

Careers and Contributions of George Sinclair and Edward Jordan: From the University of Alberta to the Origins of EMTS on Its 60th Anniversary

Ashwin K. Iyer

Abstract – Although preceded by the 1953 Symposium on Microwave Optics held in Montreal, Canada, and the 1955 Symposium on Electromagnetic Wave Theory held in Ann Arbor, Michigan, USA, it was the 1959 Electromagnetic Theory Symposium (EMTS) held in Toronto, Canada, that established the triennial EMTS series that continues to this day. This meeting was organized by George Sinclair and attended by several well-known researchers and educators of the time, including Sinclair’s close friend and colleague Edward C. Jordan. Sinclair and Jordan followed similar early careers that took them from their home town of Edmonton, Canada, where they obtained their B.Sc. and M.Sc. degrees at the University of Alberta amid the Great Depression, to the Ohio State University (OSU) in Columbus for their doctoral studies. At OSU they were instrumental in the development of the Antenna Laboratory (now the ElectroScience Laboratory). They moved on to independent academic careers at the University of Toronto and the University of Illinois at Urbana-Champaign, respectively, where they established now-renowned antenna-research facilities and educational programs in electromagnetics. The 2019 URSI EMTS held recently in San Diego, California, USA, marked the 60th anniversary of the 1959 EMTS meeting. In tribute to this event, and following from the author’s presentation on the topic at the 2019 URSI EMTS, this paper presents a brief historical summary of the careers of Sinclair and Jordan and their contributions to the landscape of antenna research and education in North America.

1. Foundations at the University of Alberta

The University of Alberta was established in 1908 in the provincial capital city of Edmonton, Alberta, Canada, a few hours east of the Canadian Rocky Mountains. Like many schools of the time, electrical engineering (EE) was a division of its Department of Physics within its School of Applied Science, founded in 1913 [1]. The school’s first professor of EE was Prof. Hector J. MacLeod, a graduate alumnus of the University of Alberta, who was hired in 1914 shortly after he obtained his Ph.D. from Harvard University for

early experimental studies of the frequency response of dielectric loss up to 1 MHz (work that was referenced by Cole and Cole in their seminal paper [2]). By the early 1930s, the EE division was graduating approximately seven students per year, and the University of Alberta was one of the few Canadian schools actively offering engineering courses in radio and operating one of the earliest radio stations for educational broadcasting, using the call letters CKUA [3, 4]. CKUA employed a 500 W transmitter broadcasting at 580 kHz using two 20 ft mast radiators placed atop windmill towers. Its programming was intended to be educational in nature and consisted of lectures, music, and variety programs directed toward the rural communities of Alberta [5]. It was during this time, at the beginning of the Great Depression, that the EE division would count among its graduates a young George Sinclair and Edward Jordan. Their ensuing careers and outlook on antenna research and education would be greatly influenced by their formative experiences at the University of Alberta.

Edward Conrad Jordan was born in Edmonton on December 31, 1910. After completing his public- and high-school education, the 17-year-old Jordan was hired by the University of Alberta as the first operator of CKUA following its acquisition by the university through a provincial grant. A 1932 photograph of the CKUA control room operated by Jordan is shown in Figure 1. While serving in this role, Jordan displayed an uncanny talent for electronics; he invented the first automatic gain control circuit for radio broadcasts and designed his own hearing aid [6]. He served in this position until 1935 to support himself while he earned his B.Sc. and M.Sc. degrees in EE from the University of Alberta in 1934 and 1936, respectively. His M.Sc. thesis was entitled “Automatic Gain Control for a Broadcast Amplifier” and was conducted under the supervision of MacLeod [7].

Another notable student of MacLeod and a contemporary of Jordan was George Sinclair. Born in Hamilton, Ontario, Canada, on November 5, 1912, Sinclair moved to Edmonton at a very early age, where he completed his public- and high-school education before entering the University of Alberta as an undergraduate student in 1929. He received his B.Sc. and M.Sc. degrees in EE in 1933 and 1935, respectively. His M.Sc. thesis was entitled “The Determination of the Constants of an Ungrounded Antenna System” [8].

The B.Sc. graduation photos of Sinclair and Jordan, which now hang in the Department of Electrical

Manuscript received 6 January 2020.

Ashwin K. Iyer is with the Department of Electrical and Computer Engineering at the University of Alberta, 11-203 Donadeo Innovation Centre for Engineering, 9211-116 Street NW Edmonton, Alberta T6G 1H9, Canada; e-mail: iyer@ece.ualberta.ca.



Figure 1. CKUA control room in 1932. Reproduced from [3].

and Computer Engineering at the University of Alberta, are shown in Figure 2.

2. Doctoral Studies and Establishment of the Antenna Laboratory at the Ohio State University

Although Jordan sought a position in the electronics industry following the completion of his M.Sc. degree, the diminished opportunities of the Great Depression led him instead to the nickel mines of Sudbury, Ontario, Canada, where he worked as an electric power engineer until 1937. Thereafter, Jordan set out to pursue his Ph.D. degree at the Ohio State University (OSU) in Columbus, Ohio, USA, under the guidance of Prof. William L. Everitt. Jordan received his Ph.D. in 1940 for studies of acoustic models of radio antennas. His natural inclination toward engineering education led him to a one-year teaching assignment at Worcester Polytechnic Institute, Worcester, Massachusetts, USA, following which he returned to OSU to join its EE faculty, first as an instructor and eventually as an assistant professor [6, 10].

The author was not able to find any information about Sinclair's activities between 1935, when he obtained his M.Sc. at the University of Alberta, and 1939, when he, too, arrived at OSU to pursue his Ph.D. under Everitt. Sinclair investigated the radiation characteristics of antennas mounted on aircraft and other vehicles using 20-40 \times miniaturized scale models, for

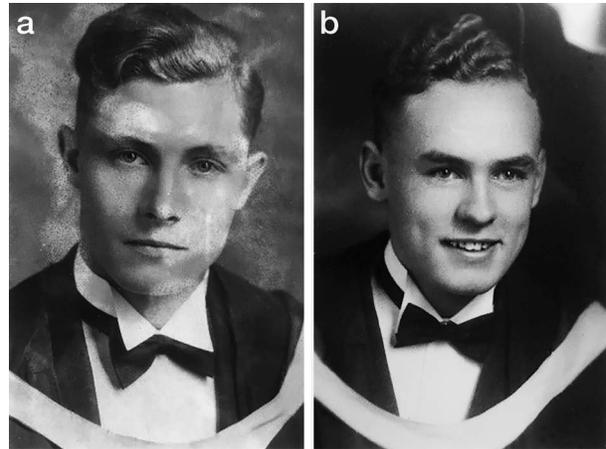


Figure 2. University of Alberta B.Sc. graduation portraits of (a) Edward Jordan (1934) and (b) George Sinclair (1933) displayed in the University of Alberta's Department of Electrical and Computer Engineering [9].

which measurements could be performed at correspondingly up-scaled frequencies [11]. To eliminate the requirement for cables to retrieve the signal from the antenna-under-test (AUT) and simultaneously circumvent the unavailability of radio transmitters at the up-scaled frequencies, Sinclair invented a method of modulating the scattered fields of the AUT in an approach that is akin to modern RFID [12]. In fact, Sinclair and Jordan collaborated on some of these scale-model studies [13]. The first such scale-model aircraft-antenna measurement setup at OSU is shown in Figure 3 [14].

The relevance of Sinclair's and Everitt's research to the impending war effort drew the attention of the US Army Air Corps (now the US Air Force), resulting in a contract to measure the radar signatures of aircraft and tanks. After the USA joined World War II in 1941, Everitt was assigned to direct operations research for the US Signal Corps in Washington, D.C., leaving only

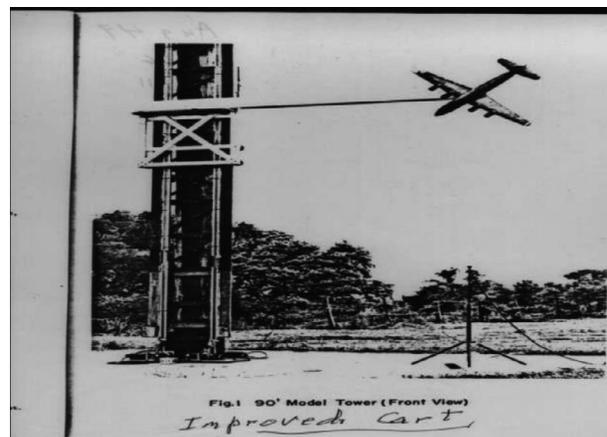


Figure 3. First scale-model antenna measurement at Ohio State University. Reproduced from [14].

Sinclair and Jordan to manage OSU's antenna research and teaching activities. Sinclair was made responsible for research activities and fulfilling the US Army Air Corps contract, whereas Jordan, who was by this time an assistant professor, was tasked with supervision of laboratory staff. Jordan additionally assumed responsibility for all of Everitt's courses in electromagnetic theory and electrical communication, and concurrent with this heavy teaching load he provided assistance to Sinclair in managing the laboratory's affairs [15].

The US Army Air Corps contract brought state-of-the-art equipment and expertise to OSU, which Sinclair saw as an opportunity to develop a world-class antenna-research facility. Thus was established the OSU Antenna Laboratory (now the ElectroScience Laboratory). Sinclair, while still pursuing his doctoral degree, remained the founding director of the laboratory until 1946, by which time it had grown to employ 50 staff [14, 15]. Sinclair received his Ph.D. degree the same year.

3. Post-OSU: UIUC and the University of Toronto

After the end of the war, Everitt assumed the position of head of the Department of EE at the University of Illinois at Urbana-Champaign (UIUC). Jordan, who saw Everitt as both a mentor and friend, decided also to join UIUC as an associate professor in 1945 and was promoted to the rank of professor in 1947. He eventually became the head of the department in 1954 and remained in this position for 25 years until his retirement in 1979, by which time he had signed over 600 Ph.D. theses and established the department as the largest in the USA, with 100 professors and producing the largest annual complement of EE undergraduates and graduates. During this period, Jordan founded the UIUC Radio Direction Finding Laboratory, serving as its director from 1946 to 1954, and he assumed leadership of the UIUC Antenna Research Laboratory from 1950 to 1954. He was successful in attracting several notable researchers to UIUC, including V. Rumsey, P. Mayes, J. Dyson, R. C. Hansen, R. DuHamel, Y. T. Lo, R. Mittra, and G. A. Deschamps [16]. He authored or edited nine books, including his most popular textbook, *Electromagnetic Waves and Radiating Systems*, whose first edition was published in 1950 shortly after his arrival at UIUC. A second edition of the book was co-authored with his student Keith G. Balmain and released in 1968; it quickly became a classic text, recognized as a gold standard for the elucidation of several intricate antenna concepts. Jordan received many honors and awards. He was elected a fellow of the National Academy of Engineering (NAE) and the Institute of Radio Engineers (the precursor to today's Institute of Electrical and Electronics Engineers or IEEE). He was also a member of the US National Committee of Union Radio-Scientifique Internationale (URSI) and a chair of the Commission VI (later, Commission B). Some of his other notable awards

include the prestigious IEEE Education and Centennial medals, the Stanley H. Pierce and Alumni Honor awards from UIUC, the George Sinclair award from OSU, and the Professional Achievement award from the University of Alberta [10].

Sinclair decided to move back to Ontario, Canada, after completing his Ph.D. degree. There he was appointed a professor in the Department of Electrical Engineering at the University of Toronto, where he pursued an equally remarkable research career in areas such as slotted cylindrical antennas and integral-equation formulations for numerical solution of scattering problems. He established the University of Toronto Antenna Laboratory and championed major research initiatives in radio astronomy, and he is also credited with establishing the first Ph.D. EE program in Canada. During this time, Sinclair guided several illustrious students, including J. R. Wait, J. Allen Yen, R. Mittra, and L. Shafai. In 1951 Sinclair founded his own company, Sinclair Radio Laboratories Ltd., which is currently known as Sinclair Technologies and is based in the nearby town of Aurora, Ontario. He was very active in URSI, for which he served as the chairman of the Canadian Commission VI, and he was also involved with activities of the Canadian Institute for Radio Engineers (IRE). Sinclair, too, was the recipient of numerous honors, including being named a fellow of the IRE, the American Association for the Advancements of Science (AAAS), the Royal Society of Canada (RSC), and the Canadian Academy of Engineering (CAE). He was also awarded the Distinguished Alumnus award from OSU, the IEEE Canada McNaughton gold medal, and the Professional Achievement award from the University of Alberta [11, 17].

4. Sinclair, Jordan, and the Beginnings of URSI EMTS

The idea for a conference devoted to electromagnetic theory was born from discussions between Sinclair, G. A. Wootton (McGill University, Montreal, Canada), and R. C. Spencer (USAF Cambridge Research Centre, Bedford, MA, USA) during the 1952 URSI General Assembly held in Sydney, Australia [18]. The first such conference, named the Symposium on Microwave Optics, was organized the following year by Wootton at McGill University in Montreal (this is often incorrectly given as Toronto on several URSI websites). This meeting was cosponsored by the URSI US and Canadian national committees' Commission VI, but notably not sponsored by the URSI International Commission VI. The next installment, which was sponsored by the International Commission VI, was organized by K. M. Siegel at the University of Michigan, Ann Arbor, in 1955 and was called the Symposium on Electromagnetic Wave Theory. The 1953 and 1955 meetings were the precursors of what is known today as the URSI Electromagnetic Theory Symposium (EMTS). The first URSI EMTS was organized by Sinclair and Wait at the University of



Figure 4. George Sinclair opening the first URSI EMTS at the University of Toronto in 1959. Reproduced from [20].

Toronto in 1959, with Jordan placed in charge of the conference proceedings. Figure 4 shows Sinclair delivering his opening speech, and Figure 5 shows Jordan absorbed in technical discussions during the conference. This landmark meeting established the triennial series that continues to this day, with its most recent installment in San Diego in 2019 marking its 60th anniversary [Dr. Ross Stone, e-mail messages to author, 30 October to 1 November 2018; 19].

5. Conclusion

This paper pays tribute to two bright lights in the early evolution of antenna research and education [9] by tracing the careers and contributions of George Sinclair and Edward Jordan. Their interest in antennas took flight at the University of Alberta in the midst of the Great Depression and led them down similar paths: to OSU for doctoral studies, and then to illustrious independent careers in which they established them-



Figure 5. Samuel Silver (left) and Edward Jordan (right) during the first URSI EMTS in 1959. Reproduced from [20].

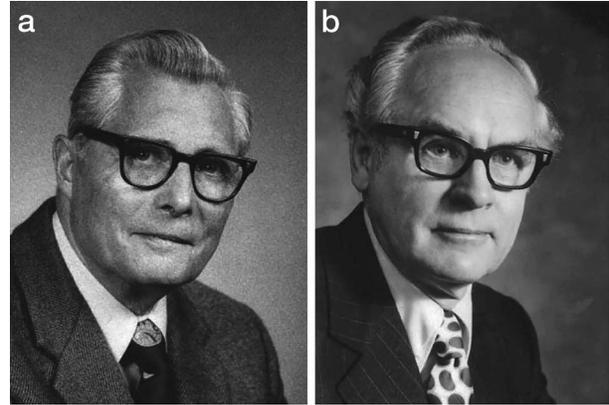


Figure 6. (a) Edward Jordan and (b) George Sinclair in their later years. Reproduced from [6] and [14], respectively.

selves as brilliant educators and researchers. In founding the OSU, UIUC, and University of Toronto Antenna Laboratories and producing a cascade of brilliant students and researchers, they bestowed a legacy that would shape the development of antenna research and education in North America. Finally, they were instrumental in establishing the triennial URSI EMTS series, whose 60th anniversary was marked by the most recent URSI EMTS meeting in San Diego in 2019.

6. References

1. G. Samuel, "An Early History of the U of A," *Edmonton Journal* (Winter 1953), reprinted in the University of Alberta Alumni Association, *History Trails*, <https://sites.ualberta.ca/ALUMNI/history/founding/53winhist.htm> (Accessed 22 March 2020).
2. K. S. Cole and R. H. Cole, "Dispersion and Absorption in Dielectrics I: Alternating Current Characteristics," *Journal of Chemical Physics*, **9**, 4, 1941, pp. 341–351.
3. A. M. Rebus, "Treasures from The Vault—H. P. Brown: Founder Innovator Altruist," *CKUA*, <https://ckua.com/read/h-p-brown/> (Accessed March 22, 2020). Photo reproduced with permission from Provincial Archives of Alberta, Object No. A8335 (March 1932).
4. E. C. Jordan, "Recollections of CKUA," University of Alberta Alumni Association, *History Trails*, Summer 1987, <https://sites.ualberta.ca/ALUMNI/history/faculties/87sumckua.htm> (Accessed 22 March 2020).
5. "History of Canadian Broadcasting: CKUA-AM," Canadian Communications Foundation, http://www.broadcasting-history.ca/listing_and_histories/radio/ckua-am (Accessed 22 March 2020).
6. T. C. Jordan, "Eulogy for Edward C. Jordan," in E. C. Jordan, M. E. Van Valkenburg, and W. Miller (eds.), *Centennial History of the Department of Electrical and Computer Engineering: 1891–1991*, Urbana, IL, College of Engineering, University of Illinois at Urbana-Champaign, 1991, pp. iii–v.
7. E. C. Jordan, "Automatic Gain Control for a Broadcast Amplifier," *Internet Archive* (2017), <https://archive.org/details/jordan1935> (Accessed 22 March 2020).
8. G. Sinclair, "The Determination of the Constants of an Ungrounded Antenna System," *Internet Archive* (2017),

- <https://archive.org/details/sinclair1935> (Accessed 22 March 2020).
9. A. K. Iyer, "From the University of Alberta to the Beginnings of EMTS: Contributions of George Sinclair and Edward Jordan to Antenna Education," presented in the Special Session: History of Electromagnetics at the URSI Commission B International Symposium on Electromagnetic Theory (EMTS 2019), San Diego, CA, May 27–31, 2019.
 10. G. W. Swenson Jr., "Edward Conrad Jordan," in *Memorial Tributes: National Academy of Engineering*, Washington, DC, National Academy Press, 1993, **6**, pp. 97–101.
 11. K. G. Balmain, "In Memoriam: Professor George Sinclair—1912–1993," *Physics in Canada/La Physique au Canada*, **49**, 6, November 1993, pp. 317–318.
 12. P. H. Pathak, "Origins of RFID Concepts in Early Wireless-Based Scale Model Airborne Antenna Pattern Measurements," 2012 IEEE International Conference on Wireless Information Technology and Systems (IC-WITS), Maui, HI, 2012, pp. 1–4.
 13. G. Sinclair, E. C. Jordan, and E. W. Vaughan, "Measurement of Aircraft-Antenna Patterns Using Models," *Proceedings of the IRE*, **35**, 12, December 1947, pp. 1451–1462.
 14. J. L. Volakis, "ElectroScience Laboratory: How It All Began, and a Walk-Through Its History," https://electroscience.osu.edu/sites/electroscience.osu.edu/files/uploads/about/History/electroscience_lab_history.pdf (Accessed 22 March 2020).
 15. The Ohio State University. "ElectroScience Lab Directors," <https://electroscience.osu.edu/ElectroSciencelab-directors> (Accessed 22 March 2020).
 16. "Chapter 4—Research Laboratories," in E. C. Jordan, M. E. Van Valkenburg, and W. Miller (eds.), *Centennial History of the Department of Electrical and Computer Engineering: 1891–1991*, Urbana, IL, College of Engineering, University of Illinois at Urbana-Champaign, 1991, pp. 27–35.
 17. "G. Sinclair, Director, 1960–1962," *Proceedings of the IRE*, **48**, 12, December 1960, p. 1950.
 18. T. B. A. Senior, "The Commission B Electromagnetic Theory Symposia," *IEEE Antennas and Propagation Magazine*, **35**, 6, December 1993, pp. 26–28.
 19. V. Twersky, "Electromagnetic Waves: A Conference Report," *Physics Today*, **13**, 7, July 1960, pp. 30–36.