Early Women of Radio and Electrical Science [Historically Speaking] [Women in Engineering]

Trevor S. Bird Francesca Vipiana

Early Women of Radio and Electrical Science

This article looks at the careers of some pioneer women in radio and electrical sciences who were active within the hundred years of Hertz's verification of Maxwell's equations. Of the seven women chosen here, most were subject to major discrimination, even at universities or in the workplace, due to either being married or just being women. In many cases, their talent was recognized early, and they were put on the right path to achieve what they did. My intention is to concentrate on women in radio and electrical science who were first to achieve something that was productive or led to research so that they made it easier for other women who followed. Seven remarkable women are identified whose work had lasting impact.

INTRODUCTION

In a recent column [1], I mentioned the work of Elizabeth Alexander concerning the unraveling of the Norfolk Island effect that raised the possibility of solar radio astronomy. This prompted a closer look at pioneer women in radio and electrical sciences. In this article, I intend to mention some women who were the first in some way to break through in their field. There are many candidates outside radio and electrical science, including the Hollywood movie actor Hedy Lamarr, who filed a patent on spread spectrum and frequency hopping technology, the concept of which is still used today. In 1941 when it was filed, Lamarr was married to the second of her six husbands, and, for credibility, she chose to use her married name on the patent [2].

Due to space limitations, this article concentrates on seven remarkable women researchers in radio and electrical science whose work had lasting impact. Except in one case, I have limited the field to those making their major contributions before 1970, that is, within the 100 years of Maxwell's equations appearing in a textbook as 20 partial differential equations in 1873 and Maxwell's death in 1879. A more detailed investigation is beyond what is possible here.

EDITORS' NOTE

This month's column is prepared in conjunction with the "Women in Engineering" column. It celebrates the contributions of some pioneering women in the wider field of radio science. It became apparent when the column editor was researching material for the "Historically Speaking" column that there had been many important contributions by women scientists in our field. These contributions often used antennas and propagation or created new areas that required better knowledge of antennas and propagation, such as in radio astronomy and interstellar radar observations. The article in the "Historically Speaking" column this month describes the contributions to radio science of seven women scientists. Some of them may be well known to some readers, but, for others, information was scarce. Even when drafting the article, there was one scientist for whom there was material available online but scattered among many documents. Even from this basic information, to get a fuller picture, we had to approach her immediate family. For instigating this, I am very grateful for the help of Dr. Nina Baker from *Women in Technology* (https://www.womenintech.co.uk/women-in-engineering).

I was hoping to have the article ready for International Women's Day last March, but, alas, due to other commitments and delays, this proved impossible to achieve. Nonetheless, the article this month in "Historically Speaking" and "Women in Engineering" identifies, for the first time, some early pioneering women in radio science, some of whom had an impact on our field. These were sometimes in areas, such as radar, radio astronomy, and mathematical tables, where unique contributions were made that allowed antennas to be designed or utilized antennas with particular characteristics. My hope is that the article stimulates further investigations of other pioneering women in radio science and in antennas and propagation in particular.

Digital Object Identifier 10.1109/MAP.2022.3197958
Date of current version: 6 October 2022

1045-9243/22©2022IEEE

Readers are invited to contribute articles to future columns on other pioneering women of radio science.

SEVEN REMARKABLE WOMEN

SCIENTIST OF ELECTRIC ARCS

One of the earliest women engineers in electrical technology was Hertha Ayrton (born Phoebe Sarah Marks) (1854–1923) [3]. She was a physicist, mathematician, and inventor [see Figure 1(a)]. As a teen, she showed considerable talent, and, through her involvement in the suffragette movement, the author George Eliot supported her application to attend Girton College, Cambridge, to study mathematics. Girton College at the time had been recently established for women. As an undergraduate, her studies were very successful, and she passed the difficult Mathematical Tripos, but Cambridge did not grant her an academic degree because it did not award full degrees to women at the time. In 1880, she passed an external examination at the University of London, and she was awarded a bachelor of science degree. Afterward, she taught in London and, for recreation, did mathematical puzzles. She had a patent granted in 1884 for a line divider, which enables the division of a line into any number of equal parts. This is used for enlarging and reducing figures. She also attended evening classes on electricity delivered by William Ayrton, a pioneer in electrical engineering and physics education and a Fellow of the Royal Society, whom she married in 1885. Thereafter, she assisted William with experiments in physics and electricity and became an experimentalist, which she used to considerable effect in later work.

Their first child, Barbara, was born in 1886. Barbara later became a suffragette and a member of parliament. A little later, Hertha Ayrton began independent studies on electric arcs [4]. In 1902, she published the book *The Electric Arc* [5], which states in its preface that it "owes its origin to a series of articles published in The Electrician in 1895-86." This book is now a classic that is still available for sale today. It established her reputation in the field of electrical engineering. In her book, she explains that the arcs were the result of oxygen coming into contact with the carbon rods used in the process. This work on electric arcs and Ayrton's image has inspired artists, such as the one shown in Figure 1(b).

In 1899, she was the first woman ever to present her own paper before the Institution of Electrical Engineers (IEE). Shortly afterward, Ayrton was elected a full member of IEE, the first woman member until 1958; hence, she was a pioneer for more than half a century. She studied wave motion in fluids and the formation of ridges in the sand below the oscillating fluid [6], [7]. She was the first woman awarded the Hughes Medal of the Royal Society in 1906 for her work on the motion of ripples in sand and water and her work on the electric arc. She was the fifth recipient of this prize, awarded annually since 1902, in recognition of an original discovery in the physical sciences, particularly electricity and magnetism or their applications. She was the only woman so honored for over 100 years. It is relevant to note that the paper [6] was based on earlier work by Lord Rayleigh and was communicated to the Royal Society in December 1907 by J. H. Poynting, Fellow of the Royal Society (FRS), both of whom are well known in electromagnetics.

Ayrton was nominated as a FRS the Royal Society in 1902. However, her nomination was rejected by the Council of the Royal Society, who decreed that married women were ineligible to be Fellows. However, in 1904, she became the first woman to read a paper before the Royal Society, which was later published in 1906 [7]. Six papers were presented before the Royal Society during her lifetime, and one posthumously. Her interest in vortices in water and air inspired the Ayrton fan, or "flapper," which was used in the trenches during the First World War to disperse poison and foul gases [8]. The Ayrton fan [9] was made of waterproof canvas stiffened with cane, with a wooden handle. It was about 80 cm long and weighed less than half a kilogram, which enabled it to be folded and easily carried in a soldier's backpack. More than 100,000 of these fans were manufactured. A lifelong friend endowed the Hertha Ayrton Research Fellowship at Girton College, which continues to the present day. Ayrton's house in London received an English Heritage blue plaque in 2007 [3].

(a) (b)

FIGURE 1. Hertha Aryton. (a) A pioneering scientist, who died in 1923. (Source: Manchester Guardian archive. Photograph: https://www.alamy.com/stock-photo/hertha-ayrton.html [3]; used with permission.) (b) A present-day artist's depiction. [Reprinted with permission of George Doutsiopoulos, creator of STEM: Epic Heroes (https://mythiclab.com/collections/card-game-puzzles).]

WIRELESS SIGNALER

The Australian radio technician Florence Violet McKenzie, Order of the British Empire (OBE) (neé Wallace) (1890–1982) had an enormous impact as a signals trainer, electrical contractor,

and experimenter with television [10]. She enrolled in the science faculty at the University of Sydney in 1915, but, because of financial difficulties, she was unable to complete her studies. Having a keen interest in electricity, she attended classes in electrical engineering at Sydney Technical College. She graduated in 1923 with a diploma—probably the first woman in Australia to receive this qualification. Remarkably, McKenzie ran a radio sales and repair shop in Sydney while she was studying. In 1924, she married Cecil McKenzie, an electrical engineer. At the same time, she became Australia's first female certificated radio telegraphist, the first female member of the Wireless Institute of Australia, and the first woman in Australia to hold an amateur wireless license (Figure 2).

In 1934, she founded the Electrical Association for Women (EAW) (Australia), where women could learn to use an electric kitchen and modern appliances at meetings and lectures. She published a book on electricity for children [11] and numerous articles on electrical safety, all under the EAW. As noted in [9], McKenzie had a wide correspondence, including with Albert Einstein [on his 74th birthday, as reported in the *Sun* (Sydney) newspaper, 11 March 1953, p. 1].

With the Pacific war coming ever closer to Australia, in 1939, McKenzie and her husband formed the Women's Emergency Signaling Corps (WESC), as she foresaw a need for trained female wireless telegraphists. In 1941, she persuaded the Navy to accept 14 of her operators for the service. These women formed the nucleus of the new Women's Royal Australian Naval Service. Meanwhile, the role of the WESC was expanded to include pre-enlistment signals training for Australian servicemembers, men and women, and continuing instruction for American personnel. By August 1945, her school had trained some 12,000 people in Morse code, visual signaling, and international code. For her service to Australia, McKenzie was awarded the OBE. She closed her school in 1955.

INSTIGATOR OF SOLAR RADIO ASTRONOMY

Earlier, I referred to Dr. Elizabeth Alexander, a British geologist, academic, and physicist, whose wartime work with radar and radio led to early developments in solar radio astronomy. Her full name was Frances Elizabeth Somerville Alexander (née Caldwell) (1908–1958) [12]. She is also known for her work on the geology of Singapore, which she started in the early 1940s and is considered to be significant foundation research in the area.

Alexander earned her Ph.D. degree from Newnham College, Cambridge, most likely when the photo in Figure 3 was taken. Shortly after, she worked in radio direction finding at Singapore Naval Base from 1938 to 1941, where she held the rank of captain. In January 1941, she and her three children were repatriated to New Zealand, where she became head of operations research in New Zealand's Radio Development Lab, Wellington. In New Zealand, due to her previous experience with solar effects in geology, she correctly interpreted that the noise effect on radar signals at stations located on Norfolk Island was caused by the sun.

This interpretation led to pioneering work in the field of solar radio astronomy, making her one of the first female scientists to work in that field. She authored a report on the effect in 1945 [13], and some of this was summarized in a later paper [14]. Although she corresponded with the Division of Radiophysics in Australia, which had observed a similar effect, she submitted a paper to *Nature* [15] that was rejected and the work did not receive the credit that was due.

FIGURE 2. Florence McKenzie signaling by wireless. (Reprinted with permission of the Women's Museum Australia.)

FIGURE 3. Frances Elizabeth Somerville (Caldwell) Alexander (1908–1958), circa 1936. [Printed with permission of WikiTree (https://www.wikitree.com/wiki/Caldwell-4783).]

ENGINEER IN GUIDED WAVES

A very fine paper I personally became aware of during my master's degree studies is one by Alice M. Woodward, Master of Arts (MA). This paper was published in 1947 and was one of the first papers on dielectric-loaded waveguides [16]. At the time, she was at the Telecommunications Research Establishment (TRE), which included radar research for the Royal Air Force. She detailed the field solution for a slab-loaded rectangular waveguide. This structure is used in microwave components and feed horns. The advantage as a feed the field..., the field in the central region can be made almost uniform with the appropriate thickness of the dielectric slabs [17]. Her paper included results for dielectric loss to second-order approximation and wall losses. One conclusion was that above the cutoff, the attenuation of the H_{01} mode increased with the slab width, although it had a similarly sloped asymptote with increasing frequency.

This paper was based on a TRE report completed in October 1941 [18], but—most likely due to secrecy—the material was not published until later. Through this, Woodward missed priority on being the first to publish on the dielectric-loaded waveguide, which was done by Pincherle [19] at King's College, London, in 1944. Incidentally, they became colleagues at TRE, and later published a report together on photodiffusion effects in germanium. Nevertheless, her 1947 paper is listed under significant progress in a summary of the year in *Proceedings of the Institute of Radio Engineers* [20].

FIGURE 4. Alice M.W. Robertson (far left) at Madras College, St Andrews, in June 1935 with other senior students. (Source: http://www.madrascollegearchive.org.uk/pupils2.htm; used with permission.)

It was revealing from several directions to research the background of Woodward, a little-known female mathematician who had a relatively short 15-year working career. While she wrote more than 21 TRE reports, many of them on electronic devices, she appears to have published only three papers in the open literature, including the paper mentioned previously [18]. The year 1950 was a big publishing year for Woodward. The IEE published two multiple-author papers [21], [22]; one of them, on periodic waveguides, won an IEE Ambrose Fleming Extra Premium [21]. The other, on wave propagation in an electron beam [22], won the IEE Heaviside Premium award in the same year. It was commented by one of her nieces to Nina Baker, engineering historian, during research for this column that she worked collegiately and supported other researchers.

Alice Mary Winter Woodward (neé Robertson) was born 5 May 1917, and she attended Madras College, St Andrews (Figure 4), from 1929 to 1935, where she was dux in mathematics. She matriculated in 1935 at University College Dundee, which was part of St Andrews University. Later, she graduated from St Andrews University in mathematics and natural philosophy in 1939 with honors MA Class I [23]. Her supervisor was mathematician E.T. Copson, Regis Professor at St Andrews and known to many for his textbook on complex variables [24]. With a recommendation from Copson to Watson Watt's radar team at Bawdsey Research Station, she was appointed a mathematician at the research station on the Suffolk coast. She had to travel to this new position from Dundee, which she did the day war was declared on Sunday, 3 September 1939. When she arrived at the gate the following day, the guard told her that the entire staff had evacuated the previous day to Dundee! As described by Bowen [25], on declaration of war, the Bawdsey team was moved to Dundee. After several other moves, the radar team moved to Worth Matravers near Swanage in May 1940.

The name of the research station was changed to *TRE* in November 1940. At the time, A.M.W. Robertson was listed as a junior scientific officer in the 26 Maths Group [26]. There were seven people in this group, headed by Prof. Henry G. Booker. They worked at Durnford House in the nearby village of Langton Matravers. At TRE, Alice shared an office with George Macfarlane (later Sir George) and Philip Mayne Woodward later Fellow of the Royal Academy of Engineering (FREng). The latter went up to Wadham College Oxford in 1938 to study mathematics. His undergraduate course was interrupted when he was drafted in 1941 to TRE. After about 18 months, Alice and Philip married in August 1942. Later, Philip became well known for his book on probability and information theory [27] as well as expertise in radar and leadership in computing. At the time, TRE was literally a who's who of researchers and academics who were prominent from the 1940s until near the end of the 20th century [26].

Alice and Philip delayed their honeymoon until after the war, when they traveled to Europe in Philip's MG and must have been the focus of great interest in the tiny Swiss hamlet of Fionnay, after which their house was named [28]. Alice continued to work at TRE on a variety of projects until 1954, when she resigned. She was promoted to principal scientific officer grade, and Philip said she resigned because she could see that, as a woman, she would not progress any further and be overlooked. This had already happened to her. Her nieces remember her as humble, determined, and a very kind person. She was an artist in later years, and the nieces remember her paintings covering the walls of the Woodward house in Malvern. Philip obviously thought highly of Alice's mathematical prowess, as he commented on this several times in interviews after her passing in 1999.

MICROWAVE ENGINEER AND GENERAL MANAGER IN RADAR SYSTEMS

Closer to the present time, a name that cropped up in a recently compiled list of famous scientist and engineers in the United Kingdom [29] was Dr. Elizabeth Laverick (neé Rayner), OBE, FIET, SMIEEE, Fellow of the Institute of Physics (FInstP) (1925–2010) [30]. She was a microwave engineer who worked on guided weapons systems (Figure 5). In 1943, Laverick undertook a bachelor's degree in physics and radio at Durham University. She stayed on at Durham to undertake a Ph.D. degree, researching dielectric measurements at audio frequencies using a differential transformer [31]. In 1950, she became the first woman to receive a Ph.D. degree in any scientific discipline from Durham University. Laverick remained at Durham as a research assistant for a year and was then hired by Sir Robert Clayton at General Electric Company (GEC) Stanmore (Marconi Defense Systems Ltd.) as a microwave engineer.

During this time, she published several papers on microwave measurements [32]–[33]. At the time, there were five or six female mathematicians, physicists, and engineers at GEC Stanmore compared with several hundred male employees. Later, she worked for Elliott Automation (part of Elliott Brothers), rising to become the general manager of Elliott Automation Radar Systems. She was engaged in the development of an airborne early warning system that later became known as *the Nimrod*.

FIRST WOMAN FELLOW OF THE ROYAL ACADEMY OF ENGINEERING

Another very-well-credentialed female engineer with a first was Elizabeth (Betty) Audrey Killick, FREng (10 September 1924–7 July 2019) [34]. She was a British antenna engineer who worked on radar and weapons systems for the U.K. Ministry of Defence. In 1982, she became the first woman to be elected a Fellow of the Royal Academy of Engineering, the leading engineering body in the United Kingdom.

During the Second World War, Killick was a radar mechanic in the Women's Auxiliary Air Force. Afterward, she completed a degree in natural philosophy at the University of St Andrews. She joined the Admiralty Signals and Radar Establishment after graduating in 1951, where she commenced worked in the antenna group. Killick worked on secret projects and, therefore, only a little of her work was published, for example, [35], [36], and [37]. In 1969, she joined the Admiralty Underwater Weapons Establishment (AUWE). At the AUWE, she worked on the radar systems for Royal Navy warships as well as the torpedoes used in submarines and aircraft. She concentrated on radar systems before moving to torpedo development. The AUWE's work is on future techniques and technologies, such as homing and guidance systems for the torpedoes, which, under Killick's direction, were eventually incorporated into submarines as Spearfish and Sting Ray torpedoes. In 1976, she was promoted to deputy chief scientific officer and head of the Underwater Weapons Department at AUWE.

Killick (Figure 6) always wanted to be considered on her merits as an engineer and leader and avoided being considered as a woman. Other women worked at AUWE, and some led groups, but none had the seniority or presence that she did. She was strong willed and very strong technically, and she made her positions or opinions clearly known [38]. She was made a fellow of the IEE in 1980. She resigned from the AUWE in the 1980s and joined GEC, which was building the torpedoes developed by Killick's group. She left GEC after a conflict with the managing director. She was awarded an honorary doctorate by St Andrews University in 1988. Throughout her life, Killick enjoyed skiing, sailing, local history, and archaeology. She died in 2019 after a heart attack, aged 94 [38].

PRESIDENT OF THE IEEE ANTENNAS AND PROPAGATION SOCIETY

Finally in my selection, there is Prof. Irene Peden, Life Fellow of IEEE (1925–present) [39], who commenced her significant research on Antarctica in the 1960s, which was not fully recognized until after 1970 [40]. When Peden graduated with her Ph.D. degree in 1962, she became the first woman to do so in engineering from Stanford University. She is known particularly for geophysical techniques, terrestrial electricity, antennas, and electromagnetic wave propagation [41]–[44]. She became the first female president of the IEEE Antennas and Propagation Society in 1989, and she was elected as a member of the National Academy of Engineering in 1993 for her leadership in engineering education in antennas and propagation as well as contributions to radio science in the polar region. Peden was prominent also in promoting women in engineering (Figure 7) and contributed numerous articles on this over a 20-year period, starting with [45].

CONCLUSION

This has been a brief survey of some prominent female engineers and

FIGURE 5. Elizabeth Laverick in the laboratory. (Reprinted with permission of "Magnificent Women in Engineering" [29].)

FIGURE 6. Elizabeth Killick enjoyed sailing. (Reprinted with permission of "Magnificent Women in Engineering" [29].)

FIGURE 7. Irene Peden speaking at the 1983 Society of Women Engineers National Convention in Seattle, WA. (Printed with permission of Society of Women Engineers/Wayne State University.)

scientists who had a significant impact on technology areas in electrical science, ranging from signaling to advanced warning radar systems. All of these women overcame obstacles that confront men, but they also had significant cultural and institutional barriers, which women face more regularly than their male counterparts. There are many other women groundbreakers whom I hope we shall hear about in the future. It is important to celebrate the achievements of these outstanding engineers so as to inspire future generations. I am hoping, through this article, that others will be prompted to inform and celebrate the achievements of other pioneer women in radio science. I would be delighted to hear from people who can suggest other outstanding female engineers who inspired them.

ACKNOWLEDGMENT

The author thanks Prof. Will Whittow of Loughborough University, United Kingdom; Dr. Nina Baker, engineering historian; and Katie Bird, archivist of the University of New South Wales for their assistance with preparing this article. Also, Suzette Woodward, Imperial College, London; Barbara Watson; the Defense Electronics History Society; and the Bawdsey Radar Group all helped fill out the picture of Alice Woodward.

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Dr. Sudhakar Rao's IEEE APS Distinguished Lecturer Program During May/June 2022

IEEE Antennas and Propagation Society (AP-S) Distinguished Lecturer (DL) Dr. Sudhakar Rao gave six talks titled "Antenna Technologies for 21st Century Satellite and Ground Communications" at various AP-S/IEEE Microwave Theory and Technology Society (APS/MTT) Chapters and Student Chapters in India from 2 May 2022 to 3 June 2022. All the talks were well attended with an average of 110 attendees and good interaction from the audience during the Q&A. The location and organizers of the talks were

Digital Object Identifier 10.1109/MAP.2022.3197348
Date of current version: 6 October 2022

EDITOR'S NOTE

The COVID-19 pandemic has hindered the delivery of Distinguished Lecturer (DL) talks in person over the past two years. Thanks to the availability of webinar tools, our DLs can still give many insightful and informative talks to attendees in different regions and countries across the globe. With the protection by vaccinations and the removal of international travel restrictions in many countries, our DLs are eager to travel again to give in person talks. My special thanks are given to those who are willing to share their experiences after their fruitful trips, including Dr. Levent Sevgi and Dr. Sudhakar Rao. Chapters of the IEEE Antennas and Propagation Society are most welcome to invite our present and past DLs to visit your places and meet your members and students.

1) the IEEE APS/MTT/Electromagnetic Compatibility Society Chapter of Hyderabad, held at the Osmania University, organized by Dr. Sandeep Chaturvedi and Prof. Dasari Ramakrishna on 2 May 2022 (Figure 1)
2) the IEEE Student Branch of the Raghu Institute of Technology (RIT),

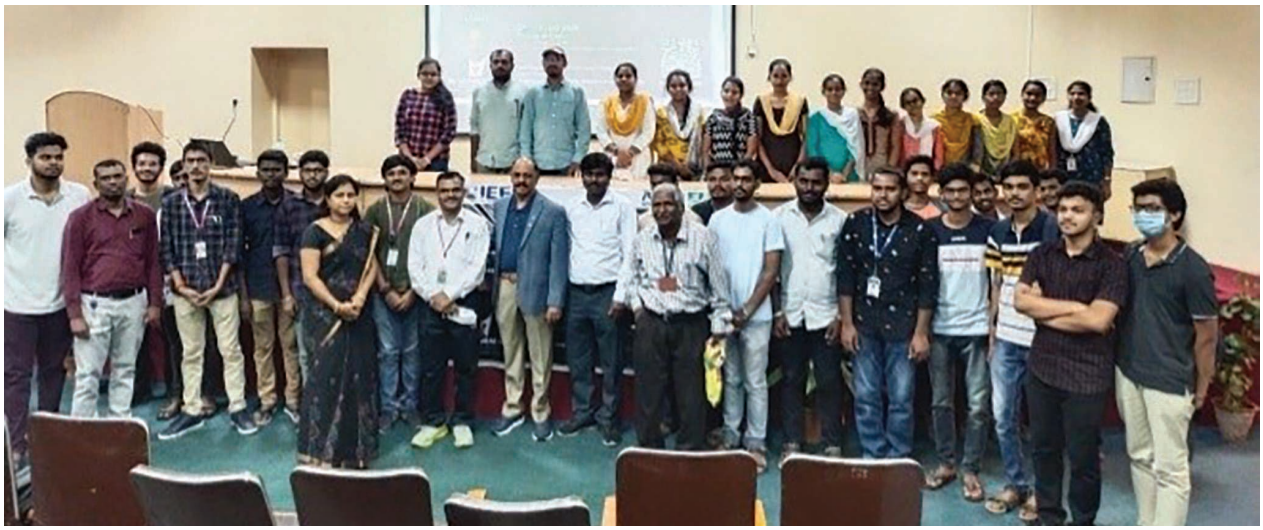

FIGURE 1. The DL talk at Hyderabad: Dr. Sudhakar Rao (eight from left) seen with Dr. Sandeep Chaturvedi (seventh from left) and Prof. D. Ramakrishna (ninth from left) and attendees.

FIGURE 2. Dr. Rao (in the blue jacket) with attendees at RIT, Visakhapatnam.

Visakhapatnam, chaired by Prof. Chowdary Paladuga and Prof. Sameer Chakravarty on 6 May 2022 (Figure 2)

3) the IEEE Student Branch Chapter (SBC) of the ToC H Institute of Science & Technology (TIST), held at Arakkunnam, Kerala, coordinated by Prof. Perumal Sankar, on 16 May 2022 (Figure 3)
4) the IEEE APS/MTT-S Kerala Chapter in association with the Department of Electronics, Cochin University of Science and Technology (CUSAT), organized by Prof. Deepti Das Krishna, on 17 May 2022 (Fivgure 4)
5) the IEEE APS/MTT SBC of the National Institute of Technology (NIT), Tiruchirappalli, organized by Prof. S.S. Karthikeyan

FIGURE 3. Dr. Rao (fourth from left) with DL talk attendees at TIST, Arakkunnam.

FIGURE 4. Dr. Rao (in the dark blue jacket) at CUSAT, Kochi, with attendees.

FIGURE 5. Dr. Rao (center) at NIT Tiruchirappalli with Prof. S.S. Karthikeyan (first from the right) and other organizers

FIGURE 6. Dr. Rao (second row, fourth from the right) after the DL talk at NIT Rourkela with Prof. K. Subhashini Ratna (second row, third from the right) and attendees

and N. Pradhan, on 19 May 2022 (Figure 5)

6) the IEEE Student Branch of NIT Rourkela, organized by Prof. Subhashini Ratna and Prof. Deepti Patra, on 3 June 2022 (Figure 6).

The DL program given by Dr. Rao was highly beneficial to students and young professionals (YPs) and was successful in motivating them to take up the antenna field for their future studies and careers. Because he is the DL from industry, his talks attracted a lot of attendees, ranging from 60 to 210, who saw how antenna theory is used to design complex antenna systems for satellite and ground applications. This was also the first DL given in India in person post-COVID and was well attended by several students, especially from small colleges. I thank IEEE AP-S DL Chair Prof. Kwai Man Luk, IEEE APS YP Chair Dr. CJ Reddy, and all the IEEE APS/MTT Chapters and SBCs in India for supporting this DL program.

Our Flagship Conference and SHE in ECE

Anisha M. Apte

EDITOR'S NOTE

The Committee on Promoting Equality (COPE) met in person for the first time after its inception, during the IEEE Antennas and Propagation and U.S. National Committee–International Union of Radio Science Radio Science Meeting (IEEE AP-S/URSI 2022), which was held in "the Mile High City" of Denver, CO, USA, on 10–15 July 2022. The activities of COPE were presented during the AdCom meeting and also discussion of COPE activities was held during the Chapter Chair/COPE/SIGHT/MGA joint luncheon meeting at Denver.

Anisha M. Apte

We are excited to share with you that the IEEE Antennas and Propagation Society (AP-S) flagship conference, the 2022 IEEE AP-S International Symposium on Antennas and Propagation and U.S. National Committee–International Union of Radio Science Radio Science Meeting (IEEE AP-S/URSI 2022), which was held in "the Mile High City" of Denver, CO, USA, on 10–15 July 2022, was a great success. Many of the attendees were happy to join the in-person meetings and events. Many could not do so for various reasons and inconveniences caused by the pandemic. Virtual attendance was made possible for all those who could not be there in person.

Dr. Ajay Poddar, chair of the AP-S Chapter Activity Committee (CAC) and vice chair-1 of the Committee on Promoting Equality (COPE), invited the Chapter officers and committee members to attend the Joint AP-S Chapter Chairs, AP-S COPE, AP-S Member and Geographic Activities (MGA), and AP-S Special Interest Group on Humanitarian Technology (SIGHT) Luncheon Meeting at IEEE AP-S/URSI 2022 on Thursday, 14 July 2022, 12 p.m.–4 p.m. The meeting was held at the Hyatt Regency, Denver, in the Silver A-B Rooms. The lunch meeting was a very successful event. AP-S COPE Chair Prof. Weng Chew presented the activities carried out under the COPE mission during the Administrative Committee (AdCom) meeting held on 10 July in Denver during the conference as well as during the Joint AP-S Chapter Chairs, AP-S COPE, AP-S MGA, and AP-S SIGHT Luncheon Meeting on 14 July.

Photos of the AdCom meeting and the presentation by Prof. Chew can be seen in Figure 1. It was a good opportunity for our Chapter officers and volunteers to get together after a three-year gap due to the COVID-19 pandemic to share experiences, raise concerns, and make suggestions for long-term engagement and contributions to society.

The presentations by the Chapter officers globally and the AP-S leadership were motivating, and interactions with Chapter officers and volunteers, attending from different parts of the world, made the event a great success. Dr. Poddar conducted several discussions and brainstorming ideas for future joint events, including ham radio workshops and other activities with the various officers of Young Professionals, SIGHT, IEEE Smart Village (ISV), and Diversity, Equity, and Inclusion, among others. The photos in Figures 2 and 3 show these meetings and discussions for future collaborative efforts. Prof. Durga Misra from the IEEE North Jersey Section has provided the following report of another event held at the New Jersey Institute of Technology (NJIT) on 22 July 2022.

THE IEEE SHE IN ECE EVENT

A REPORT BY PROF. DURGA MISRA

On 22 July 2022, a "One-Day Summer Camp for Female High School Students" was hosted at NJIT, from 8:30 a.m. to 3:30 p.m., to encourage female students to join engineering, especially electrical engineering and computer engineering. The theme was

Digital Object Identifier 10.1109/MAP.2022.3195999
Date of current version: 6 October 2022

FIGURE 1. The in-person AdCom meeting on 10 July 2022 in Denver and Prof. Chew presenting on COPE activities during the meeting.

"Soaring High-powered Excellence" (SHE) in IEEE and SHE in Electrical and Computer Engineering (ECE). More than 75 girls, including several minority students, entering grades 9 to 12 at local high schools, attended the event.

The students were welcomed by Prof. Durga Misra, Chapter chair of the Electron Devices Society (EDS)/Circuits and Systems Society (CASS) Chapter of the North Jersey Section. He emphasized the financial sponsorship of the IEEE EDS and CASS.

The morning panel session included a faculty panel, an industry panel, and a student panel in addition to a hands-on activity by the girls (Figure 4). The faculty panelists were Prof. Xuan Liu of the ECE Department, Prof. Ratna Raj of the ECE Department, and Prof. Janice Daniel, Associate Dean for Research at the Newark College of Engineering, and the moderator was Ryoko Mathes. The faculty panel advised the students on career development.

FIGURE 2. From left: Dr. Ajay Poddar, Prof. Yahia Antar, Dr. Cynthia Furse, Dr. Wei Lin, and Prof. Mahrukh Khan.

The industry panelists were Chitra Venkatraman, retired telecommunications engineer from Nokia, IEEE North Jersey Section pre-university chair, and IEEE Women in Engineering (WIE) cochair; Dr. Reena Dahle, senior radio-frequency scientist of Metamagnetics, IEEE North Jersey Section WIE cochair; and Dr. Anisha Apte, senior design engineer at Synergy Microwave

Corporation, IEEE AP-S AdCom member, and AP-S COPE vice chair-2; and Dr. Charlotte Blair, technical manager, Ansys, IEEE CAC Region 1 coordinator. The panel was moderated by Prof. Ratna Raj.

The panelists described various activities geared toward girl students, including the WIE and TryEngineering programs, and discussed how female engineers make a highly positive impact in the industrial workspace. Dimana Kornegay of NJIT's admission office guided the senior students in the application process.

The hands-on activity was guided by Dr. Byron Chen, director of labs of the ECE Department. The students were given Snap Circuits MyHome Plus from Elenco Electronics and a multimeter to set up the activity.

After lunch, the students were divided into four groups for a visit to Makerspace and to view the ECE Department labs and take part in campus tours and an "Ask Anything" session with the student panel, which was managed by Anushreya Ghosh, Jehan Salabi, and Cori Frockowiak. An excellent breakfast and a stupendous lunch were served to the attendees. The entire project was managed by Teri Bass and Ryoko Mathes of the ECE Department of NJIT.

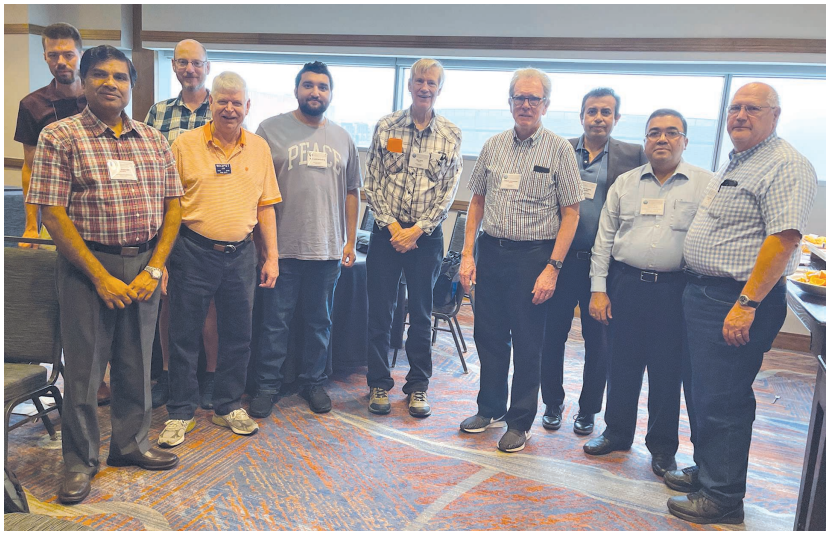

FIGURE 3. Dr. Ajay Poddar (AP-S CAC chair, COPE vice chair), first from left, and Dr. Jawad Siddiqui (AP-S SIGHT chair), third from right, met with ham radio group to discuss possible joint activities with COPE, SIGHT, ISV, and others.

AP-S COPE FUNDING REQUEST DEADLINE: 15 NOVEMBER 2022

AP-S COPE aims to fund projects that provide good use of IEEE expertise exhibiting a strong technological component, with clear engagement with the community, indicating that the proposed solution is both desired and feasible. We look for established relationships, ideally documented, with stakeholders who will be involved in the project and implementation with a clear, detailed, and credible project

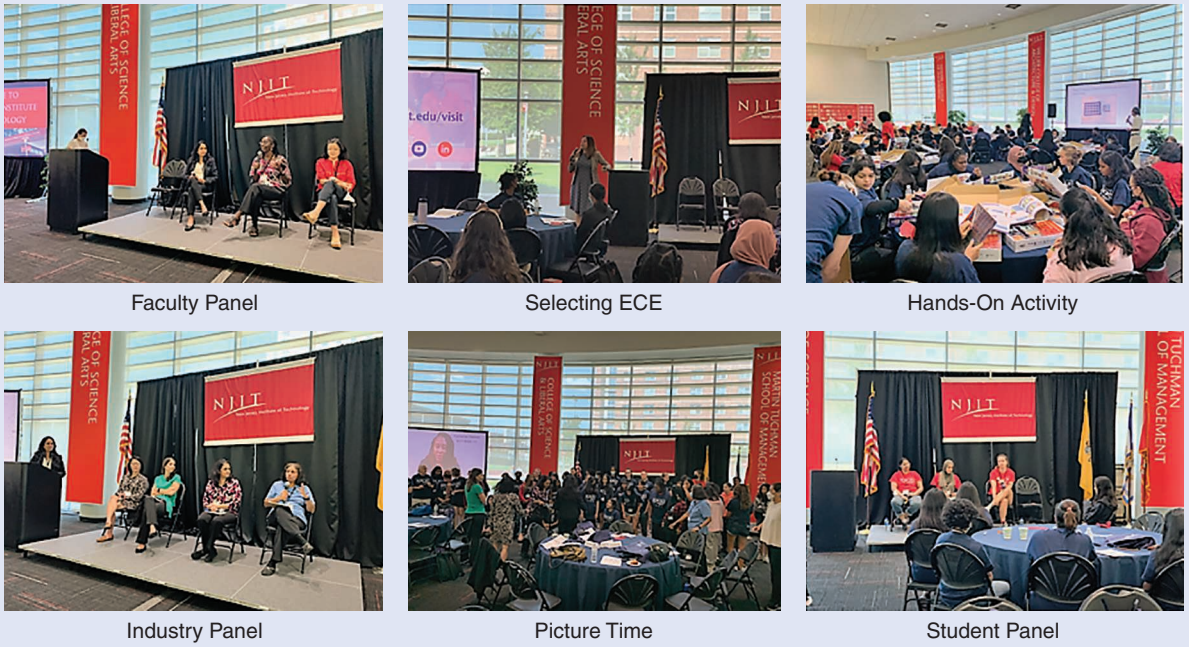

FIGURE 4. Panels and activities during the "One-Day Summer Camp for Female High School Students" hosted at the NJIT on 22 July 2022.

assessment matrix, project implementation plan, and budget. The team should demonstrate combined experience to credibly execute the project and identify and address potential risks, and the project should have a real, tangible impact. If a proposal is missing the mark in two or more of these areas, it might not be ready for funding.

AREAS OF FOCUS

AP-S COPE is prioritizing immediate impact on poverty mitigation and inequality reduction through the following project areas:

- upgrading of marginalized populations
- science, technology, engineering, and mathematics education for marginalized populations
- information and communications technology for underserved populations
- sustainable power sources for underserved populations
- water, sanitation, and hygiene for underserved populations.

The panelists described various activities geared toward girl students, including the WIE and TryEngineering programs, and discussed how female engineers make a highly positive impact in the industrial workspace.

Projects must be successfully completed and submitted to the AP-S through final reporting, indicating the status of the project and utilization of funds at the end of each calendar year. Expense vouchers should be submitted as supporting documents for audit. A spreadsheet, "APS COPE Project Budget Template 2021," should be submitted for budget proposal during application and an expense report on completion of the project. The fund utilization should be clearly indicated. Each AP-S Chapter/Joint Chapter/Student Branch Chapter may submit multiple proposals. Proposals are subject to review and scrutiny, and the total project funding will not exceed US$3,000 for any calendar year.

Please use the link to the Google Form to submit your project proposals under the COPE mission. AP-S Chapter officers/members can fill out and submit the IEEE AP-S COPE - Special Project Funding Request Form 2022 using the link: https://forms.gle/XwDUrDtZSkYojE35A. If Google Forms is not available in your region, you may use "AP-S Special Project Request Form MS Word:: PDF" found on the IEEE AP-S website: APS | IEEE Antennas and Propagation Society | Chapters (ieeeaps.org).

HISTORICALLY SPEAKING & WOMEN IN ENGINEERING *(continued from page 136)*

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