

Richard Boudreault

P.Phys., B.Sc., M. Eng., MBA, FRSC, HFRCGS, FCMOS, FlinstP, FCASI, FWAAS, FCAE, FIAA, AFAIAA, SMIEEEE, Adj. Prof. (É. Polytechnique and U. of Waterloo), Visiting Scholar (McGill)

Introduction and Summary

Richard Boudreault is a successful STEM serial entrepreneur and innovative C-level general management, innovation management and commercialization executive with professional board director/chairman governance experience and a 40-year track record of achievements in leadership roles with a deep interest and passion for the development and environment of northern and remote communities, focused on delivering and enhancing Canada's competitiveness.

A problem solver, he has held CEO, CTO, CRO (turnaround mandates) and top corporate positions within large and small entrepreneurial organizations, in both private and public sectors. Richard's notable experience is in Advanced Materials, Natural Resources/Metallurgy/Hydrocarbons, Clean Tech, Photonics, Medical Devices, Computer Simulation and Rendering, Energy & Nuclear, Big Data, Quantum Computation, Robotics, AI, and Aerospace sectors, and includes the authorship of 16 awarded patents and 68 more pending. He was involved with 8 private and 4 public successful ventures as a principal, as well as five national-level technologies-based centers of excellence.

Richard led 12 STEM ventures, all very successful, starting with floor value and raising them to c. billion dollars. His corporation's portfolio is divided in three tiers, the first tier went public in Canada, US, and overseas, the second and the largest, is composed of active and revenue generating corporations that were fused to larger international organizations of the likes of Microsoft, GE (2), Essilor, MDA and Textron. The last tier consists of private firms undergoing further development and growth. His median life-cycle residency with ventures and organizations is about 8 years with a one-year variance.

Engaged and a team builder, he served with purpose on more than 30 boards of directors, including public, private, and para-governmental/Crown Corporations, international airports, not-for profit boards, centers of excellence, and is currently active on 6 external BoDs. Serving principally as board chair, but he has deep and relevant experience on various board committees, such as audits, finance, and governance. Because of this extensive and wide experience base, he developed an extensive action-oriented Rolodex of valuable contacts in all ramifications of society, both in Canada and abroad.

Entrepreneur and Builder

Richard was engaged until recently with the Canadian Space Advisory Board for two ISED ministers. As a member of the SAB, he was key in securing the Radarsat satellite constellation, a prolongation of the space station mission extension to 2022 and the new TMT telescope funding. The Radarsat constellation is a primary Canadian Big Data tool for remote sensing and environmental research. Cumulating in a unique Big Science infrastructure development experience and savoir-faire.

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He was a staff scientist and system engineer for the Canadarm I and II and special purpose (ambi)dextrous manipulator (SPDM), now called Dexter, programs for the Canadian Space Agency. Was involved in STEAR technology programs for CSA dealing with advanced robotics systems and imagery for space applications. As well as being a PI on robotics maintenance of European Space Agency ORU and satellites servicing.

He is the CEO and Chair of Dymedso a Canadian private medical device corporation with a proprietary and unique technology for dislodging the excessive mucus production in lung ailments including those of pneumonia, Bronchitis COPD and infections such as the SARS, thus of COVID-19.

POLAR, a National Polar Agency

He is presently the inaugural Board Chair for the new Canadian polar agency—Polar Knowledge Canada (POLAR), an agency of INAC. At Polar, he is passionate about integrating Traditional Knowledge of First Nations and Inuit communities in current polar research, exploration, and science streams. The inclusion of Traditional Knowledge and Northerners is a true force multiplier for Arctic research and development. Polar is active in developing technologies and new environmental knowledge about the poles and with and for the Canadian Arctic. Dealing with permafrost thawing, sustainable infrastructure, energy storage and delivery. He is also focusing on the quickly occurring Climate Changes that principally affects the Arctic and the Northerner's firsts. Of the five top-global climate tipping points, of direct Canadian concern, 4 are in the Arctic and monitored by Polar.

During his mandate, Polar has completed a world-class quarter-of-billion-dollar CHARS Arctic research facility in Cambridge Bay, and was officially inaugurated in August 2019. A total federal investment of half billion dollars over 4 years. One of the great accomplishments of Polar is the co-development of an environmental technologist training program with the Arctic College, combining western and traditional knowledge, and graduating proud highly sought-after skilled specialists. Providing a source of Inuit specialists for hire by government departments with respect to the land claim agreement. POLAR has set up a biodiversity and ecological area, providing collaboration and data exchange with other circumpolar countries related to the impact of global changes. Also developed a food safety program related to the ecosystems impact of climate change on Inuit cultural land food.

At Polar, he is leading towards improving Northern research and higher learning with the NSTP. Using his skills in science diplomacy, he is bringing together the various national and international research communities, research stations, departments and vessels operating in the Canadian Arctic, to reach a higher level of efficiency through enhanced collaboration, national cohesion and maximize creativity. Polar developed its relationship with NASA under the ABoVE mission, it seeks a better understanding of the vulnerability and resilience of Boreal and Arctic ecosystems and for society to climatic changing environment. Polar has also formulated a northern entrepreneur program within its CHARS campus that attracts many first nations and Inuit incubates. Richard has been an invited lecturer on arctic issues widely in Canada and abroad. Polar is at the interface for circumpolar nation interface and collaborations, requiring his trusted well-honed geopolitical and scientific diplomacy skills. The BoD provides *gravitas*, *Savoir-Faire* and *Savoir-Être* to the agency and its executives.

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Recognized Engineer and Scientist

Prof. Boudreault is also an international authority on space engineering and science with more than 40 years' experience. He was the youngest to be raised fellow of the International Astronautics Academy and one of the first Canadian to be called. He has flown more than 18 missions related to remote sensing, extreme communication, optical communication, synthetic aperture radars, science instrumentation (HF and optical), microgravity material processing furnaces and crystallography. He was involved in many missions studying earth's upper atmosphere. Working on civilian and military applications. He created the aerospace engineering program and courses for the Canadian Military Colleges, including developing a robotics end-effector. He has worked for ESA, NASA, and CSA but also with the Swedish Space Corporation. He was a system engineer involved in the development and simulation of the Canadarm flown on the Shuttle, its version for the space station and the ambidextrous remote manipulator (Dexter). Worked with NASA on closed ecological life support system (ECLSS). He developed the Moon-Mars strategic plan for the Canadian Space Agency. Worked as a remote sensing consultant for CNES and participated to NASA's workshop on asteroid deflections as well as on in-situ resources utilization (ISRU) on the Moon, Mars, and asteroids. His research team at McGill is involved in oxygen production from lunar regolith and autonomous mining systems. Finally, he is a member the editorial board for *Space Policy*, an Elsevier journal.

Richard is also a recognized expert in quantum technologies, high performance computation, and communication. He serves as a consultant to governments on the development of an industry. He has initiated the Anyon quantum computing start-up which was a principal consultant to Google on crosstalk noise abatement, leading to the quantum Supremacy demonstration of a 53 qubits device and sold a Quantum Computing device to the Defense Research Board in Canada. He works on topologically quantum computers and has programmed 5-qubit computer computers provided by IBM. He collaborates with different groups internationally on quantum processors, simulators, and annealing devices as well as the associated government policies. He has developed a multimillion-dollar funded start-up in applied Quantum Chemistry, enabling immediately actionable solutions in Li-Ion batteries and atmospheric water extraction.

Academic Life

Richard is a full professor, with an adjunct status, at École Polytechnique in Montreal (ÉPM) where he teaches and performs applied research on environmental engineering, green chemistry, quantum chemistry and clean tech innovation. He his involved in developing nanotechnologies to generate low or no energy atmospheric water for remote location and First Nations and Inuit communities. His research team at ÉPM/McGill involves 6 faculties, 3 post-docs and two master's students in two universities. He collaborates with the U. de Sherbrooke in developing various tools to improve Northerner's life through a biodiversity research centre focused on the Arctic (computational and experimental) and on north—south ecological gradients and is active on the advisory board of a novel Bios2 Biodiversity postgraduate training program. Richard also leads an entropy-driven biodiversity modelling research program to further understand the impact of climate change on biodiversity and on northern ecological resilience. He is a member of the Ecological Society of America.

He is developing permafrost clathrate science and a natural gas clathrate-based energy transportation to provide low-carbon methane fuel to the northern communities. With the U. of Waterloo, he is developing an innovative technology to capture and extract methane emission off the melting permafrost craters and thermokast lakes, lowering the magnified impact of GHG on the Arctic environment, while providing a local low-carbon fuel source for Northerners.

He was also recently appointed as Professor Adj. (Full) in Earth Systems and Environmental Science at the U. of Waterloo, supervising graduate students. He was also engaged as Visiting Scholar at McGill University to develop, with upper class chemical engineering undergraduate students, environmental technology projects of importance as degree leading Capstone Theses. His team is a finalist in the Hatch Design Award competition in Canada representing McGill, with a novel way (methane hydrates) of transporting natural gas as a transition fuel to produce power in Nunatsiavut and Nunavik. The project can lead to production of power in the arctic at 1/10 of their actual production costs and significantly reduce the deposition of soot onto ice and snow within the Polar Vortex, slowing down the summer arctic ice melting climatic tipping point, while enhancing the economy of the high arctic. Prof. Boudreault is an award-winning faculty and loves teaching and coaching.

Richard Initiated a Ph.D at McGill with J. M. Hollerbach in surgery robotics application, before he transferred to Utah U. and where he became involved with Da Vinci medical surgery robotics. He became to later worked on Haptics technology with McGill and Humanware.

Governance Expertise and Service

He was, until recently, member of the Board of Directors of the public corporation Atomic Energy of Canada (AECL), an independent crown agency of NRCAN, and three committees, as well as the board and the audit committee of Mechtronix Systems Inc. The two mandates held on Atomic Energy of Canada's (AECL) BoD were both challenging and very rewarding in terms of exceptional experience. Mr. Boudreault was asked to prepare the transition of the highly regulated nuclear physics and energy sector crown corporation towards improved performance. Change management was required. The second Governor-in-Council (GiC) mandate resulted in the highly successful management of the crisis engendered from the emergency stopping the aging and leaking Chalk River research reactor, then the largest source of biomedical isotopes in the world, without international commotion through an open communication process with stakeholders and the public. The solution for the leak reactor repair was the development of a special purpose robotics system. The Real-Time Crisis and Communication Management experience at a national and international scale was second-to-none. The firm was then sold to SNC-Lavalin, maintaining the knowledge base and jobs in Canada. And the Chalk River Lab was transformed into a GOCO innovation centre aimed at spawning entrepreneurial ventures. He has also served Hydro-Québec and Ontario Hydro, as a consultant on power and energy transport and risk mitigation.

He was selected to serve as a Board appointment at the Institut National de la Recherche Scientifique (INRS) du Québec, a provincial agency. A hub of postgraduate research and educational research centres throughout Quebec. With major hubs in Earth and Water; Energy, Materials & Telecom; Health & Biotechnology; Society, Culture & Urban Studies.

He presently serves as Chair of the S&T oversight for the National Optical Institute of Quebec City (INO). Prior to that, he was Board member for the first formative years of the Non-Profit

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Organization. INO is the foremost industrially oriented research and development organization in Canada, financed by the two levels of government. Richard has been involved for 20 years with INO/NOI and has offices throughout Canada. A national treasure, receiving most of its funding from industry and its IP portfolio dividends. INO is a technology innovation facility with a strong entrepreneurial with many photonics spin-offs. It is said rightfully that INO is the reason for the full employment enjoyed by Quebec City.

Richard was key to the development of 5 national and international scale innovation centers-of-excellence in aerospace, optics, nuclear and in innovative future skills development. Including one in extreme environment with NFLD C-CORE at Memorial University funded jointly by the European and the Canadian agencies. He also provided expert report on industrial development for many provincial governments including Québec, Ontario, and Newfoundland.

The Future Skills Centre, a joint venture of the Conference Boards and Ryerson University, was created with an endowment of \$1/2B from Employment and Social Development Canada (ESDC), to develop new skills for Canada to maintain and increase national competitiveness. The center has a blue-ribbon board of advisors with leaders from academia, first nations, industry, not-for-profits, and government. Richard, a life-long learner, and teacher has responded to the call of the center's mission and purpose and is active within its Board of Advisors where he focusses on northern, first nations, data, and environmental issues.

He also serves on the board and the executive committee of the Sigma Xi, the Research Honor Society, and is the non-exec-director responsible for the international chapters of the organization. He was elected and serves on its Executive Board. Active on the advisory committee for the *American Scientist* magazine.

As a governor for the purposeful First Nations University of Canada located in Saskatchewan, he is dedicated to the land-based teaching approach and philosophy using traditional knowledge to re-center the students, enabling them to succeed as undergraduates. He is leading a concept for a new Boreal Forest Traditional Knowledge Conservancy Program. He serves on the executive and chairs of the Audit, Finance and Risk committee.

Canada's NSERC CREATE uses him as a subject matter expert for projects evaluation. He operates in sciences and technologies: optical physics, medical and bioengineering, robotics, aerospace, quantum computation and communication, astronomy, environment, energy, and ocean sectors. The CREATE program has been developed to prepare HQPs with career-ready education and in developing the entrepreneurial innovation spirit.

Executive Service and Entrepreneurship Experience

He presently leads, as the Executive Chairman and CEO of Dymedso, a radical innovation-based medical device corporation involved in pandemic-rated pulmonary medicine. Prior to that, he was Executive Chairman and Chief Technology Officer of Sigma Energy Storage. SES is a SME introducing remote markets of the north with a high-efficiency transportable grid and sub-grid level adiabatic heat and compressed air energy storage system, Arctic ready, with 25 years' life and high turnaround efficiency. The technology enables to save generator-dependent arctic remote communities, mines, and stations, with 70–80% of all their costly diesel uptake, thus improving the quality of life of Northerners while enhancing their economy. It has been

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commissioned by IESO to develop underground high-pressure storage cavity to enable grid level energy storage systems. The system is controlled by an AI deep-learning module tuned the energy storage market requirements of Northern Ontario's First Nations. Moreover, he served as a grid consultant for 4 ministers of energy in Quebec, Ontario, NB, NS and Nunavut about the integration of intermittent power on the grid, power mix, cost abatement and management and grid stability. He is a sought expert on remote and islanded micro-grids and their link to regional economic growth and energy sustainability.

Richard has recently created Awn Nanotech, an award-winning start-up corporation involved in no-to-low energy Atmospheric Water Generation. It has developed a quantum scale nanotech 3D textile that permits low energy and cost extraction of water from the atmosphere to supply industry and remote communities with clean potable water. The atmosphere's water content represents about twice of the water flowing in the planet's rivers at any point in time. The firm has already received an international national award for creativity in industry and the international Gold Stevie Award for the Start-Up of the year with a consumer market new product.

Prior to SES, he was CEO of Orbite Aluminae Inc. (TSX: ORT) from 2005–2014. A firm involved in developing a clean tech for the extraction of alumina and rare earths from various clays and mining tailings. Where he conceived, developed and patented an innovative metallurgical/chemical process enabling the clean production of alumina from various aluminous ores, the transformation of industrial and mining wastes (Red Mud, Fly Ash...) into a series of metallurgical (Al, Fe, Si, Ti, ...) and rare metals products including rare earths (REE) and rare metals (Ga, Sc, ...). Raised over \$140M of financing from institutional and government sources and directed a knowledge-based publicly traded start-up with a valuation circa 1B\$. He has received many awards for his work there, including the Green Chemistry award from the government of Québec and the Regional and National Innovation Award from the Canadian Research Council of Canada (IRAP).

Prior to 2004, he was Chief Restructuring Officer (CRO) of Pyrogenesis, a firm involved with the nanotechnology, biomedical devices and materials sectors turning municipal and shipping wastes-to-energy technology using plasma projections. During his career at Pyrogenesis, its nanotechnological medical device materials division was divested into Raymor and eventually sold to GE. The nanotubes were sold to Boeing for integration into B-787 wings rendering it a conductive structure countering lightning strike on a composite aerostructures.

Prior to his employment with Pyrogenesis, he was Vice-President of Corporate Strategy as well as Chief Technology Officer of ART (TSE : ARA), a publicly traded firm implicated in high-speed femtosecond fiber-optic bio-optical imagery with regards to *in vivo* detection of cancers and pharmaceutical dispersion applications. During his career, he has been involved with publicly traded files such as 5Nplus (semiconductors and photovoltaics, VNP), Softimage (acquired by MSFT), and private firms such as Mechtronix (in Mechatronics, the Flight Simulator Corporation was sold to Textron) and Visuaide (Technological aid to the visually handicapped) now named Humanware (world leader and merged with Essilor), developing Haptics Technology.

Throughout the years, Mr. Boudreault was actively involved, as an executive, in high-tech venture capital portfolio management, particularly regarding industrial application: sustainable energy, new materials, medical and transport industries of the Caisse de Dépôt et Placements du Quebec (CDPQ) one of the largest North American pension funds. Prior to joining Sofinov, a finance and

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innovation society of CDPO, he achieved many corporate leadership goals within the aerospace industry. He served as VC consultant and BoD member for multiple other funds in Canada. He presently serves on the Investment Board for the innovation-based VC fund Innovobot in Montréal.

Furthermore, he held a position as director within Swiss firm Oerlikon-Burhle, was also CEO and founder of Centre de Technologies Aérospatiales (CTA) research center, as well as the first professor of mechanical engineering at Sherbrooke University, lecturer at Ottawa U. and member of faculty in the physics dept. of at U of Waterloo. Richard was tasked with writing the first Moon-Mars strategy for CSA. He also produced the first study that led to the Radarsat mission and for COSPASS-SARSAT, an international satellite aimed at locating the ELT signature and position the origin of the emergency signal, resulting in thousands of lives saved in remote locations.

Richard has been involved in Natural Resources sustainable extraction. In mining with Orbite, and in many oil and gas recovery in the St-Laurence valley and in its Gulf. He is a recognized expert in coastal environment and petroleum spill recovery in northern and icing conditions. He worked with Petrolia and Jag Mines on oil and gas projects as a consultant and executive. He is a trained CSR and Sustainability professional with a specialty in coastal and wet environments.

Richard worked at CAE in flight simulation and canadarm robotics control systems.

International Experience

Mr. Boudreault has also held the position of simulation specialist with CAE. Throughout his illustrious career, he has worked within the fields of marketing, technology, and finance. He has studied, lived, and worked in the US, France, Germany, Switzerland, and Japan. He has taught and lectured at universities around the globe: The University of Sherbrooke, University of Ottawa, Royal Military College, Michigan Tech, Cornell University, U. Louis-Pasteur, MIT, AIAA, York University and the International Space University (ISU) have all welcomed Richard as a faculty and lecturer in low-gravity processing and space robotics.

Formal Education and Training

He holds an honours bachelor's degree specialized in applied Physics and earth systems science from University of Montreal, an MBA from University of Sherbrooke, as well as a professional master's degree in aerospace and mechanical engineering from Cornell University minoring in planetary science. He has pursued governance continuing education programs at MIT, HEC and Harvard, and he completed the IAS program for governance of crown corporations. To maintain his edge, he is recently completed further graduate school programs in environment, sustainability, and ecology (3 micro-programs at the postgraduate level) with the University of Sherbrooke and a certificate from MIT in Quantum Computing.

He is the originator of 86 patents standing and pending separated in *circa* twenty families, has published more than 54 learned scientific and technical articles, many of which were reviewed by peers. He is certified as a Professional Physicist in Canada.

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Internationally Recognized Expert

Mr. Boudreault is a Fellow of the Royal Society of Canada, of the Canadian Academy of Engineers, of the International Aeronautic Academy, and of the World Academy of Arts & Sciences. He is a member of *Sigma Xi*—the science honour society (more than 200 Nobel laureates are members), a Fellow of the Space and Aeronautic Institute of Canada and an Associate Fellow of the American Institute for Aeronautics and Astronautics and Senior Member of the US Institute for Electrical and Electronics Engineers (IEEE).

A finalist in the first Canadians Astronaut competition, he is a licensed pilot and served time in the Military. He is also an advanced scuba diver with a strong interest for Canada's nature, oceans and polar regions and was elevated to an Honorary Fellow of the Royal Canadian Geographic Society. He was awarded the Gold Medal of the RCGS for his achievements in the Arctic and was raised to the fellowship of the top Canadian national science academy, the Royal Society, in 2019. He was elevated by the Canadian Meteorological and Oceanography Society (CMOS) to Fellow for his work on atmosphere and ocean science in the Arctic, he is the chair of the industrial and executive of the Arctic focused groups.

He was awarded with Queen Elizabeth II Diamond Jubilee Medal for services to the nation and the Canadian Association of Physicist's Medal for Outstanding Service in Applied Photonics. Moreover, he was elevated to the grade of Fellow of the UK Institute of Physics (IoP).

He has been recognized in the US by *Photonics Spectra* as a *Beacon of the industry* in their August 2016 edition. Both of those latest ones were for industrial contribution of optical system to the medical device industry.

And, he is the first Canadian to be presented the George E. Pake award of the American Physical Society, in 2018, for research and innovation management excellence. He was awarded by the US IEEE-EMBS with Professional Career Achievement Award, at an international congress held in Germany in 2019.

He was Knighted into the Ordre des Palmes Académiques by France's President Macron in 2017 and decorated in a ceremony at INO in 2019, for his career achievements in higher education, innovation, and research management.

Civic Service and a Veteran

Finally, he is a veteran, trained as a Royal Military Engineer while serving in the armed forces and with UN Blue helmet forces. Military engineering is essentially civil engineering, thus building infrastructures, environmental stewardship, but performed in the wildest of environments and conditions. Providing him also much *realpolitik* leadership, inspirational, multicultural, and get-it-done skills. His management style is underlined by coaching. He has worked, studied, and lived in the US, Japan, France, and Germany. Richard is of First Nation descent, multilingual and multicultural, married, has three children, two dogs and lives in Montréal.

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