

In this issue of *IEEE Control Systems*, we speak to Guy A. Dumont, a professor at the University of British Columbia (UBC), Canada; Ebru Aydin Gol, an assistant professor in the Department of Computer Engineering at the Middle East Technical University (METU), Turkey; Tryphon T. Georgiou, a distinguished professor at the University of California, Irvine (UCI); and Silvère Bonnabel, a professor at the University of New-Caledonia (a French university) and at Mines ParisTech.

Guy A. Dumont received the Dipl. Ing. degree from Ecole Nationale Supérieure d'Arts et Métiers, Paris, France, in 1973 and the Ph.D. degree in electrical engineering from McGill University, Montreal, in 1977. He was with Tioxide, France, from 1973 to 1974 and again from 1977 to 1979. He was with Paprican from 1979 to 1989, first in Montreal and then in Vancouver. In 1989, he joined the Department of Electrical and Computer Engineering, UBC, where he is a professor and Distinguished University Scholar. From 2000 to 2002, he was the associate dean of research for the faculty of applied science. Since 2008, he has been an associate member of UBC's Department of Anesthesiology Pharmacology and Therapeutics, and he became an associate member of the UBC School of Biomedical Engineering in 2020. He is also a principal investigator at BC Children's Hospital Research Institute and is a cofounder and codirector of the Digital Health Innovation Laboratory. His current research interests include patient monitoring, signal processing for physiological monitoring, physiological closed-loop control systems such as for automated drug delivery in anesthesia, circadian rhythms, global and mobile health, noncontact patient vital sign assessment, and brain monitoring via electroencephalography and near-infrared spectrometry.

He was awarded a 1979 IEEE Transactions on Automatic Control Honorable Paper Award, a 1985 Paprican Presidential Citation, the IEEE Control Systems Society (CSS) 1998 Control Systems Technology Award, three NSERC Synergy Awards (the latest one in 2016 for the development of the phone oximeter), and the 2010 Brockhouse Canada Prize for Interdisciplinary Research in Science and Engineering. In 2020, he was awarded the IEEE Control Systems Society Transition to Practice Award. He is a Fellow of IEEE, the International Federation of Automatic Control (IFAC), and the Royal Society of Canada.

Ebru Aydin Gol is an assistant professor in the Department of Computer Engineering at METU, where she received the B.S. degree with a minor in mathematics in 2008. She received the

M.S. degree in computer science from Ecole Polytechnique Fédérale de Lausanne in 2010 and the Ph.D. degree in systems engineering from Boston University in 2014. After graduation, she worked as a reliability engineer at Google before joining the faculty of the Department of Computer Engineering at METU in 2016. At METU, she leads the Cyber-Physical Systems research group. In addition, she is a member of the Robotics and Artificial Intelligence Technologies Applications and Research Center (romer.metu.edu.tr) and the METU Design Factory (tf.metu.edu.tr). She currently serves as an associate editor of *Nonlinear Analysis: Hybrid Systems*. In the past three years, she has served on the program committees of various conferences, including ADHS, FSEN, FormaliSE, HSCC, ICCPS, and QEST. She has authored one book and nearly 40 journal and proceeding articles. She was a Marie Skłodowska-Curie Fellow between 2018 and 2020 and received the IEEE Transactions on Control of Network Systems Outstanding Paper Award in 2017. Her research interests include formal methods as well as the verification and control of cyberphysical systems. At METU, she led and participated in various high-impact interdisciplinary projects with real-world applications, including smart traffic control, the restoration of earthquake damaged electrical systems, designing critical real-time systems, and estimating electrical vehicle battery use for microgrid applications and system monitoring.

Tryphon T. Georgiou received the diploma in mechanical and electrical engineering from the National Technical University of Athens (Ethnikon Metsovion Polytechnion) in 1979 and the Ph.D. degree in electrical engineering from the University of Florida in 1983. Before joining UCI in 2016, he served on the faculty at the University of Minnesota starting in 1989, where he held the Vincentine Hermes Luh chair (2002–2016) and was a codirector of the Control Science and Dynamical Systems Center (1990–2016) with Allen Tannenbaum and later with Gary Balas. Prior to his tenure at Minnesota, he served on the faculty at Iowa State (1986–1989) and Florida Atlantic University (1983–1986). He served as an associate editor for several journals, including *IEEE Transactions on Automatic Control* and *SIAM Journal on Control and Optimization* as well as the program chair for the 2016 International Symposium on the Mathematical Theory of Networks and Systems, which took place on the campus of the University of Minnesota. He received the George S. Axelby Outstanding Paper Award of the CSS in 1992, 1999, 2003, and 2017.

He is a Fellow of IEEE, IFAC, and the Society for Industrial and Applied Mathematics, and he is a Foreign Member of the Royal Swedish Academy of Engineering Sciences. His research interests span control and systems theory, applied mathematics, and mathematical physics.

Silvère Bonnabel received the M.Sc. degree in engineering and the Ph.D. degree in mathematics and control from Mines ParisTech in 2004 and 2007, respectively, as well as the Habilitation in mathematics from Sorbonne University in 2014. He was a postdoctoral fellow at the University of Liège, Belgium, in 2008 and joined Mines ParisTech as a permanent faculty member in 2009.

In 2017, he was an Invited Fellow of Sidney Sussex College at the University of Cambridge. He serves as an associate editor of *IEEE Control Systems*, and he has also served as an associate editor of *Systems & Control Letters*. His honors include the joint IEEE & SEE Glavieux Prize in 2015, the 2017–2019 Automatica Paper Prize, and the European Control Award in 2021. His primary research interests include systems and control as well as robotics (with a focus on state estimation and geometric methods). He has contributed to developing products in the industry.

Rodolphe Sepulchre

GUY A. DUMONT

Q. How did your education and early career lead to your initial interest and continuing interest in the control field?

Guy: Early on, my father (whose dream of postsecondary studies were crushed by the onset of World War II) decided that his five (!) boys would go into engineering. So, although my first calling would probably have been medicine, by the age of 12, I became a boarder in a Lycée Technique d'Etat (famed for its success rate in the Concours des Grandes Ecoles). Six years later (after one year of specialization in math and physics), I was admitted to the Ecole Nationale Supérieure des Arts et Métiers, an engineering school founded in 1780 by the Duke of Rochefoucauld-Liencourt, now known as Arts et Métiers ParisTech. The aim of their program is to provide students with a foundation in general engineering principles for the disciplines of mechanical, structural, electrical, and industrial engineering; it is very broad.

The last year in Paris we had to choose a specialization, and I chose electronics and automation. For my capstone project, I spent six months at BP's headquarters in Paris developing a predictive control system for a methane catalytic cracking unit for hydrogen production that was later implemented at a BP site in Lavera near Marseilles, France. After graduation, I was hired by Tioxide (a pigment manufacturer located in my hometown Calais, in Northern France) to



Guy Dumont and his wife, Andrée, trying to pass as locals while in Tokyo in 2016.

look into automating the control of TiO_2 rotary kilns. Realizing my limitations to solve this complex problem, I decided to further my education in control theory. After one year, I joined McGill University in Montreal, Canada, to pursue a Ph.D. under Pierre Bélanger's supervision. During my Ph.D. studies, I developed an adaptive control scheme for those rotary kilns that I successfully implemented. My control schemes—in various incarnations—remained in use in that plant for nearly 40 years. This was really the start of my fascination with control in general and adaptive control specifically. After completing my Ph.D. (and two years at Tioxide), I went back to Canada to work for the Pulp and Paper Research

Institute of Canada, a job that would then lead me to Vancouver and the University of British Columbia.

Q. What are some of your research interests?

Guy: For more than four decades, my research has been motivated by and focused on applications. The first two decades of my career were strongly focused on adaptive control and its applications to the process industries, especially pulp and papermaking processes. This is during that time that I developed Laguerre-based adaptive control algorithms for systems with variable time delay that led to the development of the Brainwave controller, now commercialized by Andritz Automation. I also worked extensively on the cross-directional control of paper machines in close collaboration with Honeywell Process Solutions, for which several of my graduate students went to work for. Even after joining academia, I remained strongly focused on applications of advanced control to the process industries.

Since 2000, I have refocused my efforts toward biomedical applications, primarily the closed-loop control of anesthesia. I started by developing a depth of hypnosis sensor called NeuroSense for use in a feedback loop (now commercialized in Canada and the European Union). We then used it to design a two-drug control system called iControl using robust control techniques that we successfully tested

in clinical trials. The commercial prototype of this will soon go through regulatory approval. For such safety-critical systems, I have become interested in safety-preserving control. For the multidrug, multiloop situation with potentially conflicting interests, we are currently investigating the use of game theory.

My interest in medical sensors has also led me to develop devices such as a low-cost pulse oximeter running off a smartphone as well as a novel ultra-wide band dc electroencephalography (EEG) system. The pulse oximeter has been used in a number of global health studies, for which we have developed indices to help frontline health workers screen, for example, for preeclampsia or pediatric pneumonia and sepsis. We currently use our EEG system to study epilepsy and have combined it with near-infrared spectrometry to estimate neurovascular coupling in preterm infants using system identification techniques. I also have a strong interest in closed-loop neurostimulation for patients affected by major deep depression and in stroke rehabilitation and have had discussions with clinician researchers (which I hope will lead to a project).

I also recently became interested in the noncontact physiological monitoring of preterm infants using RGB cameras and depth sensors. The ongoing sanitary crisis has prompted me to investigate the use of feedback to help health authorities plan their nonpharmaceutical interventions to manage the COVID-19 pandemic and convince epidemiologists and public health experts of its benefits. Also, in response to this crisis, I recently started to investigate the closed-loop control of oxygen therapy based on pulse oximetry to maximize clinical impact in COVID-19 treatment in low- and middle-income countries, where medical oxygen is a scarce resource.

Q. What courses do you teach relating to control? Do you have a favorite course? How would you describe your teaching style?

Profile of Guy A. Dumont

- *Current position:* distinguished university professor, associate member, School of Biomedical Engineering, University of British Columbia; principal investigator, BC Children's Hospital Research Institute; associate member, Department of Anesthesiology, Pharmacology and Therapeutics, UBC.
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- *IEEE Control Systems Society experience highlights:* general chair, 2nd IEEE Conference on Control Applications, Vancouver (1993); associate editor, *IEEE Transactions on Control Systems Technology* (January 1998–January 2001); guest editor, Special Issue on Control of Industrial Spatially Distributed, *IEEE Transactions on Control Systems Technology* (September 2003).
- *Notable awards:* IEEE Control Systems Society Honorable Paper Award (1978); Canadian Pulp and Paper Association Weldon Medal (1994); IEEE Control Systems Society Control Systems Technology Award (1998); NSERC Synergy Award for Innovation (1999, 2002, 2016); Canadian Society for Chemical Engineering DG Fisher Award (2003); Brockhouse Canada Prize for Interdisciplinary Research in Science and Engineering (2010); IEEE Life Fellow (2017); Fellow, IFAC (2016), Royal Society of Canada (2017); IEEE Control Systems Society Transition to Practice Award (2020).



(From right) Andrée and Guy Dumont enjoy predinner drinks with Jan and Robert Bitmead at the IEEE Conference on Control Technology and Applications in Hawaii in 2017.



Guy Dumont's ("Baba Guy's") attempt at drawing two of his grandchildren to combat boredom during the COVID-19 lockdown.

Guy: I regularly teach at the undergraduate level: either ELEC341 (our introductory control course) or ELEC441 (our senior control course). At the graduate level, I teach a course on adaptive control. In ELEC441, I spend a fair amount of time on Youla–Kucera parameterization, not only as an analytical tool but also as a design tool. I feel it not only provides a different way to look at control but also a powerful way to design for robustness and disturbance rejection in a more intuitive fashion. I particularly like my course on adaptive control, a topic that (after a long lull) has regained a lot of interest, particularly due to the attention machine learning has received in the last few years. While lately it looks like computer scientists have had the upper hand in this field, I believe control engineers still have fundamental contributions to make as they (more

than anyone else) understand dynamic systems; feedback theory; and the need for ensuring stability, robustness, and safety for those systems. In all my courses, I present a lot of applications, drawing from my 40-plus years of developing and implementing control systems in very diverse fields of application. I also try to convey my passion for the field, insisting on the fact that control is much more than applied mathematics. It is truly an exciting engineering discipline that can be applied everywhere.

Q. What are some of the most promising opportunities you see in the control field?

Guy: Control theory has matured a lot in the 48 years I have been working in the field. It is now omnipresent, although not always visible. These days, sensors can be embedded

everywhere, which opens up a vast array of possibilities in our vehicles, homes, and health care. My own involvement in biomedical engineering leads me to think that control has a big role to play (for instance, in smart prostheses, novel neurotherapies for epilepsy, Alzheimer's and Parkinson's diseases, and a number of neurological conditions). Closed-loop pharmacological interventions will also allow for truly personalized medicine, where the detected physiological effect is continuously modulating treatment to achieve the desired clinical effect despite enormous intersubject variability. Control engineers are in a unique position to understand complex dynamics and interactions that are all-too present in human physiology.

Q. What are some of your interests and activities outside of your professional career?

Guy: I normally like traveling, something that COVID-19 made impossible for over a year, so I am looking forward to this becoming possible again. Being a grandfather, I love spending time with my four grandkids. Otherwise, I love walking and swimming. Over the last year (after several decades), I have resumed playing the guitar, both electric and acoustic. An extra motivation for me is to keep up with my eight-year-old granddaughter, who has been taking guitar lessons for the last 18 months! I also started drawing lately, mostly portraiture and life drawings so far. Eventually, when I have more time on my hands, I hope to start painting.

Q. Thank you for your comments.

Guy: You are welcome. Thank you very much for this opportunity.