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POINT OF VIEW

Expanding Collaborations with Brazilian Scientists

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Based on data compiled by the International Monetary Fund and reports from the World Economic Outlook, Brazil currently enjoys the 9th largest economy in the world, edging out Canada by a fraction of a percentage point in Gross Domestic Product.[1] Achieving such a metric is a laudable feat and speaks to Brazil's richness in natural resources, the power of its industries, and the availability of a technologically competitive and educated workforce. Paradoxically, Brazil also possesses one of the most unequal economies in the world due to the persistent high poverty amongst many of its citizens. Changes to this situation will require continued pressure for investment in education, targeting science and technology to support development and protection of intellectual property (IP) emerging from academic and public research organizations. Protected IP, a recognized prime driver influencing today's economies, allows for innovation and improvements, driving global markets and societal benefits.[2,3] Interesting statistics[4] based on 2022 Scopus® data (an interactive search engine) place Brazil in position 17 (Canada at 14) internationally with respect to total publications in all areas of chemistry, rising to position 14 (and 18, respectively) when only publications related to analytical chemistry are considered and 16 (and 15, respectively) for the chemistry area pertaining to spectroscopy. Perhaps surprising to some, it is evident that Brazil is currently functioning at a relatively high level amongst its' technologically peer nations.

My first "awareness" of Brazil occurred in 1983, arising from a serendipitous meeting with the late Professor Adilson J. Curtius (PUC-RIO, UFRJ) as we both attended the 23rd Colloquium Spectroscopicum Internationale, convened in Amsterdam. He suggested I should give some future consideration to attending meetings in Brazil and remarked that he was contemplating organizing one focussed on GF-AAS (graphite furnace atomic absorption spectrometry) techniques, as this methodology was being heavily utilized for trace element analyses. True to his word, the "First Rio Symposium on Furnace Atomic Absorption Spectrometry" was convened at the PUC in Rio de Janeiro in September 1988. This was a first step, at that time, in overcoming the general difficulties that scientists from South America had in participating in international conferences, i.e., taking ownership of an international meeting organized within South America which would draw international participants to foster face-to-face discussions. This conference was an overwhelming success and paved the way for a continuing series of such meetings that gradually expanded in scientific content and culminated, most recently, with the 16th Rio Symposium on Atomic Spectrometry organized last year by Prof. Erico Flores in Bento Gonçalves, RS.

This 1st Rio meeting had a lasting impact on me as I experienced firsthand the passionate interest Brazilian analytical chemists had in establishing broader contacts and collaborations with their foreign counterparts, their open and pleasant disposition as hosts, and the varied geographic beauty of the country, all of which enticed me to return. Interrupted only by the COVID-19 pandemic years, I was fortunate to

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enjoy some 20 research-related visits spanning the past three decades, participating in all Brazilian Rio Symposia as well as other international meetings, including the 2011 XXXVII CSI, and several of those organized by the Brazilian Chemical Society such as ENQA, with its most recent 20th iteration convened in Bento Gonçalves. Equally enjoyable has been the honor of participating in Ph.D. defence proceedings and witnessing a progressive upswing in the capabilities in (analytical) chemistry throughout Brazil. During this time, some 13 visiting scientists undertook research in our Ottawa laboratories along with a half dozen sandwich Ph.D. students that I had the pleasure of mentoring. More recently, and since my formal retirement from the NRC in 2015, I have had the time and opportunity to take advantage of a number of unique opportunities to visit Brazil afforded by specific invitations supported by the Capes PRINT program, allowing stays of a minimum of 2 weeks to foster more in-depth interactions with professors and their students. I remain very grateful to the individuals who championed my nomination for these visits and shepherded the paperwork through the bureaucratic channels to turn them into first-rate successes.

It was *via* such visits that a solid network of research collaborations was established; the first tangible evidence being a joint publication in 1993,[5] which was followed by some 32 more between 1997 and present, all in international peer reviewed journals, as well as all the outcomes of mentoring Brazilian Ph.D. students or arising from visits of professors from academia or industry undertaking work in Ottawa.

The practice and teaching of analytical chemistry has long been scrutinized in various editorials highlighting its perceived weaknesses, including its often diminished position within academic departments.[6] One aspect, always underscored, but by no means unique to analytical chemistry, has been the benefits arising from collaborations. Much of modern science has, by necessity, become multidisciplinary in efforts to tackle ever more complex issues, requiring unique (and often expensive) facilities frequently unavailable in a single laboratory, as well as expertise spanning multiple disciplines to ensure success. Further, the generation of accurate, reproducible and robust results is often a given outcome from collaborative projects, enhancing the value of reported findings.[7] Among other benefits, collaborations increase productivity, generally decrease costs, broaden participants' knowledge, and shorten delivery times for publications, a win-win scenario for all involved. It is interesting to note that Richard Zare[6] has recently co-opted the international definition of metrology as "the science of measurement and its application"[8] to suggest that *analytical chemistry* be redefined as *the science of measurement* in an effort to raise awareness of the contributions of such activities to advancements in all areas of science so as to regain standing within the broader chemistry community. He further argues that "...we need more scientists working collaboratively, interacting with each other, and understanding exactly what it is we need to model and measure. Perhaps we could invite people who aren't "traditional" analytical chemists but have a connection with measurement....".

My experience, stemming from such interactions, is that capabilities and global collaborations have grown significantly in Brazil over the past three decades; continuity of this progress is contingent on continued government investments in education, science, and technology. Certainly, the activities of the BrJAC as an international portal for these accomplishments serve a complimentary role.

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Ralph Sturgeon received his Ph.D. in 1977 in analytical chemistry and has been with the NRC since that time. His interests lie in inorganic analytical chemistry, comprising trace element analysis, vapor generation, organometallic speciation, and Certified Reference Material production with a focus on atomic and mass spectrometry measurement techniques. He has published some 350 peer reviewed articles, several book chapters and edited two books. He served as Editor for *Spectrochimica Acta Reviews* for 16 years, is a member of the advisory board of a number of international analytical chemistry journals, and represented Canada's interests at the International Bureau for Weights and Measures where he participated in the working groups for both Inorganic Analysis as well as the Joint Committee on Traceability in Laboratory Medicine for 14 years. His contributions to the analytical sciences have been recognized through a number of awards and distinctions, including Fellowship in the Chemical Institute of Canada (1990) and the Royal Society of Chemistry (UK, 2012), the Barringer and Herzberg awards of the Spectroscopy Society of Canada, the McBryde Medal from the Chemical Institute of Canada, the Ioannes Marcus Marci award of the Czech Spectroscopic Society, the Maxxam Award of the Chemical Institute of Canada, and the Lester W. Strock medal from the Society of Applied Spectroscopy (US). Most recently, he shared an Outstanding Achievement Award from the NRC (Research and Technology Breakthrough Award, 2022) in recognition of work in mass spectrometry. He holds three patents relating to sample introduction for atomic spectroscopy.