE established the IEEE History Center to provide staff support to the History Committee. The Center currently employs several professional historians and a digital archivist who support a variety of institutional and outreach programs as well as advise and support IEEE organizational units engaged in history activities. The Center also maintains relationships with external organizations, such as the Society for the History of Technology.

In 1983, IEEE established the Milestones program to recognize significant achievements within IEEE's designated fields that took place more than 25 years prior. Milestone proposals may be submitted by any IEEE Member, but they must pass a detailed and rigorous review by the History Committee before they are submitted to the IEEE Board of Directors for final approval.

The Milestones program has become one of IEEE's most effective outreach activities and has been cited as IEEE's most valuable intangible asset. Once a milestone proposal is approved by the Board of Directors, a bronze plaque containing the milestone citation is cast, installed at the location identified in the proposal, and dedicated at a formal ceremony. As of 2021, 216 Milestones have been approved and dedicated worldwide, including 16 in Canada.

The Engineering and Technology History Wiki (ETHW) at https://ethw.org/ is managed by IEEE on behalf of a partnership between the United Engineering Foundation and seven leading engineering societies. It acts as a central repository and digital archive for many IEEE history programs and organizational units. It also complements the IEEE Archives, which is a relatively small collection of documents and other archival material that records the history of IEEE and its predecessor organizations, the American Institute of Electrical Engineers and Institute of Radio Engineers.

Our professional sense of identity is, in turn, shaped by the experiences that we share with each other and the stories and anecdotes concerning those who came before us.

The IEEE History Center provides editorial support to the peer-reviewed "Scanning Our Past" feature that appears monthly in *Proceedings of the IEEE*, the Institute's flagship publication. "Scanning Our Past" explores the history of technology and the people associated with it through scholarly articles of between 4,000 and 8,000 words in length.

The IEEE History Center Press works with authors to publish books on the history of electrical- and computing-related technologies, including 1) biographies and autobiographies of electrical and computing pioneers, 2) histories of technological systems and devices, 3) corporate histories of electrical and computing corporations, 4) the historical effects of technologies on society, 5) the changing interface between a technology and people, and 6) histories of technology in emerging economies and developing countries.

Other important IEEE History Center programs include 1) the Oral and First-Hand History program, which has resulted in more than 650 full-transcript histories on ETHW; 2) the IEEE William and Joyce Middleton Electrical Engineering History Award, which is awarded to the author of a book in the history of an IEEE-related technology that both exemplifies exceptional scholarship and reaches beyond academic communities toward a broad public audience; and 3) the Bernard S. Finn IEEE History Prize, which is awarded to the author of the best paper on the history of electrical technology published during the preceding year.

The Raising Engineering Awareness through the Conduit of History (REACH) program is funded by the IEEE Foundation and is administered by the IEEE History Center. It provides high school social studies teachers with free, dynamic, educational resources that will engage students by bringing to life the history of engineering through the use of multimedia. Each lesson focuses on the historical aspects of a different technology and the impact that it has had on humanity.

The IEEE Fellowship in the History of Electrical and Computing Technology is funded by the IEEE Life Members' Committee and administered by the IEEE History Center. It supports one year of full-time graduate research or one year of postdoctoral research for a scholar in this field who has received his or her Ph.D. degree within the past four years in the history of IEEE's designated fields.

The Elizabeth & Emerson Pugh Young Scholar in Residence program seeks to provide research experience to graduate students in the history of electrical and computer technologies. It is intended for future historians and is not suitable for engineering students unless there is a strong history component to their studies.

History and IEEE Canada

Many IEEE organizational units, including Societies, Regions, and Sections, have their own history committees. The IEEE Canada History Committee is led by the IEEE Canada historian and is responsible for promoting history and archival activities relevant to IEEE Canada and its members. The Committee has established several priorities for 2021, including

- supporting Section-led efforts to document Section history, collaborate with local groups with an interest in preserving the history of technology, and propose IEEE Milestones
- supporting the IEEE Canadian Foundation's efforts to reprint John Swettenham's three-volume biography of General A. L. McNaughton, which was published in 1968 by Ryerson Press
- engaging and supporting the community of Canadian scholars, collectors, and archivists who are helping to preserve the history of electrotechnology in Canada
- reviewing and updating the *25-Year History of IEEE Canada* booklet that was published in 2008
- launching a regular history column in *IEEE Canadian Review*
- launching a regular history session at the IEEE Canadian Conference of Electrical and Computer Engineering
- reviewing and updating IEEE Canada's strategy for participation in both the IEEE History Center and Engineering Institute of Canada History and Archives Committee programs.

The Committee is mindful that history and archival activities generally have institutional, outreach, and scholarly aspects and is attempting to see value returned along each line.

In our next column, we will review the status of Canadian IEEE Milestone proposals that have been submitted but are still in review or approved but not yet dedicated. We will also review the status of IEEE Canada's effort to reprint John Swettenham's three-volume biography of General A. L. McNaughton, which is nearing completion. Finally, we will review our strategies and efforts to engage and support the community of Canadian scholars, collectors, and archivists who are helping to preserve the history of electrotechnology in Canada. ■

About the Author



David G. Michelson is the IEEE Canada historian and chair of the IEEE Canada History Committee. An active contributor to the history of technology for two decades, he has been a member or associate member of the IEEE History Committee since 2012 and is responsible for one quarter of the 16 IEEE Milestones that recognize Canadian achievements. He is also a member of the Society for the History of Technology and a member of 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 Second World War, and the development and impact of both wireless technology and space technology since the Second World War. He can be contacted at dmichelson@ieee.org.

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.



There are many exciting milestones throughout the lifecycle of a satellite mission, but nothing that I have experienced in my career compares to the launch and early orbit phase for the RADARSAT Constellation Mission. This article offers a behind-the-scenes look into what was happening at the Canadian Space Agency during the first few days of the mission.

Ad astra,
Dario Schor; schor@ieee.org

At 14:17 UTC on 12 June 2019, Canada's eyes took to the sky to watch as a SpaceX Falcon 9 rocket carrying Canada's RADARSAT Constellation Mission (RCM) emerged over a thick cloud of fog (Figure 1) [1]–[3]. Minutes after launch, the rocket's first-stage booster separated for a controlled landing back at Vandenberg Air Force Base in California. Meanwhile, the second-stage engine injected the rocket into a temporary parking orbit, where it would coast through space for 42 min before performing one final burn to circularize the orbit. Finally, at 54 min 43 s after launch (T+0:54:43), the first of the three satellites, *RCM1*, separated from the Falcon 9's upper stage.

The live video feed was simply breathtaking (see the screenshot in Figure 2). The first satellite floated away from the launch vehicle and entered a circular 600-km, dusk–dawn sun-synchronous orbit with a 97.74° inclination. *RCM2* and *RCM3* followed at T+0:58:24 and T+1:02:13, respectively.

At last, after 15 years of labour, the RCM was now in orbit. The trio of satellites builds on the success of the RADARSAT-1 and RADARSAT-2 programs that have provided Canada with synthetic aperture radar (SAR) images since the mid-1990s [4]–[7]. However, unlike its predecessors, the orbital geometry of the constellation offers an increased revisit period with daily passes over Canada and close to 90% of Earth's surface. Altogether, this makes it easier to observe temporal changes for maritime surveillance, disaster management, and ecosystem monitoring [4]–[7]. Yet, as exciting as the launch was, there was still work to be done before taking the first image.

Back at the Canadian Space Agency's (CSA's) satellite operations centre in Saint-Hubert, Quebec, the mission control team celebrated the successful launch and promptly returned to their consoles in preparation for the first contact (Figure 3). The separation from the launch vehicle marked the beginning of the launch and early orbit phase (LEOP) for the RCM. Over the next few days, the team would establish contact with the satellites, verify they survived the launch, deploy solar panels and SAR antennas, and, ultimately, place the spacecraft into a safe and stable attitude to begin the payload commissioning activities.

The LEOP was the first time the satellites were exposed to the "real" space environment and the first end-to-end test of the entire combined ground and space segments. This cumulates in the highest-risk period for the mission [8, p. 81]. "If anything can go wrong, it's most likely to happen during LEOP" [9]. For instance, spacecraft engineers recalled a problem with *M3MSat*'s battery charge regulator discovered during the LEOP and how that was ultimately solved with a software patch [10]. Thus, to mitigate the aforementioned risks, additional personnel and ground resources were added to the mission operations roster.

A LEOP team was formed to provide 24-h/day operations and immediate



Figure 1: A Falcon 9 rocket emerging over a thick cloud carrying the RCM. (Photo courtesy of SpaceX; used with permission.)

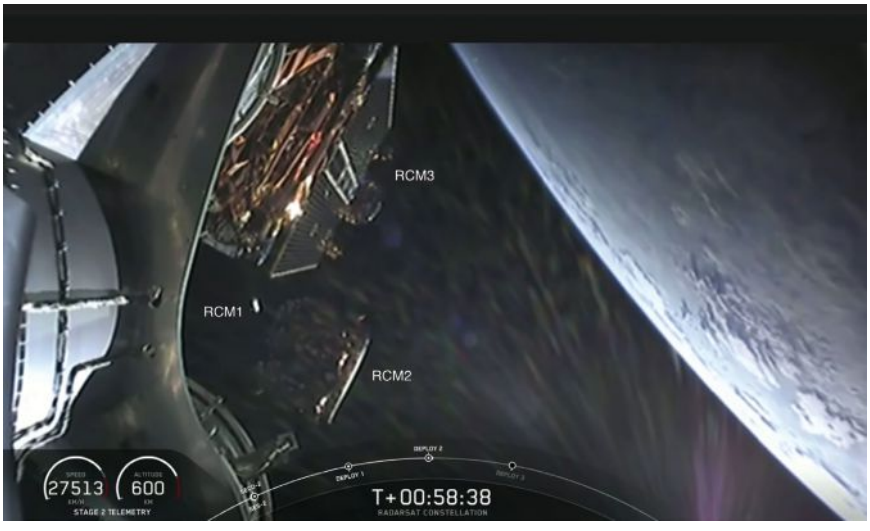


Figure 2: A screenshot from the live feed from the upper stage of the Falcon 9, taken moments after the *RCM2* deployment, with *RCM1* seen at the distance and *RCM3* still attached to the rocket [2]. (Image courtesy of SpaceX; used with permission.)

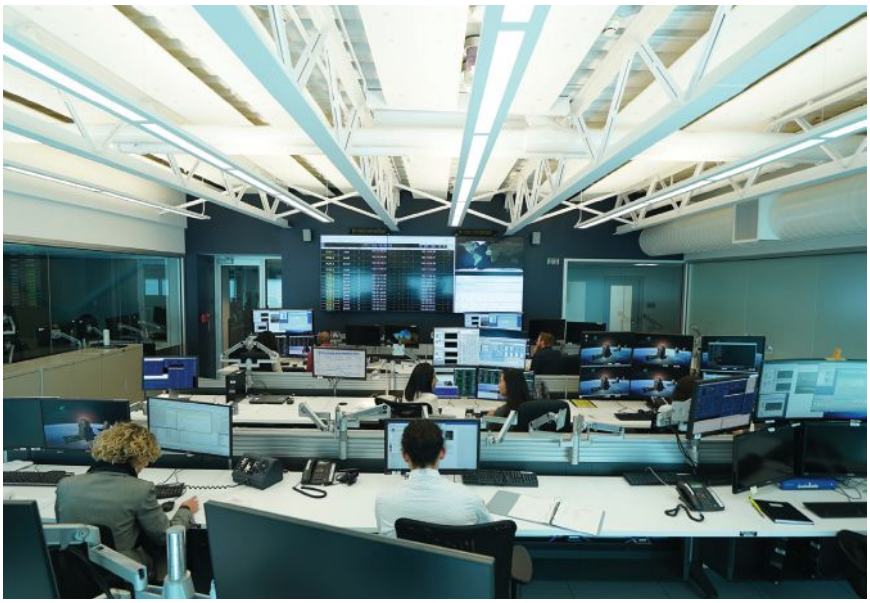


Figure 3: The main room of the Satellite Operations Centre at the CSA. (Photo courtesy of CSA; used with permission.)

response for any anomalies. Led by the mission prime contractor, MDA, the large integrated team included experienced spacecraft operators from the CSA, MDA, and Calian, along with Magellan Aerospace and MDA subject matter experts who had designed the spacecraft bus and payload units, respectively. Collectively, the LEOP team pictured in Figure 4 had representatives from all over Canada with a combined corporate knowledge from decades of satellite programs, human spaceflight missions, and rocket launches. Needless to say, this was a unique networking experience to share stories and lessons learned from previous missions.

The structure for the RCM LEOP team was divided into three groups. The Management Group was led by the MDA mission manager and flight director, who would oversee all activities and make final go/no-go decisions. The Flight Operations Group was responsible for executing spacecraft procedures and operating the ground segment equipment. Finally, the Engineering Support Group consisted of bus and payload engineers with intimate knowledge of the designs, who monitored telemetry in real time to identify and resolve issues as needed. This structure was duplicated to support 24-h/day operations with 12-h-long daytime and nighttime shifts.

Unlike the live video stream from the SpaceX launch, the LEOP team did not have the privilege of continuous communication with the satellite. Instead, engineers made contact with the satellites for roughly 8–12 min at a time as they passed over one of the ground stations associated with the mission [8, p. 70]. The RCM was designed to operate with three Canadian ground stations located in Gatineau, Quebec; Prince Albert, Saskatchewan; and Inuvik, Northwest Territories [5], [6]. However, to have additional coverage during the LEOP, MDA and the CSA reserved passes with ground stations in Kiruna, Sweden, and Bharati, Antarctica. Altogether, this enabled the team to communicate with the satellites once per 96.4-min orbit.

As an additional caveat, all three satellites used the same S-band frequencies for housekeeping telemetry, anticipating that they would be separated by 120° on an orbital plane [5]–[7]. Be that as it may, the phasing maneuvers to position the spacecraft would not be executed until after the LEOP. Therefore, mission planners scheduled when to turn on/off the transmitter on each spacecraft to avoid conflicts. While this may seem like an extra hassle, having the trio of satellites relatively close to each other allowed two other Canadian satellites, *NEOSSat* and *CASSIOPE*, to capture pictures of the three satellites, as shown in Figures 5 and 6, respectively.

The LEOP timeline was divided into an initiation and a completion phase. During the initiation phase, the ground was to establish contact with all three satellites, perform a health check, and



Figure 4: The RCM LEOP team in the lobby of the CSA one day before the launch. (Photo courtesy of Bryan Cooke; used with permission.)

initialize key components. Practically speaking, this was performed in parallel with all three spacecraft to be able to catch problems shortly after separation from the launch vehicle. More importantly, the sooner contact was made with all three satellites, the sooner the engineers, both at the CSA and across the country, who worked on the mission could finally exhale.

For a novice to satellite operations like the author, the first contact was extremely nerve-racking. There was no telemetry when the clock struck 15:30 UTC and *RCM1* was flying over Kiruna. The satellite operations centre went silent. Without any hesitation, the seasoned satellite operations engineers went through their signal acquisition flowchart, changed a setting on the ground system, and resolved the issue in real time. Telemetry showed the spacecraft was healthy. Power levels looked good, and the tumbling rates were within nominal bounds. As the system lead emphatically said over the intercom, "*RCM1* [was] green!"

Successful contacts with *RCM2* and *RCM3* meant the trio was healthy. From then on, each pass began with the system lead polling the room to ensure the satellite was green before dumping back-orbit telemetry (data saved to memory while the satellite was not in contact with a ground station) and issuing the command to perform the next activity in the timeline. Over the course of the day, the attitude determination and control algorithms began spinning the satellite along its minor axis in what was amicably referred to as a *rotisserie roll*, designed to prevent any one side of the spacecraft from getting too hot or cold. This was the final prerequisite for the go/no-go meeting to declare the LEOP initiation phase complete.

In contrast to the initiation phase, the LEOP completion was performed in its entirety, one spacecraft at a time, while only monitoring the health of the other two satellites. Major milestones for this phase included deploying the solar panels and payload antennas, powering on the GPS receivers and star trackers, and pointing the deployed SAR antennas toward Earth.

As is the case in many missions, the RCM satellites were launched in a stowed configuration with the solar panels and payload antennas folded to fit within the Falcon 9 fairing. Once in orbit, each component would be deployed following a series of well-rehearsed commands. That being said, deployments in space missions account for a significant portion of the LEOP failure scenarios. For instance, the 1987 German *TV-SAT1* communication satellite failed to fully deploy its solar panels, which subsequently hindered a payload deployment and, ultimately, led to a total mission failure fewer than six months after launch [8, pp. 84–88]. Even though the RCM design specifically avoided these compounding failure modes, the team still paid special attention to each detail of the deployment.

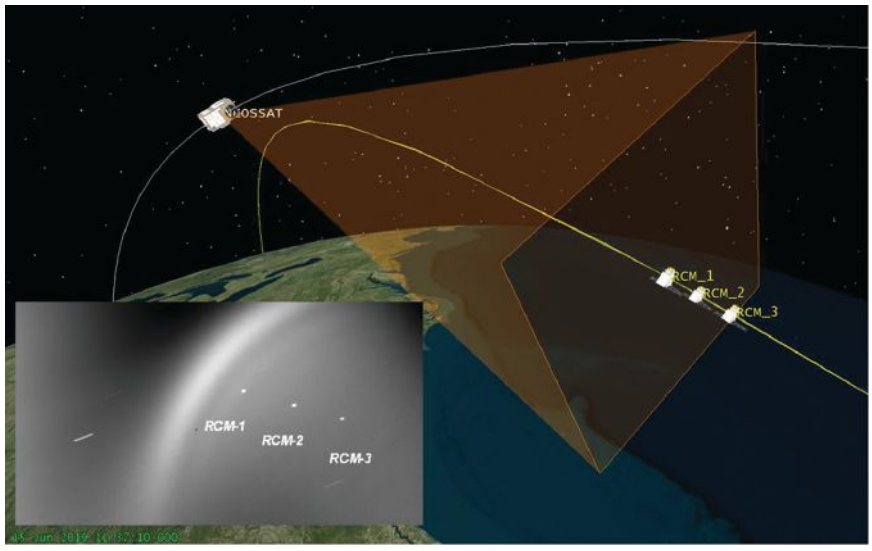


Figure 5: The three RCM satellites photographed by Canada's *NEOSSat* satellite on 15 June 2019. (Image courtesy of Defense Research and Development Canada; used with permission.)

Since the duration of an RCM SAR antenna deployment was longer than a single pass, the activity was split over three passes. The first pass was used to configure the stepper motor. A second pass was used to initiate the activity and monitor the first few minutes while holding a finger over the abort button in case something happened during the pass. Unfortunately, the engineers would have to wait until the third and final pass to check the potentiometer readings in telemetry to confirm whether the deployment had succeeded. As one would expect, the deployment exerted a moment on the spacecraft, so it took a few additional passes to reach a stable attitude postdeployment.

In contrast, the deployments of the solar panel and automatic identification system payload antennas were much simpler. All the ground had to do was issue the commands to cut the tie-downs for the spring-loaded mechanisms and watch for real-time confirmation via telemetry.

Following all of the deployments, the team completed the initial power-on of the GPS, star trackers, and momentum wheels. Except for a GPS taking longer to acquire a signal than planned and requiring a configuration change, the rest of the steps went very smoothly. To wrap up the completion phase, the SAR antennas were pointed toward Earth.

Overall, the LEOP went exactly as planned: uneventful and successful. The detailed plans and rehearsals paid off. Moreover, the attitude mode transitions completed faster than expected, allowing the team to finish off the LEOP on 18 June, a day ahead of schedule. The satellites were now in a safe and stable orbit, ready to begin commissioning activities.

On 29 June 2019, RCM captured its first engineering image over Baffin Island, Nunavut (Figure 7). Commissioning activities finished in November 2019. Since then, the satellites have completed



Figure 6: A screenshot of the video captured by the Fast Auroral Imager instrument on Canada's *CASSIOPE* spacecraft that shows the RCM satellites on 15 June 2019 [11]. (Image courtesy of the University of Calgary, Magellan, and C-CORE; used with permission.)

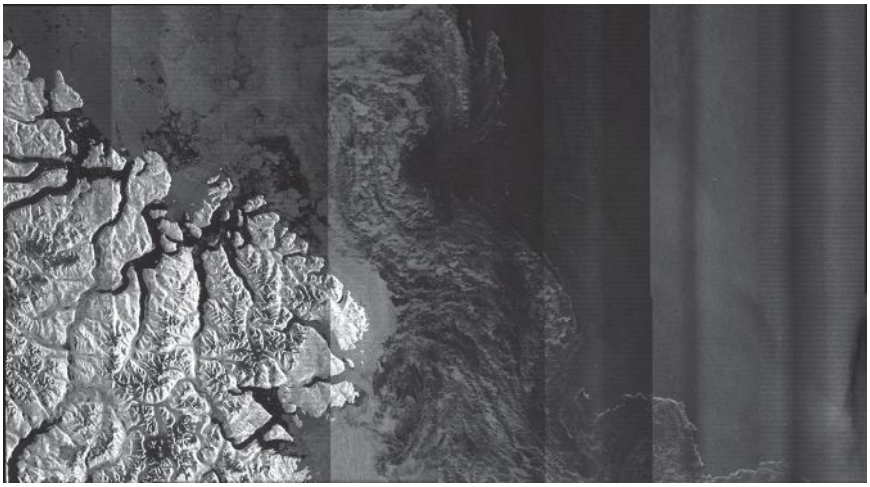
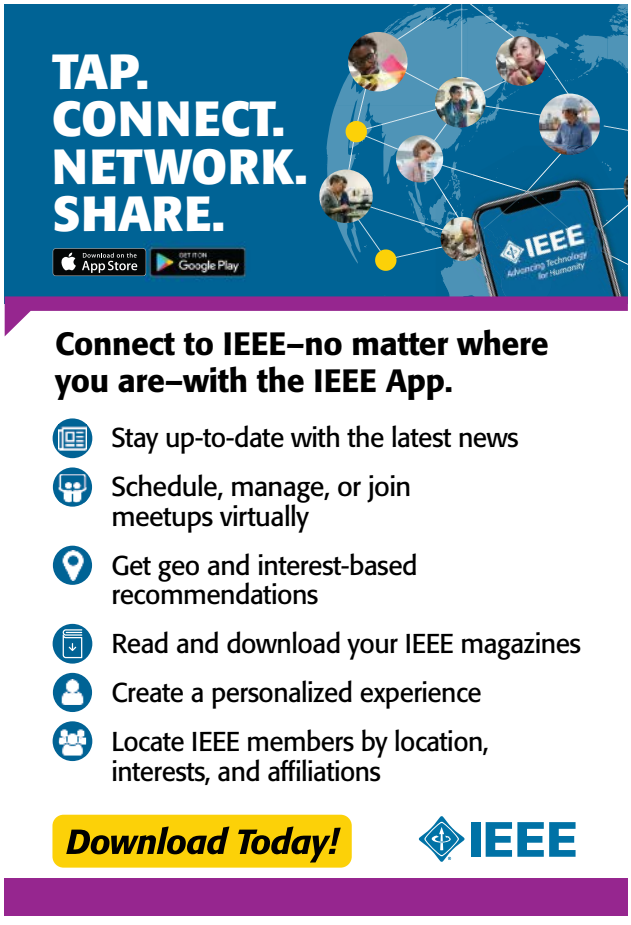


Figure 7: The first engineering image captured by the RCM. (RADARSAT Constellation Mission product © Government of Canada, 2019 – All rights reserved. RADARSAT is an official trademark of the Canadian Space Agency. Image courtesy of CSA; used with permission.)

more than 10,000 orbits and, in spite of COVID-19, ramped up imaging to full capacity. Happy two-year launch anniversary, RCM, and to many more!

Acknowledgments

Special thanks to Guennadi Kroupnik, Michel Doyon, and Christian Carrié from the CSA for allowing me to provide a behind-the-scenes look of the RCM LEOP campaign. I would also like to thank MDA's Terence Lee and Will Richardson-Little as well as Magellan's Diane Kotelko and Paul Harrison for their invaluable feedback ensuring the article captured the key milestones from that week. Finally, thank you to the entire RCM LEOP team for making this an unforgettable experience. ■



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About the Author

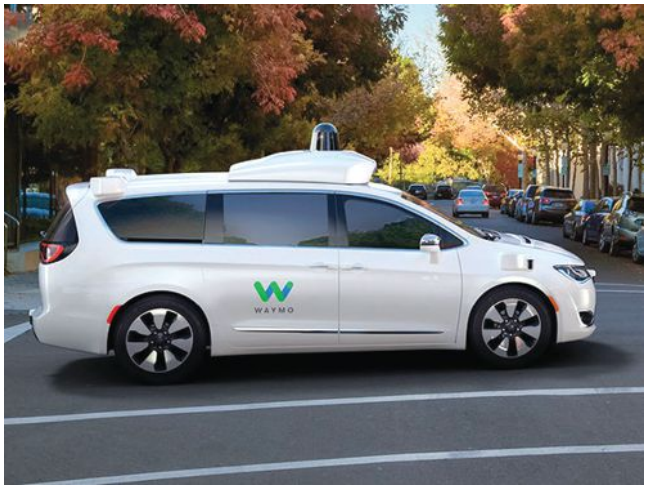


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Driving Into the Future

by Matthew Wilder

I enjoy driving. Few things feel as natural as the connection with a vehicle, controlling its motion, often with barely a thought, as if the vehicle is little more than an extension of a driver's body. Maybe not every driver feels this way, but I am sure that I am not alone. Songs have been written about the experience of driving. The competition for car-loving songs includes The Beatles, who sang "Drive My Car"; Willie Nelson's "On the Road Again"; and The Beach Boys, who proclaimed, "I Get Around." Without a doubt, the crown belongs to Queen for "I'm in Love With My Car."



A Waymo vehicle outfitted with LIDAR on top. (Source: Waymo.)

Despite my love for driving, I am looking forward to a future where driving becomes increasingly optional. The benefits of autonomous cars will range far and wide. Our attention—no longer required—can be spent on more meaningful and useful activities, such as work, reading, entertainment, or even sleep! Our roads, being safer, will be home to fewer accidents, and, when paired with smart driving algorithms, will run more smoothly, resulting in improved fuel efficiency. Another effect of enhanced safety and fewer collisions will be declining insurance rates. Imagine saving time, money, and stress from this one technology. Well, in truth, it is more of a fleet of technologies than one single technology that will contribute toward these outcomes.

Autonomous Vehicle Technologies

What are the technologies that are going to provide the foundation of this driverless future? It all begins with the sensory instrumentation. Most early attempts at autonomous vehicle technology (and some current technology) have been built on a LIDAR (Light Detection and Ranging) platform to gather environmental information. A spinning device on top of the vehicle emits lasers and measures the distance of objects, which are lit up by the laser light. As a full sweep around the vehicle is completed, a computer is able to combine the data to construct a 3D model of the environment surrounding the vehicle. Combining these data with preloaded map data, the vehicle can have a high-precision awareness of its location.

Waymo, the Alphabet start-up developing self-driving technology, has complemented its LIDAR instrumentation with radar (for visibility through fog, rain, and snow) as well as cameras to detect common shapes. This approach is common in engineering, where a combination of complementary technologies creates a more robust and reliable system than a system made up of only one of these components.

Tesla has employed multiple types of sensory inputs in its vehicles to detect the elements of the vehicle's environment. Notably, this set of sensors does not include LIDAR, and the auto manufacturer has recently discontinued the use of radar systems which were used to detect objects in front of the vehicle. Its system now relies on eight cameras around each vehicle and a dozen ultrasonic sensors to detect nearby objects. Because vision is the cornerstone of Tesla's system, the company has built a custom image processing neural network system to make sense of all of the incoming imagery.

Vehicle Communication Technologies

Several new technologies focus on the transmission and retrieval of information. Vehicles will soon communicate with almost everything imaginable (the so-called V2X). Most obviously, vehicles will communicate with each other (V2V), pedestrians (V2P), road infrastructure (V2I), networks (V2N), devices (V2D), and electric power grids (V2G). The basis of these concepts is that vehicles may be able to access all sorts of useful information that will inform safe and efficient routing as well as the location of parking spots, particularly those equipped with charging stations.

Imagine an ambulance in an urban environment that is moving quickly through a city street. Vehicles around corners today have little hope of knowing where the siren's sound is coming from (if the driver hears the siren). However, these technologies promise to deliver this information in real time to the surrounding vehicles. Similarly, traffic lights may be able to signal to vehicles the precise timing of their nearing red light. Whereas drivers today depend on an amber light

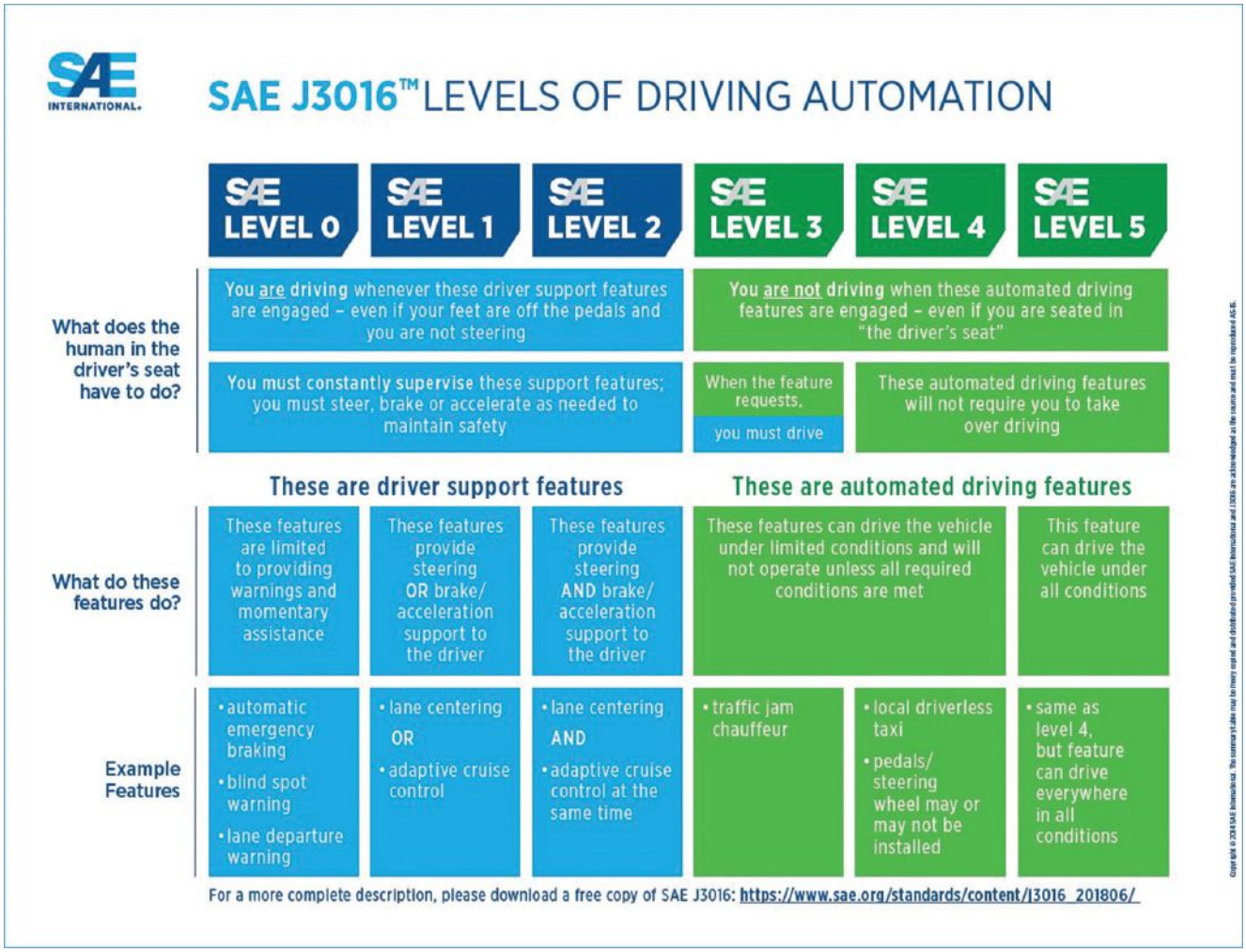


Figure 1: The SAE driving automation levels. (Source: https://www.sae.org/news/2019/01/sae-updates-j3016-automated-driving-graphic.)

to let them know about the imminent red light, vehicles of tomorrow will be able to decide to come to stop more gently as they approach the intersection.

IEEE introduced a cornerstone communication standard in IEEE 802.11p. This protocol is a purpose-oriented adaptation of Wi-Fi to suit V2V communication at high speeds, even if those vehicles are speeding in opposite directions. Imagine, then, that this protocol optimizes communication for briefly established connections.

One promising possibility we can foresee is that of vehicle platooning. This maneuver will allow a chain of vehicles on a highway to follow one another efficiently and safely by coordinating vehicle speeds. Such an approach will make better use of our transportation infrastructure and could alleviate the occurrence of traffic congestion.

Policy and Regulations

In recent decades, technological innovation has accelerated, challenging our policy-making apparatuses to keep up. Road transportation is perhaps an exception, where public opinion is fairly well informed of the expanding capabilities of autonomous vehicles. A domain that—understandably—emphasises safety has generally proven to be risk averse. As a result, autonomous vehicles have been given relatively little leeway by regulators.

The Society of Automotive Engineers (SAE) has defined five discrete levels of vehicle autonomy. This model is helpful for understanding the transition from ordinary manual driving (level 0) to fully autonomous (level 5), as shown in Figure 1.

Virtually all vehicles in the 20th century would fall into the category of level 0. Adaptive cruise control (patented in 1991) has been making its way into many of the vehicles that fill our roads now, signifying the arrival of the first step in driving automation found in level 1. In the last decade, lane centering has been introduced to the market, with Tesla leading the charge in this level 2 automation. In March, Honda released the "Legend" in Japan, the world's first level 3 autonomous vehicle sold. Many more automakers are developing their own capabilities for level 3 and higher features. Tesla is outspoken in its ambition to achieve level 5 automation, promising that all of its cars being sold now have the necessary hardware to support level 5 autonomy when the feature is rolled out. In March, Elon Musk announced that the full self-driving ("FSD") Beta was doubling its participation base from 1,000 to 2,000 users testing the company's level 2 autonomous system.

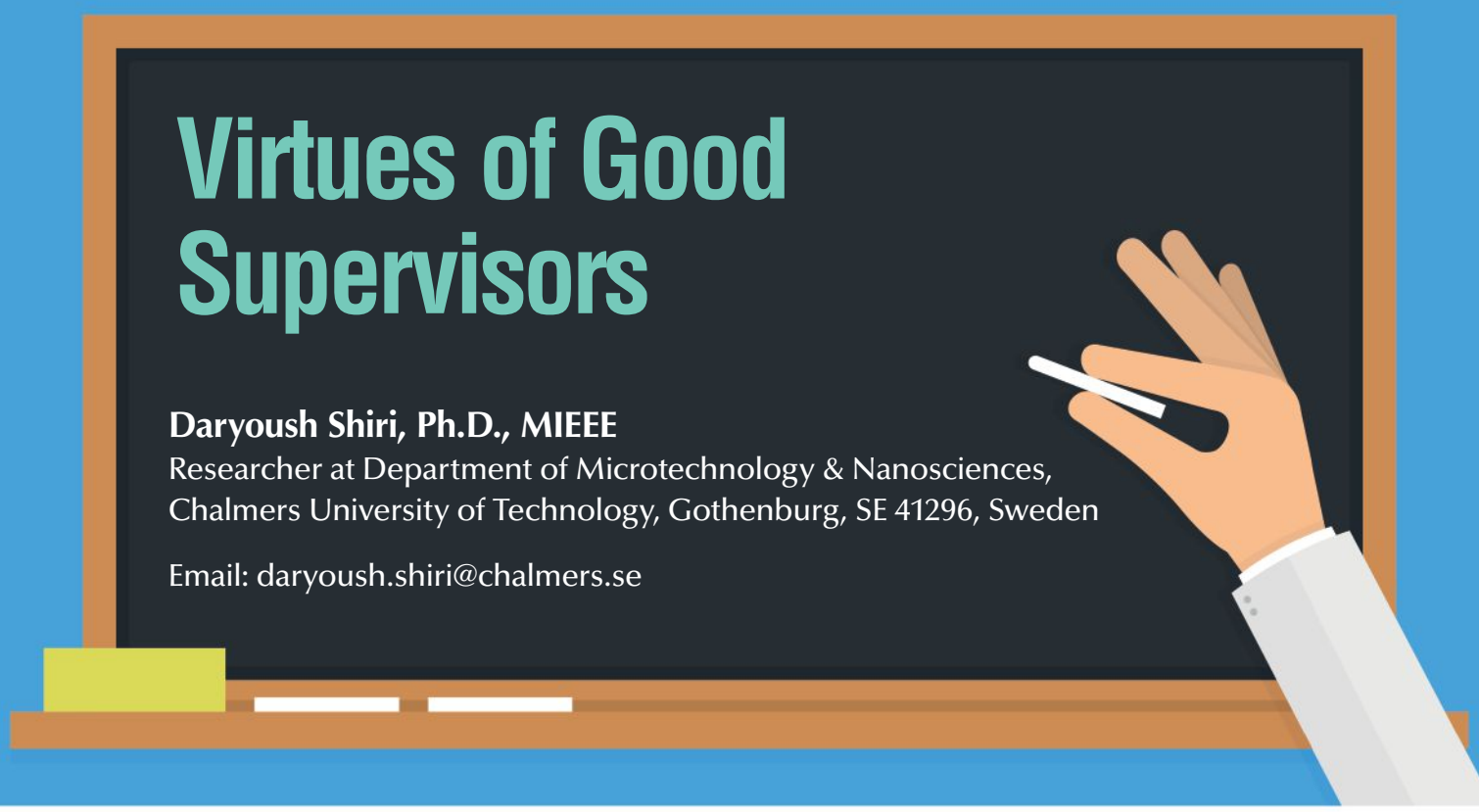
Policy makers understandably seek to control risks, so this set of capabilities needs to pass through regulatory scrutiny. The early signs are promising, with Tesla announcing that its fleet has logged billions of kilometers of autopilot, with an accident occurring once every 7.4 million km, compared with a typical driver's average of an accident every 770,000 km

(Continued on p. 32)

Virtues of Good Supervisors

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There were moments in my roles as both a graduate student and cosupervisor when I stopped and asked myself, why are we doing this? What is it in this student–supervisor relationship that is rewarding? Is this just a way of life or a publishing factory? Sometimes, I was totally at a loss and could not find an answer, especially when you are not getting any motivation from your student or when, as a student, you see the prospects of graduation as very dim and unimaginable.

Then I came across these words from legendary physicist and teacher John Archibald Wheeler, who once said, "We all know that the real reason universities have students is to educate the professors" [1]. This was said by someone who supervised 46 Ph.D. students during 40 years of his academic career. Among his students were Richard P. Feynman (Nobel Prize in Physics, 1965) and Kip S. Thorne (Nobel Prize in Physics, 2017). Wheeler was the one who coined the term *black hole* and pushed its theory forward. His student, Thorne, directed the herculean project of building the gravitational wave detector (LIGO: https://www.ligo.caltech.edu) to detect the warping of space–time as a result of merging black holes—an observation that proved Einstein right. If there is any reward in the supervisor–student relationship, it is, then, this getting educated, as Wheeler says, and exploring new horizons "with" our students.

The Swedish government mandates that academic staff in universities, higher education, and research institutions in the country pass a special training on supervision before or during their supervision of graduate research students. Tenured faculty members must attend special courses called *kompetensutveckling*, meaning "skill development," every three years after their first enrollment, and the weight of the contents for them may change; i.e., it might be devoted to "diversity and inclusion" or "supervision of students' writing," among others [2].

As a new cosupervisor in our research group I also enrolled and passed a course, Supervising Research Students (CLS905), and I would like to share a summary of the course contents and what I have learned with my fellow IEEE Canada members. I used to believe that supervision is an art that cannot be mastered by taking courses or even practicing. I thought that all you need is to be passionate and inherently good at it, watch and learn from your good supervisors, be knowledgeable in your field of research, and have a few hard-working and smart students. All students need is to be lucky, like me, to end up working with people who have these virtues. However, after taking CLS905, I found out how little I knew and how much time and energy I wasted in my previous cosupervision roles.

The course is presented and moderated by specialists in engineering or science education, and it consists of five sessions of 3 h each. Each session is composed of lectures by the course moderator and invited guest lecturers, e.g., the winner of the best supervision prize in the university. A part of each session is devoted to discussing what we learned from the previous reading assignments. These are instructive articles or chapters chosen from journals and books on higher education research and teaching.

The attendees in the course were from a broad spectrum—from newly minted Ph.D.s, postdocs, guest researchers, project leaders, industrial Ph.D. project principal investigators, newly hired assistant professors, or even senior professors who joined Chalmers University from a different school. During the discussion sessions, I was privileged to listen to and learn a lot

from the stories and experiences senior colleagues shared regarding their experiences in dealing with different situations through their supervision activities.

A full session is dedicated to reading and learning the "policy document and regulations of doctoral programs at Chalmers University." The document is published on the university websites for both students and supervisors (Figure 1).

Thus, the first and foremost step for the supervisor is helping the student to understand that this is a journey together "with" the supervisor to explore terra incognita.

This helps us, the supervisors, to know the rules, timing, and prerequisites of students' graduations and the different persons and offices of the hierarchy, up to the university president's office, to walk the student through the administrative steps towards graduation.

In this document, we learn the syllabi of courses; contents of the employment or offer letter we give to the student; and individual study plan (ISP), which is an evolving document monitored and completed annually by the student, internal examiner, and supervisor(s). Deadlines for the midway seminar, thesis defense, and thesis submission are among the other contents of the regulation document. As Chalmers University of Technology is a private university, the government regulates research and education activities through a long-term agreement and follows up the regulations on an annual basis.

We have to read this document, and a quiz is taken thereafter to make sure we know at least the ballpark numbers, "know-hows," and "what ifs"—e.g., "What if the student fails the defense?" or "What if the student wants to change the supervisor?" and so on.

Another interesting assignment was interviewing two supervisors whom we admire or think are our role models based on five main questions, including, among others, "Do they believe in formal training of supervision?" "What is their method of giving feedback to students?" "How do they resolve issues with their students if any issue arises?" Then, we compare and analyze their views on the questions asked (anonymously).

Pooling all of these know-hows in the discussion session was really eye-opening; brought many problems to the surface; and showed how intricate this supervisor–student relationship is. A bit of carelessness and sloppiness will irreparably damage the career of the student.

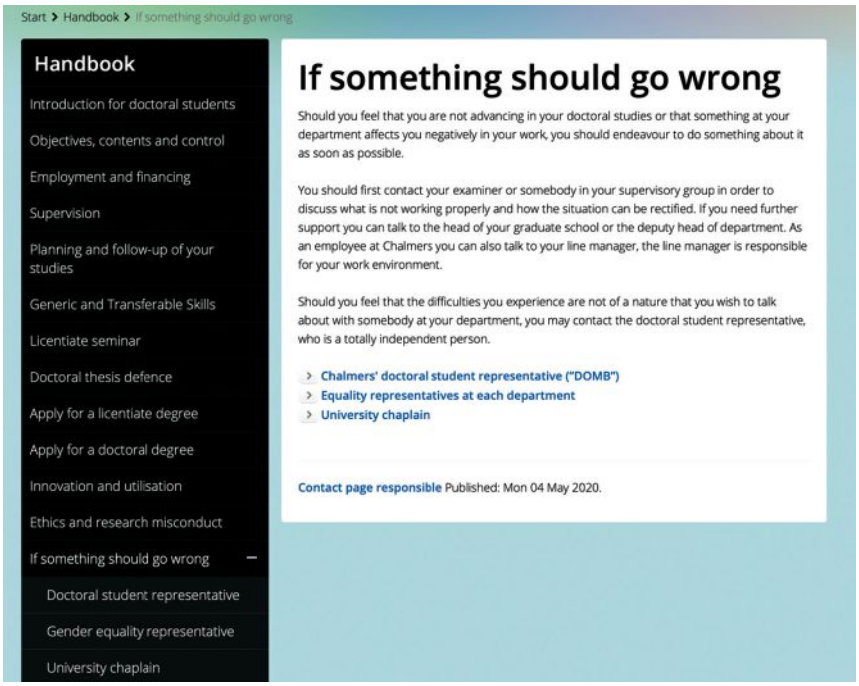


Figure 1: The handbook for Ph.D. students, including regulations and procedures for even the worst-case scenarios, i.e., withdrawal or change of supervisor or conflicts with the supervisor. (Source: Chalmers University of Technology).

On the other hand, doing a professional and ethical job will propel the student towards the best positions and bring a high reputation for the supervisor and his/her research group.

Setting a clear goal, the importance of feedback, the diversity of research groups, supervision of students' writing, keeping the student motivated, and dealing with conflicts and issues are among the other topics we learned in this course. Let me expand on a few of them here.

Setting a Clear Goal

The very first day a student steps in your office, he/she expects to leave your office with a clear and exciting goal. When the Hungarian–American mathematician Paul R. Halmos entered the office of his to-be supervisor, he was asked to borrow about 30 books on probability theory in at least five different languages from the library to find his thesis topic [3].

We cannot do this anecdotal experiment with students in these days of McDonaldized and commodified Ph.D. research [4]. When we hire a graduate student, the project is defined (in its general form at least) based on the proposal you wrote, and there is a limited time frame to get the result, culminate it through high-quality publications/a well-written thesis, and help the student to graduate.

In some cultures, the relationship between the student and supervisor is of the apprentice–master kind. The student expects to learn or, to put it in a better word, "to be trained" by the supervisor. He/she looks at the supervisor as a master of the field and expects to be told what to do and how to solve the problem, even to the extent of asking the supervisor to look at and debug the code and showing a simulation plot to the supervisor, asking, "Is this correct?"

Thus, the first and foremost step for the supervisor is helping the student to understand that this is a journey together "with" the supervisor to explore terra incognita. Students must adapt to the new way of thinking as soon as possible, unlearn the previous notion of the master–apprentice kind, and get used to the post-Humboldtian way of Ph.D. research [4].

Then, it is recommended that at this stage, the student and supervisor learn each other's expectations. This can be done informally, but we were also given a questionnaire form in this course, which contains 12 questions. We were asked to fill it in first and then let the student fill it in afterward. We compared the results to

see what the student thinks and expects from the supervisor. Excerpts of the form are shown in Figure 2.

After filling in this form, I realized my student expects me to help with writing the thesis, contrary to my belief that his thesis is his own novel or literary work and that he should write it without my help. Seeing this will help us to come to a middle-way compromise regarding this.

In this course, we learned of a few extreme cases of these expectations. As an example, a Ph.D. student went to Australia and expected his supervisor to find accommodations for him (simply because his master's thesis supervisors used to do this in his original country), and, for this reason, he was angry at his new supervisor. The poor supervisor didn't have the faintest clue of this expectation. Talking, communication, or simply filling in a form like this could avoid misunderstandings from the very first days, but note that the form does not replace talking.

Freedom and Feedback

At this stage, the student should be given a small task related to the project as a warm-up problem, with enough know-how and advice, and we have to make sure he/she understands what is next and what we are expecting as a result of this task. Sometimes, ask, "What do you think?" to see if the student really thinks or if he/she just wants to be told by someone else what to do or wants someone else think for him/her.

This stage helps us become familiar with the student as soon as possible in addition to the formal ways we learned in the previous section. It is important to find out if the student deserves the initial freedom or not. In an interview with the two supervisors, they both mentioned this step as the most important step in their supervision practices. One of them said, "Give freedom, watch, and adjust the path…" The other one calls this step "trial and error… as people are different, and you have to discover the differences soon…"

Adjusting the path involves timely feedback [5]. This is important, as performing it properly can convert the student to your research colleague and the project to a collaboration based on mutual respect and trust. Asking the student to give a summary of what has been done in a written or oral presentation helps us to find out the student's weaknesses and strengths in writing, talking, presentation, and even language skills. This way, we can provide a healthy amount of feedback and help. It is important to find out soon if your student is a good speaker, potential good teacher, good writer, or visualizer, and you have to give feedback on those virtues, ask the student to strengthen them, give encouraging remarks, and use those strengths to the benefit of your group.

The supervisor should avoid giving late feedback. If we are busy, we simply have to tell the student early. Late feedback causes misunderstandings. Usually, students are under stress emanating from different sources, e.g., being away from home, sleeplessness, course work loads, exams, and so on. The more stress the student has, the more inclined he/she is to imagine the worst [6]. For example, delayed feedback from me makes the student think that maybe I am angry or unsatisfied with the quality of the report or results. This makes the student more stressed and pushes him/her to take drastic measures to regain my attention, e.g., starting a calculation anew or thinking hard and unnecessarily about how he/she can make me happy. As a result of this, a lot of time and energy are wasted. However, a timely and healthy amount of feedback adjusts the path the student is moving on.

To keep this feedback loop closed and noise free, we were advised that good supervisors usually leave the door of their office open for the student(s), reply to their emails very fast, give early notice if they are busy or unavailable, and, most importantly, do not delay in reading the student's manuscript. An important part of this feedback revolves around the student's writing, which I discuss later.

Also, as supervisors, we need feedback and evaluation too, as a system without feedback will be very erroneous. Chalmers University of Technology has formal ways of evaluating supervisors, through which a supervisor asks his/her colleagues of the same rank or higher to evaluate him/her. Whether there is or is not such a mechanism in the school, we can rely on self-evaluation at least.

Sometimes, step in the office of your student, sit with him/her, and ask, "How do you feel? Are you happy with the research problem, workload, and deadline? Is there

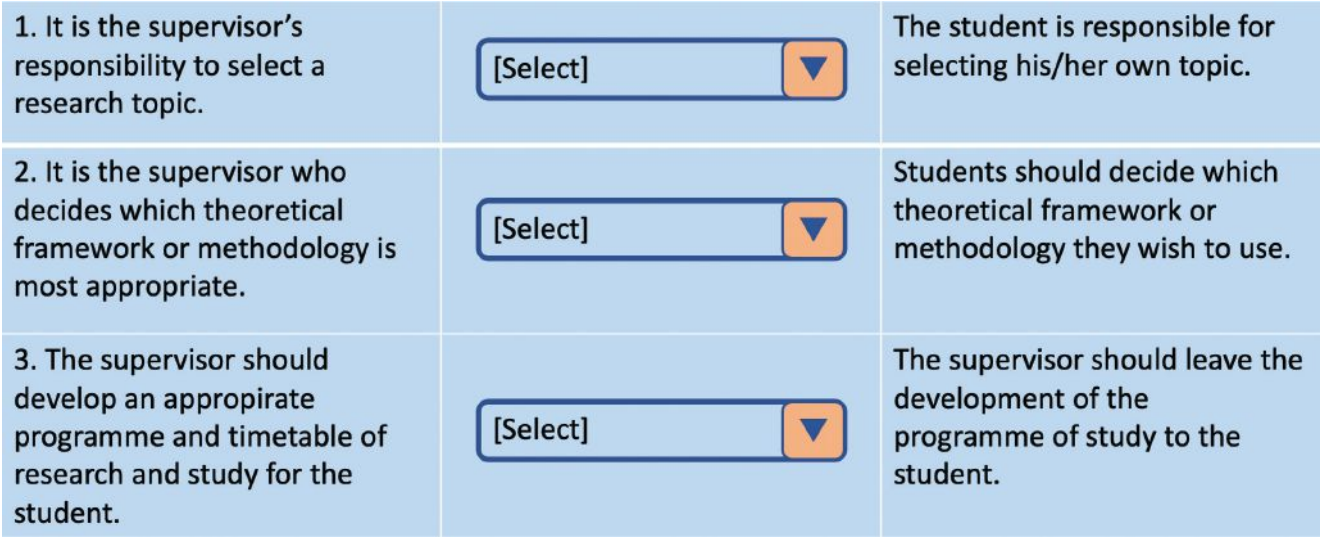


Figure 2: A snapshot of the survey form that the supervisor and student fill in separately and compare their scores. Scores are scaled from 0 (completely disagree) to 5 (completely agree).

any problem that interferes with your research, focus, and happiness? Is there anything that can be improved or help you work better?" Yes, some students might be shy and prefer not to open up, but do not assume all of them are. Every once a while, ask for feedback, and, if you cannot help or give any advice, then make sure you forward the student to professional help centers, services, and/or regulatory documents.

As a supervisor, if I realize one of my students was a graphic designer before coming to my group, then I can consult his/her skill if need be.

One of the interviewee supervisors mentioned that he always asks his students to give him feedback after graduation. He asks them to write three good things about him and three things that, if the student were the supervisor, he/she would do differently or better. He warns that asking them to write three negative things might not be effective, as some students are shy, and they might be worried about losing their relationship with the supervisor, worry about losing a recommendation letter, and so on.

Remember that, in some cultures, students did not learn to criticize their teachers, and you have to foster this attitude and let them learn that the scientific and technical research process is based on independence, criticizing, and being criticized. Speaking of cultures, let's move on to the next topic, which deals with embracing cultural diversity.

Diversity and Inclusion

Historically, there has been an exchange and migration of students and professors among different countries and universities to access the sources of a new craft, better educational facilities, and knowledge sharing. Some of the big research laboratories in the world are financed, staffed, and run by different countries, as one single country cannot afford a big facility. In addition to these incentives, most universities these days depend on international students as a source of income and solvency [7, Ch. 12].

A supervisor must look at internationalization and diversity as assets for his/her research group. Different people bring different ways of thinking and approaching a problem, and recent research on cultural diversity has also shown that diversity is correlated with better performance of a group [8]. As advised in [7, Ch. 12], we should not merely "tolerate" it but, rather, "learn from it" and, if possible, "share it" with the local people of our group.

We were advised to use a "cultural star" form once a new member joined our group or department [9]. This form is built to break the ice, help us become familiar with the background of our student, and let him/her get familiar with the background of other group members (Figure 3). The form asks everyone to write a few things, like what you are proud of; what your hobbies are; languages you speak; books/movies you like; countries you have been to, lived in, or worked in; and so on. As a supervisor, if I realize one of my students was a graphic designer before coming to my group, then I can consult his/her skill if need be. Never ignore the previous experiences of your Ph.D. students, and try to learn from them and use them for the group.

While most students start their Ph.D. studies immediately after their master's degree, some students work for a few years in industry before deciding to get a Ph.D. We have to appreciate this age difference and experience and let our group benefit from that.

Despite the benefits and assets mentioned, there are challenges brought by diversity, which supervisors should be aware of. A new international student has to find somewhere to live, settle both physically and mentally, and start focusing on the research.

The student's literacy in language is another issue. Having written one or two papers in English during his/her master's degree and passed e.g., the TOEFL exam does not mean full proficiency in English. If you find out there is an issue here, ask the student to consult with the international students office, register for an evening language or cultural course to get over the language barrier, and learn about the host culture as soon as possible [7, Ch. 12].

A colleague of mine complained that his student was silent during meetings and merely said, "Yes," or "Sure," but after one week, he realized that the student had done totally opposite of what he was asked to do! We learned that this is a symptom of insufficient language skills and that the student should be helped immediately. As supervisors, we were advised to talk slowly and clearly to new international students, give them enough time to finish what they are trying to say, and make sure they are understood and understand what we said.

Another issue is dealing with hierarchy. In my original culture, Iranian, I was advised to respect my teachers and their seniority by calling them "master," always avoid eye contact, and look down politely during conversations as a sign of respect and modesty. It took me a while to adapt to the host culture and six more years to muster courage to call my supervisor by his first name instead of "Professor."

The more supervisors know about different cultures, languages, corporate and academic cultures, and stereotypes, the better they manage to deal with different situations like these and the faster they can have a good rapport with students. Also, they can educate their colleagues should any problem emanate from similar misunderstandings. Other issues related to internationalization that a supervisor should be aware of are listed in relevant references like [9] and [10], e.g., separation from home, family, and support; stereotypes; time to complete the Ph.D. and uncertainties regarding

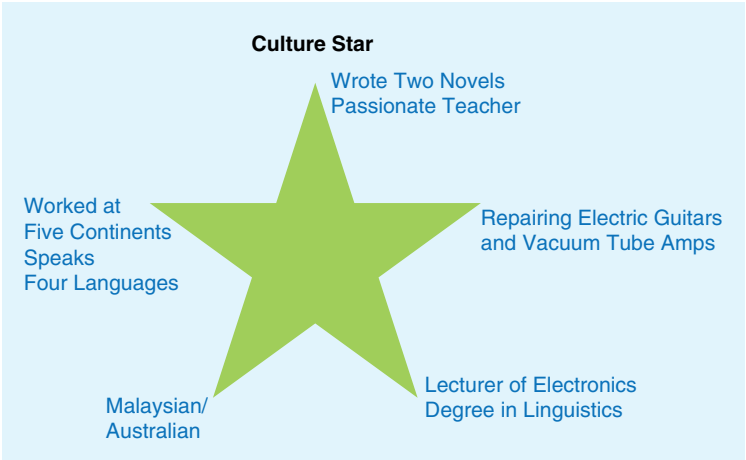


Figure 3: The culture star form of a fictitious new student showing merits he/she is proud of and wants to be known by his/her colleagues [9].

visas and immigration status; finding a job; and financing should Ph.D. study take longer than the norm and the assistantship discontinue, among others.

Supervision of the Writing Process

Annually, a Ph.D. student at Chalmers has to invite his/her internal examiner (usually a senior professor in the same field in the department), supervisor, cosupervisor(s), and director of graduate studies to the ISP meeting. This is to make sure the student in on the right path, fulfilling duties and outcomes according to the regulations. What matters here is not the number of papers or impact factors but, rather, the quality of the work as well as if the student has mastered independent thinking; has a problem-solving attitude; can define a research problem and ways of attacking that; can teach; has mastered writing, arguing, and presentation skills; has mastered disciplinary rectitude; and obeys research ethics.

It is better to make sure the student has at least a draft of a paper based on the warm-up problem he/she was working on during the first year before the ISP meeting. The student should not get the impression, however, that, after doing this and that and collecting signatures for this form, he/she is a doctor. This ISP form is a bit inflexible, and flexibility and a change of course for a research problem should be added and steered by the supervisor.

Regarding the timing of graduation, one of the interviewee professors mentioned, "I tell my student that you get closer to graduation when I feel that day by day I am learning more and more from you." The student should know and learn this expectation from the very first day, constantly be given feedback, self-evaluate to see if he/she is on the path, and look for the "aha" moment and "maturity" in research problem solving.

As supervisors, we must help our students gain writing skills, one of the virtues students should obtain before graduation [5]. The two interviewee supervisors I interviewed with were from two different continents and of different schools of thought. What I found most interesting was that both of them were complaining of the "lack of the art of storytelling" (they used the same words!) in the students they have or had.

They opined that the writing aid courses that different universities offer under different names are merely focused on grammar and formalities and do not tell students how to "present" their work. It is good, though, to ask students to take special courses on resume or CV writing, professional correspondence, and communication, i.e., formalities regarding email correspondence, presentations, and so on, but the core issue here is the lack of writing skills for research.

This problem is mostly visible in students who did not learn how to present a small project or how to sell their ideas to other people in their previous educations, e.g., in high schools. I believe that to be a good storyteller, you have to read a lot of stories. The focus in many high schools these days is cramming courses and coaching students to get the highest marks in the intense university entrance competitions. This leaves no room for literature, art, logic, working in a group, rhetoric, criticizing, exposing oneself to criticism, and making arguments. The result is a generation of students who are sharp in science and engineering topics but lack the soft skills mentioned.

As a supervisor, I do not have the bandwidth to re-educate my students to learn the art of storytelling or other soft skills; however, I try to follow the instructive recipes I learned in CLS905 to make my students good writers [7, Ch. 6], [11]. The first effective method is fostering reading to promote writing skills, something like a weekly or biweekly journal club or seminar in which students read a current state-of-the-art article and share their understandings through presentations. Disseminating knowledge does not always need to be done through "peer-reviewed" articles. Indeed, the "peer-reviewed" thing was something that did not exist before the Cold War [12].

Students can practice writing, e.g., by writing a popular science article in their field, writing a few sections of a group webpage explaining the research agenda, or sending a provisionary patent application to the patent office in their school to learn how to explain science and engineering to laypeople. As Feynman once said, if you cannot explain a thing in simple language, then your own understanding of that subject is flawed. My own supervisor always put me in this situation to help me learn writing by "writing to learn." Therefore, writing simple and clear texts helps the student to learn deeply.

The supervisor's feedback is the most important thing here. We are not allowed to return a draft to a student, who has lost sleep over the past few weeks, and say, "Bad," "Write again!", or "Totally remove this part!". Feedback should be specific and rational. If some parts must be removed, give the reason or an example. If one part is bad, tell the student how it can be rewritten better by giving an example, model, clue, or source of inspiration.

We have to re-emphasize to our students that, to be good writers, they have to be good readers and presenters. We have to ask our students to read a lot, learn the "genre" of their field, and learn how to sell their arguments and ideas using this genre language in a skillful and convincing way.

I would like to emphasize the importance of knowing a few more languages other than English for Ph.D. students.

As Feynman once said, if you cannot explain a thing in simple language, then your own understanding of that subject is flawed.

This will help them in writing by broadening their available resources and giving them access to different alternative explanations and solutions for a research problem. A computer can translate for us, but it does not knock on the door to tell us that the solution to a research problem is in an old non-English journal or book sitting in the basement of the campus library. "Learn a new language!" is a piece of advice I always give to my students and myself. That is also helpful in getting more neurons in our lazy adult brains rewired and indirectly improves happiness, reduces stress and negative feelings through biofeedback, and catalyzes graduation and thesis writing [6]. It is interesting to know that proficiency in a few languages other than English was once a prerequisite for Ph.D. admission in some schools in the United States [3].

Motivating the Student

The difficulty of the research problem, especially when the student gets stuck, makes the student believe he/she is not good enough for research, or, in some cases, he/she finds the research problem uninteresting. This puts the student in a downward spiral of stress, disappointment, and depression. The more depressed the student becomes, the less effort he/she makes to get out of this hole.

Worse than that is the scenario when the student sees some other tempting opportunities, e.g., working for a company next door with a high salary and less effort or seeing his/her happy friends in a different research group who publish each

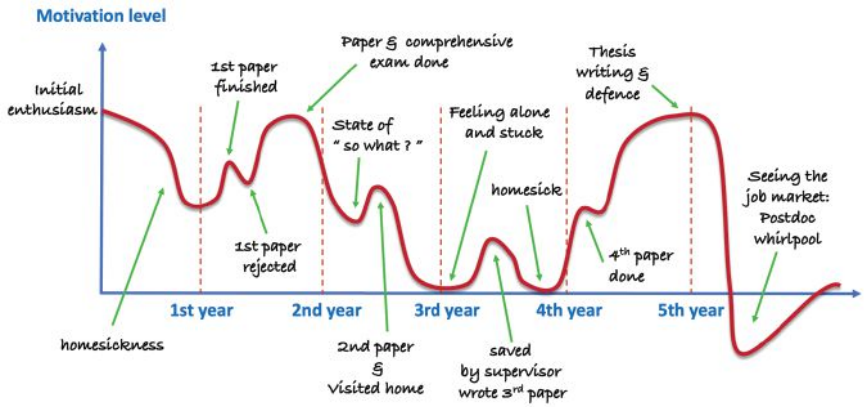


Figure 4: A Ph.D. student's motivation in swing. Each student has his/her own motivation plot. (Idea from https://www.phdcomics.com.)

and every plot their code spits out and go to conferences on exotic sunny islands.

As supervisors, we have to be aware of this stage and detect it before it is very late. How? Symptoms of this stage are lack of interest and focus, slow progress, distraction, procrastination, seeing that the student is trying different things, or digging new ground for an easy paper idea.

In this situation, we should not judge the student. Simply say that you have been through this stage (see Figure 4) and that it is a part of the research journey, and you and the student will find a solution for that. We have to find where the student has gotten stuck and see how we can help. When you ask the student, "Where did you get stuck?", beware of its negative effect. "Getting stuck" or "being slow" should not be translated as a lack of intellectual ability by the student. Even smart people get stuck and move slowly because some problems are just very hard, sticky, and impeding.

We should sit with our student and split tasks into smaller, manageable pieces. Increase the frequency of meetings, and make sure one of those small tasks is finished first without letting the student jump to the next and without letting him/her lose focus. We can find a group or person with whom the student can collaborate in writing a review article or book chapter. These "eye candies" help the student get out of the feeling of being useless or isolated and of being slow and having no results.

The reobtained momentum and vigor can then be directed towards the main research problem. This is, indeed, one of the moments when we should link the student to a big international society in his/her research field, give advice on future career planning, and let the student expose himself/herself to questions and criticism by encouraging him/her to go to conferences.

Working with a motivated student is, indeed, a rewarding thing in supervision. The interviewee professors and experienced colleagues in the CLS905 course were unanimous that supervision is enjoyable if they see the freedom that they gave to their student has led to exploring new territories. They suffer when the student loses motivation and when the student with freedom stalls instead of propelling himself/herself toward new discoveries.

Coda

One of Wheeler's students, Kenneth Ford (Ph.D. 1953), said, "We learned [from Wheeler] by watching him learn. Unafraid of stumbling before students, he led us his own paths of thinking. . . ." [1]. I'd like to be a supervisor whose students learn from him by watching him learn and, as one of the best supervisor awardees in this CLS905 course advised me, "work with my students." ■

Acknowledgements

I would like to sincerely thank Dr. Christian Stöhr and the guest lecturers of CLS905 (Supervising Research Students) for the insightful materials they presented.

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About the Author



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



What's New in the Literature?



by Terrance Malkinson

CarbonCure Technologies (www.carboncure.com), a Canadian company that develops clean tech solutions for the concrete industry, has been named one of two winners in the global NRG COSIA Carbon XPRIZE. Each winner is awarded a US$7.5 million grand prize. The competition invited participants to develop breakthrough technologies that convert carbon dioxide (CO_2) emissions into usable products. CarbonCure has developed a technology for the concrete industry that introduces recycled CO_2 into fresh concrete to reduce its carbon footprint without compromising performance. Once injected into the wet concrete mix, the CO_2 reacts with calcium ions from cement to form calcium carbonate, which becomes embedded in the concrete. Mineralized CO_2 increases the concrete's compressive strength by up to 10%. The properties, including set-time, slump, workability, pumpability, air content, temperature, and finishing, are not affected; neither are hardened properties, including pH level, freeze-thaw, density, colour, texture, and durability. CO_2 mineralization is compliant with ASTM under section C494 Type S. CarbonCure was established in Nova Scotia, Canada, in 2012, and its innovative concrete solution is now used in more than 300 concrete plants around the world. To date, producers have supplied nearly 10^3 million yards of CarbonCure concrete to a large number of projects.

On 12 April, the world celebrated the 60th anniversary of Yuri Gagarin's historic achievement as the first man in space in 1961. Gagarin's self-control was a key factor behind the success of his 108-min flight. The mission encountered emergencies, including a capsule hatch failing to shut properly just before blastoff, to parachute problems in the final moments before touchdown. Upon re-entry and his being crushed into the pilot's seat by heavy g-forces, Soviet cosmonaut Gagarin saw flames outside his spacecraft and prepared to die. He didn't know that the blazing inferno he observed through a porthole was a cloud of plasma engulfing his capsule, Vostok 1, during its re-entry into the Earth's atmosphere, and he returned safely. Gagarin's pioneering, single-orbit flight made him a hero in the Soviet Union and an international celebrity. He was killed in a training jet crash on 27 March 1968. Sixteen months later, the United States put an astronaut on the moon (https://www.dw.com/en/russia-celebrates-space-hero-yuri-gagarin-six-decades-on/av-57165057).

President John F. Kennedy's historic 1962 speech, challenging the United States to put man on the moon within the decade, inspired a generation of young, innovative people and spurred technology innovation that likely would not have happened as quickly as it did. The ingredients that led to the success of the Apollo missions were a whatever-it-takes attitude, loose management structures, and deep funding. George Mueller [www.nasa.fandom.com/wiki/George_Mueller_(NASA)], a brilliant and fearless engineering manager, was selected to lead NASA's human spaceflight program in 1963. The space agency's history office describes him as "a no-nonsense, forward-thinking leader." Mueller created a flat organizational structure, removing middle management and making sure that the engineers on the frontline were able to get their concerns communicated to the top people of NASA. Many of today's most successful start-ups and tech giants use Mueller's management techniques, which were so successfully employed in NASA's Apollo program.

In February, three spacecraft arrived at Mars after departing from different launch points on Earth in July. These missions have the goal of increasing our understanding of Mars, testing technology and preparing for future exploration. The three missions, China's Tianwen-1, the United Arab Emirates' Hope Probe, and NASA's Perseverance Rover, took advantage of an alignment between Mars and Earth on the same side of the Sun that permits shorter and efficient trips. Launched on 30 July 2020 and landing on 18 February 2021, the Mars 2020 Perseverance Rover (www.nasa.gov/perseverance) has an estimated mission duration of at least one Mars year (approximately 687 Earth days). The Perseverance Rover has four primary scientific objectives: 1) evaluating habitability, 2) seeking signs of possible past microbial life, 3) collecting core rock and soil samples, and 4) testing oxygen-producing technology from the Martian atmosphere. Additionally, an innovative small helicopter will test the possibility of powered flight. In its first test flight, the rotocopter ascended roughly 10 ft into the air and hovered in place for 30 s. It then descended and safely touched down again, for a total flight time of 39.1 s. The helicopter's counter-rotating four-ft-long blades spin at 2,500 r/min. The entire flight was autonomous, with onboard systems and algorithms doing all of the work. The following day, Rover's technology was successful in converting CO_2 from the Martian atmosphere into pure, breathable oxygen. This was the first extraction of a natural resource from the environment of another planet and is considered critical to the eventual human exploration of Mars, both as a sustainable source of breathable air for astronauts and as a necessary ingredient for rocket fuel to fly them home. Many more innovative and technology-intense information-seeking projects are planned. The future belongs to robots and humans working together, each contributing their unique capabilities in truly ingenious ways, exploring the universe.

In March, Infosys (www.infosys.com), a global digital services and consulting firm, announced its plans to expand its presence in Calgary from 10 to 500 employees by 2023. The company, which started in India and has operations in 46 countries, provides digital services and consulting for clients in many industries, such as natural resources, energy,

media, retail, and communications. Infosys believes that Calgary represents a significant and promising market and possesses the talent, critical skills, and opportunities that will build on the city's economic strengths. Infosys says it will hire tech grads from educational institutions in Canada, including the University of Calgary, the Southern Alberta Institute of Technology, and the University of Alberta.

Two Saskatoon high school students have started a nonprofit that is turning plastic waste into a new product. Sophia Lacroix and Kai Chen, Grade 11 students at Bishop James Mahoney High School, are using a Russian-built machine to turn plastic bottles into filaments for 3D printers and are making the material available at no cost to schools and other educational institutions. They established SK Eco Solutions (https://skecosolutions.wixsite.com/home), a youth-led, unincorporated, nonprofit, plastic-recycling, pollution-reducing, and eco-friendly organization devoted to cleaning up the environment. Tired of quarantining, they brainstormed different ideas about things they could do. They landed on "Project PET" (polyethylene terephthalate, the plastic used in bottles) and started their adventure. The extruder they are using is manufactured by NovaTech, a Russian company. After receiving grants from Ecofriendly Sask and the Greater Saskatoon Catholic Schools Foundation, they were able to purchase the PETBOT machine. The process involves ribbonizing the plastic bottle and extruding it, and the filament is put on a spool, which can then be fed directly into 3D printing machines. The students hope to inspire others to find new ways to innovate and reduce plastic waste.

Providence Therapeutics (www.providencetherapeutics.com) was founded as a cancer research company by Calgarian Brad Sorenson. As all of the company's work was focused on messenger RNA, it was able to quickly pivot in 2020 to develop and manufacture a Canadian vaccine for the novel coronavirus. Sorenson said that the results from Providence's animal trials are promising and on par with Pfizer and Moderna in terms of effectiveness. "Providence knows how to make very good messenger RNA, and we know how to deliver it very effectively to where it needs to go in the body. We are very confident we're going to have a very good vaccine." Sorenson said that if the clinical trials go well, the Providence vaccine could be ready for final Health Canada approval in early 2022. COVID-19 will be with us for the long haul and will likely continue to mutate and appear as new and perhaps more dangerous strains for years to come. It is important that Canada supports its skilled scientists and builds the capability to develop, manufacture, and distribute vaccines quickly to meet the challenge both for our citizens and globally.

Traditionally, installing bird-flight diverters on electrical transmission lines has been accomplished with a helicopter and a lineman or a bucket truck. There was significant risk associated with this method. Recently, a Calgary solution from a group of ex-oil patch workers to curb power line bird deaths has attracted international attention. FulcrumAir, (www.fulcrumair.com) founded in 2016, is a local robotics and unmanned aerial vehicle solutions company that has worked closely with AltaLink for more than two years to develop LineFly, an automated method for installing bird-flight diverters. (www.cbc.ca/news/canada/calgary/calgary-robot-improve-bird-safety-1.6000254). The markers are installed on the upper-overhead shield wire, which often appear invisible to birds. The flight-diverter tags act as a warning system so that they can see that wire better and avoid a collision. LineFly, a fully autonomous robot, is remotely controlled from support vehicles, which can be up to 1.5 km away. The unmanned coaxial minihelicopter picks the LineFly up and places it on the overhead power transmission wire and begins to advance, automatically placing the bird-flight diverters at any predetermined distance. LineFly can install between 300 and 600 bird-flight diverters per day. The machines are entirely designed and engineered in Calgary, as was all the software and the code. There has been interest in this product from around the world, including the US, South Africa, Chile, and Argentina.

Besides hospitality, the fitness sector has been one of the hardest-hit industries with closures during the COVID-19 pandemic. The changes have rocked the fitness industry, which was worth US$94 billion in 2018, according to the International Health, Racquet & Sportsclub Association (www.cnn.com/2020/04/01/business/fitness

About the Author



Terrance Malkinson is the author of more than 580 peer- and editorial-reviewed publications and 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 as well as 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 alumni of continuing professional education programs with Outward Bound International, Banff Centre for Management, the Massachusetts Institute of Technology, and the University of Colorado. During his long and continuing 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 and, over the years, 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 research and journalism, with an extensive portfolio of basic and applied research projects. 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.

-studios-coronavirus/index.html). Even with partial reopenings, many people continue to be reluctant to visit their gyms and studios (www.retail-insider.com/retail-insider/2020/09/gym-memberships-and-attendance-plummet-in-canada-amid-covid-19-survey). People have become accustomed to working out at home or outside since the pandemic began. Canada's fitness industry is undergoing a major technological shift due to COVID-19 as the owners of gyms and fitness studios transition to the digital world. Online training, apps, and fitness-monitoring technology as well as home workout space are the major enablers of transition. Some of the owners see it as an opportunity to pivot entirely online. The global fitness app market is forecast to grow at a rate of 23.5% from US$2.92 billion in 2019 to US$14.64 billion in 2027, according to a new report by Reports and Data (www.reportsanddata.com/report-detail/fitness-app-market). The market has witnessed an increase in demand in the past few years due to the growing penetration of smartphones and the emergence of advanced technologies in the health-care sector. Digital health has developed into a successful business, attracting several industries from outside the health-care industry. Mobile apps are able to help people manage their own health, promote healthy living, and they have access to the necessary information when and where they need it. The pandemic has also caused a lot of anxiety and depression among people, which has, in turn, generated conversation around mental health. Fitness and wellness are now merging, the impact being that the fitness industry is expanding its program offerings to include mind–body offerings and that trainers are altering their workout sessions to address mental along with physical health. Many predict continuing opportunities in developing holistic, innovative technologies for fitness enthusiasts as well as employment opportunities. ■

IEEE Canada Members Win Engineering Institute of Canada 2021 Awards

The Engineering Institute of Canada (EIC), founded in 1887, announced the winning recipients of its 2020 and 2021 senior engineering awards and fellowship inductees. The senior awards of the EIC are the highest distinctions made by the Institute and are awarded to deserving academic and industry based members of its 14 constituent societies. This year, seven IEEE Canada members won this prestigious award.

Julian C. Smith Medal

(For exceptional achievement in the development of Canada)

Ke Wu, *Ph.D., FCAE, FRSC, FIEEE*
Professor, Polytechnique Montréal, QC

John B. Stirling Medal

(For leadership and distinguished service at the national level)

Laurence Tianruo Yang, Ph.D., FEIC, FCAE, FIEEE
Professor, St. Francis Xavier University, Antigonish, NS

EIC Fellowships

(For excellence in engineering and their services to the profession and to society)

Venkata Dinavahi, University of Alberta, Edmonton, AB

Ekram Hossain, University of Manitoba, Winnipeg, MB

Karim S. Karim, University of Waterloo, Waterloo, ON

Natalia Nikolova, McMaster University, Hamilton, ON

Ya-Jun Pan, Dalhousie University, Halifax, NS

Gamal Refai-Ahmed, Xilinx Inc., Markham, ON

Alan Scott, Honeywell International, Arnprior, ON

Jinjun Shan, York University, Toronto, ON

Xiao-Ping Zhang, Ryerson University, Toronto, ON

Yi Zhang, RTDS Technologies, Winnipeg, MB

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 electromagnetics. This month's column focuses on URSI's activities involving the International Telecommunications Union and spectrum policy.

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Since its inception radio communication has been plagued by a shortage of space for ever-increasing numbers of stations and new services. . . . As new regions of the radio spectrum have been explored and opened to practical operations, commerce and industry have found more than enough new uses to crowd them. As a result, it has become increasingly clear that the spectrum is a public domain which must be conserved.

This quotation, which at first glance seems very recent, actually comes from a 1952 report on Radio Spectrum Conservation [1] prepared by the Joint Technical Advisory Committee of the Institute of Radio Engineers and the Radio Television Manufacturers Association. As debates concerning spectrum policy, spectrum scarcity, and spectrum sharing rage on today, we are reminded that the details of the technology may change, but the underlying issues tend to remain the same.

The Radio Regulations (RR) is the binding international treaty that, in 2,300 pages of texts and charts, describes how the international community has agreed to share the radio-frequency spectrum among different services. Updates and modifications to the RRs are negotiated and agreed upon at the World Radio Conferences (WRCs) that are organized periodically by the International Telecommunications Union (ITU) Radio Communications Sector and attended by thousands of representatives from the ITU's member states, private sector members, and international and regional organization members.

Spectrum policy is an attempt to 1) extract maximum benefit from the wireless spectrum, 2) minimize interference among users, and 3) regulate the use of the spectrum in a fair and transparent manner. Because all three goals must be met, economists, wireless engineers, and legal experts must work together to meet the many challenges associated with setting effective spectrum policy. Within the ITU, study groups address many of the open questions that arise at WRCs and must be resolved before the relevant issues can be properly addressed.

PROPOSED INTERNATIONAL UNION OF RADIO SCIENCE–ITU WORKING GROUP

The International Union of Radio Science (URSI) has a long history of supporting the ITU's mission. At the 1990 URSI general assembly in Prague, the URSI Council passed resolution U.3, which mandated the creation of the Scientific Committee on Telecommunications that would "facilitate the cooperation between the Commissions of URSI, and also the cooperation of these with [ITU] Study Groups for the study of scientific aspects of the telecommunications problems." The ITU's support for this activity was reaffirmed at several subsequent general assemblies.

At the 2021 general assembly to be held in Rome later this summer, the URSI Council will consider a resolution to replace the now defunct Scientific Committee with an URSI-ITU working group that will 1) work with the ITU to identify those areas that may influence the evolution of telecommunications in the long term; 2) keep the URSI community informed on specific questions posed by the ITU study groups, with particular initial emphasis on those questions concerning radio wave propagation; 3) stimulate and coordinate studies, collaborations, and symposia that will address these ITU questions and prepare URSI statements on such topics in an appropriate form; and 4) establish task groups, or other mechanisms as appropriate, to undertake these tasks.

ITU SPECTRUM MANAGEMENT TRAINING PROGRAM

The multidisciplinary nature of spectrum management places significant demands upon those training operators, regulators, and policy makers. In response, the ITU Academy recently developed the Spectrum Management Training Program (SMTP), a set of training materials that was developed by experts drawn from within and outside of the ITU. The SMTP comprises two levels: basic and advanced. Each level includes a number of obligatory and elective modules that cover the economic, engineering, and legal aspects of spectrum management.

The ITU is working with various stakeholders, including training and academic institutions, to help them develop and deliver the SMTP.

The ITU is working with various stakeholders, including training and academic institutions, to help them develop and deliver the SMTP. Because the SMTP is accredited by the Central Evaluation and Accreditation Agency, elements of it can be delivered as standalone training, toward the award of basic or advanced certificates or a master's degree.

The University of British Columbia has licensed the SMTP and is working with CNC–URSI to deliver elements of the SMTP to Canadian stakeholders starting in fall 2021. Those interested in participating in such training are invited to contact me at president@ursi.ca for further information. ■

The National Research Council of Canada is the adhering body for Canadian membership in URSI and appoints the members of the Canadian National Committee of URSI. For more information about URSI International, please visit http://www.ursi.org/.

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

About the Author



David G. Michelson is president of the Canadian National Committee of the International Union of Radio Science (2018–2021). He has led the Radio Science Lab at the Department of Electrical and Computer Engineering, University of British Columbia (UBC), since 2003. His current research focuses on short-range/low-power wireless networks for industrial vertical and transportation applications, millimetre-wave channels and systems, and satellite networks for communications and remote sensing. Prof. Michelson serves as a member of the Board of Governors of the IEEE Vehicular Technology Society, as a member of the Steering Committee of the National Institute of Standards and Technology-sponsored NextG Channel Model Alliance, as director of the AURORA Smart Transportation Testbed, and as principal investigator of the Campus as a Wireless Living Lab project at UBC.

Winners of 2021 Major IEEE Canada Awards

Achievement Awards

A.G.L. McNaughton Award

For outstanding contributions to robotics, control systems, haptics and teleoperations and their practical applications

- Rajni Patel

C.C. Gotlieb Computer Award

For foundational contributions to member dependence predictions, power-aware coherence, and value aware hardware acceleration for Machine Learning

- Andreas Moshovos

R.A. Fessenden Award

For exceptional technical contributions to wireless communications and networks

- Weihua Zhuang

P.D. Ziogas Electric Power Award

For contributions to the theory and practice of power system stability and operation

- Chi Yung Chung

Outstanding Engineer Award

For outstanding contributions to the theory and applications of computer control systems, networked control, remote state estimation and advanced alarm management and design

- Tongwen Chen

J.M. Ham Outstanding Engineering Educator Award

For exceptional training and education leadership in the design of silicon photonic devices and systems for applications in optical communications, biosensors and quantum information

- Lucas Chrostowski

Service Awards

W.S. Read Outstanding Service Award

For outstanding service and dedication to IEEE Canada (Region 7) and its members

- Voicu Groza

E.F. Glass Western Canada Merit Award

For outstanding contributions to the Southern Alberta Section and Region 7 Western Area

- Laurence Whitby

M.B. Broughton Central Canada Merit Award

For contributions to the IEEE Canada Sections and Conferences

- John Harris

Affinity Groups

Young Professionals Affinity Group of the Year Award

- South Saskatchewan Young Professionals Affinity Group

Exemplary Section

- Small Section – London Section
- Medium Section – Southern Alberta Section
- Large Section – Montreal Section (with honourable mention to Toronto Section for remaining extremely active during the pandemic)

Other 2020 IEEE Canada Awards

President's Make a Difference Award 2020

- Jeffrey Arcand

Affinity Groups 2020

WIE: IEEE Canada WIE Prize - IEEE Canadian Foundation

- Leanne Dawson - Southern Alberta Section

Young Professionals Affinity Group

- Ottawa Section

 (Continued from p. 20)

(according to the U.S. National Highway Traffic Safety Administration). As the technology is proven, it is reasonable to expect that policy makers will permit the technology to usher in the benefits of safer roads to their jurisdictions.

Drivers No Longer Wanted?

The overwhelming improvement in safety that seems already apparent begs the question: if self-driving cars are statistically safer, is it irresponsible to allow human drivers to control vehicles into the future? I suspect this question will eventually loom large in the coming decades as we see more de facto autonomous vehicles, in a similar way that automatic transmissions overtook so-called standard transmissions.

Lexus appears to have anticipated this possibility when it introduced a slogan in 2017 to "enjoy the thrill of driving while you still can." The slogan evokes a sense of mourning an impending loss. One of the great insights from the field of behavioural economics is that we humans strongly resist losing things, including things we do not fundamentally value apart from our attachment to it. This so-called "loss aversion" can cause us to disproportionately overestimate the value of the thing we have to consider losing in an exchange.

For this reason, I believe that any mandate toward surrendering the steering wheel will maintain a time and place in which we will be able to drive—if we wish. Perhaps all rush hour traffic on busy roads will be open only to cars in self-driving mode, or maybe no human driving will be permitted within city limits. Whatever regulations are introduced, it seems likely that those of us who love to drive will still be allowed to do so under certain conditions.

Loss aversion can be somewhat dampened by reframing our loss as a gain. Rather than focusing on the loss of control of our vehicle, we can consider the many benefits we expect to derive from this suite of technologies. Our attention can be relaxed and redirected to other matters of more significance. The stress of driving in rush hour traffic may become a thing of the past. The traffic itself will improve, and emissions will decrease, improving the quality of the air we breathe.

Our relationship with driving is no doubt going to be changing over the coming decades. Increasingly capable technologies will enhance our safety and liberate our time and attention spent in vehicles. ■

About the Author



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

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IEEE CALL FOR PAPERS

EPEC 2021

Electrical Power and Energy Conference

"Renewable Energy and Smart Grids for Future Sustainable Cities"

Virtually on October 22-24 and 30-31, 2021

IEEE Toronto Section will be the host for the annual IEEE Canada Electrical Power and Energy conference (EPEC 2021) that will take place virtually on October 22-24 and 30-31, 2021.

EPEC 2021 is a conference that provides an opportunity for experts from industry, academia, government sector and other interested organizations from Canada and abroad to present and discuss the latest developments in the electric power and energy systems: academic, industrial and government research and development, industrial and business trends and challenges, as well as regulatory and policy aspects. This includes debate on the potential impact of these developments on the society. The conference provides an international forum for the presentation of peer-reviewed papers and presentations on power and energy research and development, applications and their implementations.

Topics: The EPEC 2021 welcomes submission of papers related to the conference theme including, but not limited to, the following topics:

- Digital Transformation of Power and Energy Systems
- Real-Time Simulation
- System Resilience
- Active Distribution systems
- Power System Protection and Wide Area Protection
- Power System Stability and Control
- AC/DC Power Quality
- Distributed Energy Resources
- Microgrids and Isolated Grids
- Electric Vehicle Infrastructure
- Cyber Security
- Data Mining, Artificial Intelligence, Machine Learning
- Smart Grids
- Wireless Power Transmissions
- Electrical Machines & Drivers
- Transactive Energy and Electricity Markets
- HVDC, FACTS, and High-Power Converters
- Renewable Sources of Energy and Cogeneration

Paper Submission:

The format of the paper should follow the IEEE conference paper style. EPEC 2021 will only accept the electronic submission of a full paper in English. EPEC 2021 proceedings will be submitted to IEEE Xplore. The EPEC 2021 authors of the top 20% papers will be invited to submit extended versions of their presented conference papers for publication in the IEEE Canadian Journal of Electrical and Computer Engineering (CJECE) Special Issue, http://journal.ieee.ca. This will be by invitation only.

Important Dates:

Submission of full papers	July 30 ~~July 15~~, 2021
Submission of workshop and panel session proposals	July 31, 2021
Submission of tutorial proposals	July 31, 2021
Notification of workshop/panel/tutorial acceptance	August 15, 2021
Notification of paper acceptance	September 01, 2021
Submission of final camera-ready papers	September 15, 2021

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