PROCEEDINGS OF THE IEEE THROUGH 100 YEARS: 1960–1969

The 1960s was a decade of tremendous growth in the Institute of Radio Engineers (IRE's) fields of interest, and many of the achievements of the decade would later be nominated as IEEE Milestones in Electrical Engineering and Computing. Among the most influential factors stimulating this growth were: the Space Race, the rise of consumer electronics, the growing presence of computers, solid-state components, telecommunications, and new electronic devices.

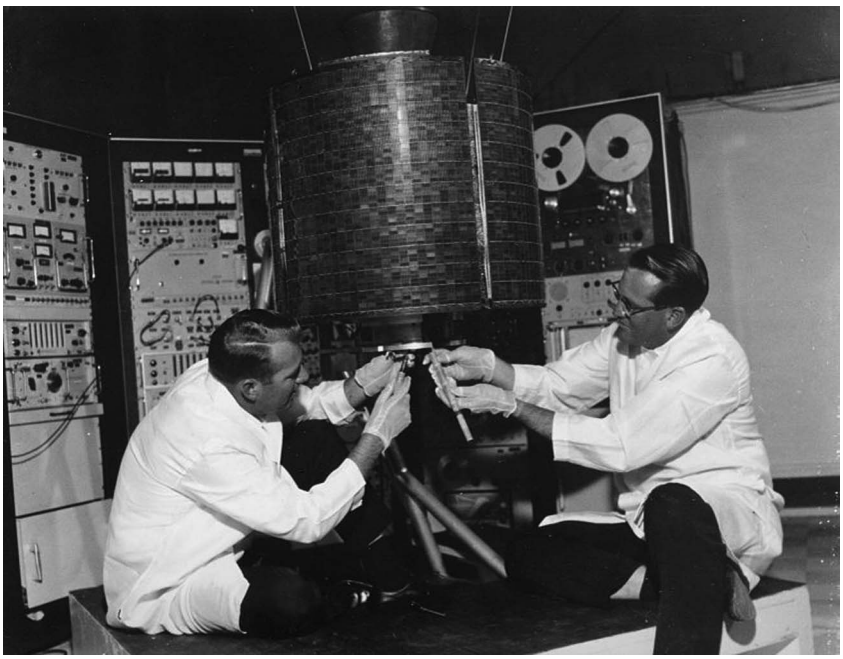

Fig. 1. *Intelsat-1.*

I. COMPUTING AND CIRCUITS

Computing was both stimulated by, and a stimulator of, progress in electronics. During the 1960s, computers grew in processing power while the reduction in size and the energy consumption of their components expanded their application to a range of uses. As more government agencies and businesses installed computing capacity, the demand for components further stimulated the electronics industry. The integrated circuit, which had been invented in 1958, and which would be marketed by Fairchild, Inc. in March 1961, would come into its own during the 1960s, further advancing the electronics industry. The metal–oxide–semiconductor (MOS), developed in the 1960s, was one of these hugely important components. As the decade closed, Simulation Program with Integrated Circuit Emphasis (SPICE) was evolving and would afterwards become the worldwide standard integrated circuit simulator. The first computers to use transistors had become operational in the mid-1950s, and the reduction in size and power consumption permitted by those components accelerated the computer's adoption by industry. The Massachusetts Institute of Technology (MIT) had a timesharing computer system in operation in 1961, and the computerized stock quotation system QUOTRON was introduced in 1962. The mouse, a device which was to

The renamed PROCEEDINGS OF THE IEEE adapted and redefined itself in the 1960s to serve the needs of the profession and the new organization as this decade saw the consummation of the long-discussed merger of the Institute of Radio Engineers (IRE) with the American Institute of Electrical Engineers (AIEE).

Digital Object Identifier: 10.1109/JPROC.2012.2193712

Fig. 2. *Apollo 11 crew portrait; left to right: Armstrong, Collins, Aldrin.*

revolutionize the human–computer interface, was invented in 1963. IBM unveiled its 360 computer on April 7, 1964, defining it as a single system capable of performing many types of information applications. It was the first commercial computer to have a cache memory. ASCII, the American Standard Code for Information Interchange, was adopted in 1966. Electronic calculators, although they did not become a marketplace force until the 1970s, were well under development in the 1960s.

II. SPACE AND SATELLITES

Space exploration was another major market and innovation driver for electronics. The need for compact devices using minimal power which could be flown aboard satellites or on manned spacecraft spurred research in miniaturization. *Sputnik*, the world's first man-made satellite, which had been launched in 1957, anticipated the use of satellites as electronics carriers in that it carried a small radio transmitter which remained active for 22 days. *TIROS-1*, the world's first meteorological satellite, was launched April 1, 1960, and proved the usefulness of television imagery to record large weather patterns. On August 12, 1960, the passive telecommunications satellite *ECHO-1* was launched. It was a large inflatable balloon with a metallic surface which was used to reflect radiotelephone signals. The day after it was launched, a successful two-way telephone conversation via satellite was conducted between Dallas, TX and Cedar Rapids, IA. Yuri Gagarin's spaceflight of April 12, 1961 began the era of manned exploration of space. Barely more than a month later, U.S. President John F. Kennedy urged the United States to commit itself to landing a man on the Moon. Work on the Grumman Lunar Module, with its specialized electrical and electronics systems, began in 1962—a busy year for electronics in space. John Glenn completed his orbital flight on February 20, and on July 10, *Telstar*, the first active communications satellite, was launched. *Telstar* introduced transatlantic television transmission on July 23. Transpacific television transmission began on November 23, 1963 via the *Relay-1* satellite carrying the news of President Kennedy's assassination to Japanese television viewers. *Intelsat-1* (Fig. 1), the first commercially successful communications satellite, was launched on April 6, 1965, and on July 20, 1969, Neil Armstrong and Buzz Aldrin (Fig. 2) set foot on the Moon.

Terrestrial transportation also saw significant advances during the 1960s. The Tokaido Shinkansen (Fig. 3)—the famous "bullet train"—operating at speeds up to 210 km/h, began service

Fig. 3. *The Tokaido Shinkansen.*

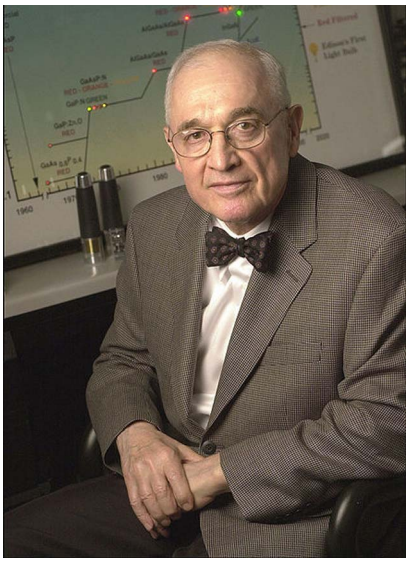

Fig. 4. *Nick Holonyak.*

on October 1, 1964, and set the standard for high-speed trains. SABRE, a computerized airline reservation system developed by American Airlines and operating over telephone lines, became operational in 1964, an early step on the path to a day when every kind of reservation—hotels, rental cars, travel tickets, theater, and sporting event tickets—would one day be made online by the individual consumer.

The 1960s saw the invention of two vital display technologies. In 1962, Nick Holonyak (Fig. 4) invented a visible light-emitting diode, a technology which would have an enormous impact on display technology, especially computer displays, and eventually on lighting, and in 1968, an RCA team led by George Heilmeier, Louis Zanoni, and Lucian Barton demonstrated the first liquid crystal display.

III. COMMUNICATIONS

One of the enduring images of the Cold War was the "red telephone," popularly known as the "hot line," a communications link between the White House and the Kremlin which went into operation on August 30, 1963. However, consumer demand by ordinary people was also driving telecommunications advances. Push-button telephones, a seminal technology for enabling the phone to become a multipurpose device capable of performing the varied tasks we use them for today, went into service. The first Picturephone transcontinental call was made between New York City and Anaheim, CA. Although the Picturephone itself was not a marketing success, visual communication would find applications beginning late in the 20th century for web meetings and for personal communication.

The 1960s was the decade which saw the first ARPANET messages transmitted between the University of California at Los Angeles and Stanford Research Institute, heralding what would one day become the Internet.

IV. CONSUMER DEMAND

Developments in solid-state components such as the invention of the transistor (in 1948) (Fig. 5) had allowed inexpensive and portable consumer electronic devices such as the transistor radio (the first ones went on sale in late 1954) to become commercial successes. By the 1960s, the expansion of a market for consumer audio devices—especially the car radio—had in turn transformed the music industry. The quartz electronic wristwatch was another consumer item that was developed and brought to market during the 1960s and which transformed an industry.

Fig. 5. *Ted Maiman and the first working laser (courtesy of the Hughes Research Labs).*

An entirely new device—the laser—worked for the first time on May 16, 1960. The 1960s was the decade of converting it into a solid-state device capable of working reliably at room temperature. In September 1962, a major step forward was achieved when IBM, GE, and MIT's Lincoln Labs independently demonstrated working gallium arsenide lasers. As a communications device, the laser would revolutionize long-distance telephony. It also became the foundation for a number of consumer electronic devices developed in future decades—revolutionizing the way sound was reproduced (CD players), movies were watched (DVD players), and the way information was stored.

Cash, electronics, and the consumer were soon linked. A cash-dispensing machine, one of the forerunners of the automatic teller machine (ATM), was introduced by Barclays Bank at its Enfield, U.K., branch in June 1967, and a cash-dispensing machine was installed at the Rockville Centre branch of New York's Chemical Bank in September 1969. The Rockville machine, developed by Docutel, used a magnetically encoded card.

Lest this article give the impression that 1960s were an unbroken march of progress in the fields of electrical engineering and computing, there were some notable setbacks as well. The famous 1965 blackout of November 9 struck parts of five U.S. states and Ontario and affected 30 million people.

V. HOW PROCEEDINGS OF THE IEEE REFLECTED THE DECADE

For the IRE as an organization, the 1960s was the decade which saw the consummation of the long-discussed merger with the American Institute of Electrical Engineers. The merger, which became legally effective on January 1, 1963, of the IRE and the AIEE formed the Institute of Electrical

and Electronics Engineers (IEEE). The renamed PROCEEDINGS OF THE IEEE adapted and redefined itself in the 1960s to serve the needs of the profession and the organization whose flagship publication it initially was.

"Poles and Zeros" was PROCEEDINGS' equivalent of "from the editor," and it was in that monthly department that topics of interest to electrical and electronics engineers were brought to the attention of the readership.

As the 1960s began, the first topic of concern in the editorial pages of the PROCEEDINGS was the decline in the numbers of university freshmen enrolling in engineering in the United States. The January 1960, "Poles and Zeros" noted a 7% decline against the 1958 statistics. The March "Poles and Zeros" noted the enormous international growth of IRE, pointing out that there were 6000 members and 22 sections outside the United States, up from just 1000 non-U.S. members from 38 countries the year before.

The impact of the Space Race on the electronics industry was reflected by the April 1960 Special Issue on Space Electronics.

Reflecting the enormous growth of computers in many aspects of business, 1961 began with The Computer Issue, the second which the PROCEEDINGS had devoted to the topic (the first had been in 1953), and ended with the December Special Issue on Plasma Physics. 1961 marked a watershed in the PROCEEDINGS' reach; the December print order exceeded 100 000. The print order was larger than the actual IRE membership for various publishing reasons, but the membership number was not far behind. The June 1962 issue of the PROCEEDINGS proudly announced "One Hundred Kilomembers," reporting that—as of April 30 of that year—IRE membership had passed the 100 000 member milestone.

A. The PROCEEDINGS Turns 50

In May 1962, the PROCEEDINGS celebrated its 50th anniversary with a special issue. The May special issue was enormous—886 editorial pages plus an index, news, and IEEE governance material. It contained retrospective articles on the history of the various technical fields of IRE's interest, and an editorial: "Shortening shadows" by Editor Emeritus Alfred Goldsmith.

Goldsmith's title referred to the shadows of early morning growing shorter as noon approaches. He wrote that the "Institute of Radio Engineers is fortunate that it still in its early morning...Its career young and promising. Its hopes and accomplishments, while great and inspiring, are as yet only partly fulfilled" [1]. In addition to the retrospective material, the issue contained "A Predictive Symposium by Fellows of IRE" on what the state of communications and electronics would be in 2012.

1962 IRE President Ernst Weber (Fig. 6) (who would also become IEEE's first president the following year) predicted that in 2012 a nuclear powered spacecraft, with a crew of 16 aboard, would be returning from a five-year mission exploring the solar system; Lloyd Berkner predicted IRE would have an active Lunar Section. Maurice Ponte accurately predicted online lectures and distance learning, J. M. Bridges' prediction that circuit and system design would be done by computer was—if anything—on the conservative side; Sir Noel Ashbridge predicted that great expansions in bandwidth would be necessary to handle the increased communications of 2012, with W. D. Lewis predicting relatedly that wideband communications would be available in the home. Henri Busignies predicted that worldwide navigation using satellites would be possible within a fraction of a mile, and that "mobile radio will be common in the form of a miniature 'wireless' unit carried by the user." Yasujiro Niwa foresaw the "languages of the world [being] translated instantly by the aid of electronics" J. Presper Eckert, commenting on the integration of human and machine, hoped that "patients in hospital rooms, and even at home over telephone wires, will be monitored by electronic medical 'pick up' units." Eckert also predicted that networked computers would be used as teaching devices, "providing more individual attention than is possible in many crowded schoolrooms." George D. Watkins predicted "living cells which perform simple logic

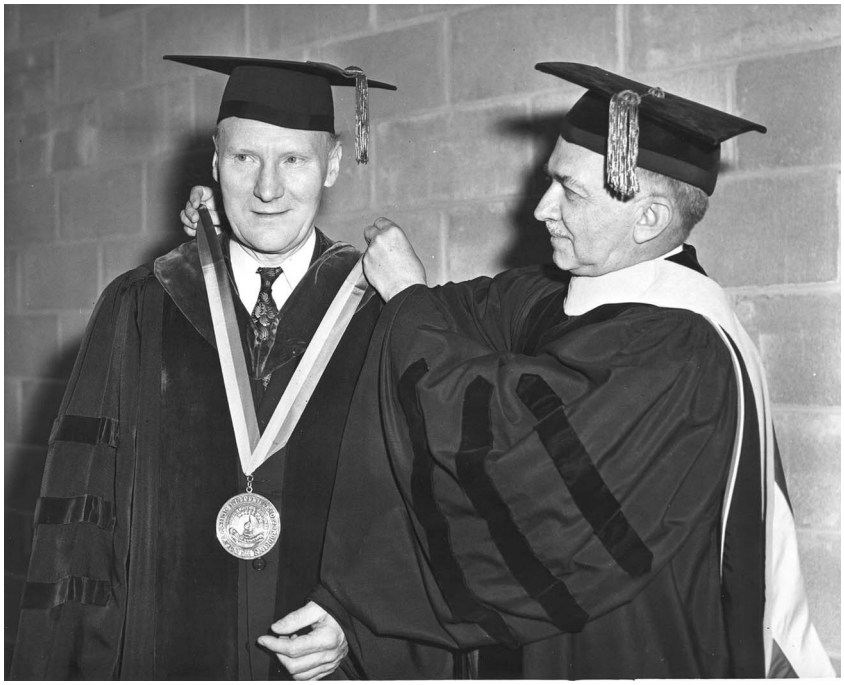

Fig. 6. *Ernst Weber becomes President of Polytechnic University (IEEE History Center).*

Fig. 7. *Simon Ramo (IEEE History Center).*

functions." Irving Wolff predicted that powerful computers would be available to work on complex problems such as modeling weather and social interactions. Vladimir Zworykin foresaw the use of medical electronics for diagnoses and rehabilitation. Marvin Camras described improvements in magnetic storage such that the contents of entire libraries could be stored in a few cubic feet in memory packs the size of a deck of playing cards and with no moving parts. Simon Ramo (Fig. 7) foresaw a system where all financial transactions were electronic; an electronic scan of one's thumbprint would act as authorization to debit one's account. The making of hotel, airline, and other reservations would be automated, and voting would be electronic. J. R. Pierce (Fig. 8) predicted communication (encrypted videoconferencing) as an alternative to travel to meetings, and that such communication would also allow people to telecommute to work.

VI. THE MERGER: IEEE IS BORN AND THE PROCEEDINGS CHANGES ITS FUNCTION

The December 1960 issue of the PROCEEDINGS OF THE IRE reported the appointment of a task group composed of IRE and AIEE members to explore areas of potential cooperation between the two organizations. In March 1962, the PROCEEDINGS published a red-covered supplement to the issue addressing the question: "Should IRE and AIEE Consolidate?" The answer was a resounding "yes," and the August 1962 issue reported that IRE members had approved the merger between IRE and AIEE by a 6.5-to-1 margin at the special July 10 meeting. With the merger approved, the September issue contained the ballot to elect the first IEEE directors, and the structure of the board of the soon-to-come into being IEEE. The January 1963 issue proclaimed "And now we are one!" It was also a special issue on quantum electronics, with the first paper—"The laser"—being a review of the field of optical masers by A. Yariv and J. P. Gordon.

The merger which produced IEEE also caused a major change in the PROCEEDINGS' role. The Merger Committee recommended establishing a new monthly magazine, IEEE SPECTRUM, in January 1964. IEEE SPECTRUM would cover the wide interests of the electrical engineer, while the PROCEEDINGS would become a subscription monthly (annual price $6.00), instead of being included in the membership dues "devoted to research-oriented papers resulting from investigations of new phenomena in all electrical or related fields, and will be particularly responsive to the need for rapid introduction of new scientific knowledge into our field" [2].

Fig. 8. *J. R. Pierce.*

John D. Ryder became the editor of the new PROCEEDINGS OF THE IEEE, with Elwood K. Gannett and Helene Frischauer continuing as Managing Editor and Associate Editor, respectively. Reed Crone became the assistant to the managing editor. Alfred Goldsmith continued to be active as Editor Emeritus.

The IRE had been—from its founding—an international organization. This influence carried over strongly into the new IEEE. The November 1963 of the PROCEEDINGS OF THE IEEE was a Special International Issue, containing exclusively contributions from outside North America. Thirty-six papers representative of research being done in 13 countries on topics such as radio, information processing, circuits, and electron devices were presented.

Reprising a theme that the PROCEEDINGS had addressed at the very beginning of the decade—engineering education—both the July and September 1964 "Poles and Zeros" discussed the problem of technical obsolescence and the importance of engineers availing themselves of continuing education opportunities in order to stay current in their fields.

Having progressed through the merger into its new role, the PROCEEDINGS was now more than 50 years old. From its birth in 1912 to 1954, when he was appointed Editor Emeritus, Alfred N. Goldsmith had served as its editor for every year except one. In the January 1965 "Poles and Zeros" column entitled "A handshake from the Editor Emeritus," Goldsmith offered IEEE some guiding suggestions: to remain vital, to conduct its affairs with maximum economy, to avoid duplication of effort, and to avoid letting the organization become too complex. He advised IEEE members to see beyond the trees to the forest, keeping in mind "the Institute itself, and humanity at large" [3].

VII. SOME IMPORTANT SPECIAL ISSUES

Military applications of the Cold War, as well as the increase in civilian air travel brought about by the jet age, spurred the Special Issue on Radar Reflectivity (August 1965). The Special Issue on Ultrasonics (October 1965), and one on Nuclear Test Detection (December 1965) concluded the year. 1966 saw the Special Issue on Frequency Stability (February) and on Microwave Technology (April). The October joint Special Issue on Optical Electronics was an experiment in joint publishing with an organization outside IEEE, the Optical Society of America's *Applied Optics*.

As space exploration expanded, the transmission of images from space—among the most notable being the spectacular images of the Moon transmitted by the *Ranger* missions—was increasing the demands on communication bandwidth. The PROCEEDINGS' March 1967 Special Issue on Redundancy Reduction addressed "new developments in signal processing which promise greater efficiency in the use of transmission means, bandwidth, and power" [4]. The June issue was the first Special Issue on Radio Measurement and Standards, and—reflecting the growth of computing—November was a special issue on Computer-Aided Design.

The April 1968 Special Issue on Transportation looked ahead to the turn of the century, being a socio–politico–economic treatment of the transportation needs of the world in 2000. September of that year was a Special Issue on MHD (magnetohydrodynamic) Power Generation, and November was a Special Issue on Electronic Scanning

VIII. THE END OF THE DECADE AND THE BEGINNING OF PAGE CHARGES

As the membership of IEEE increased, and the PROCEEDINGS' author pool increased as well, the issues—and the cost of producing them—became larger. The PROCEEDINGS announced that, beginning with the January 1969 issue, the company or institution with which an author was associated would be invited to assist in defraying part of the cost of publication by paying a voluntary page charge of $50 per page for papers or technical letters. The question of voluntary page charges for IEEE publications had already been discussed in the October 1967 issue of IEEE SPECTRUM.

The 1960s had been a decade of accelerating and enormous change, and the four special issues in the last year of the decade reflected the social and technological changes of the period. The April 1969 Special Issue on Remote Environmental Sensing addressed the new tools that had become available for monitoring the environment—a topic that was on many people's minds as the 1960s unfolded, and whose protection was of rising concern. The June issue was a Special Issue on Topside Sounding and the Ionosphere, containing papers on the *Alouette-ISIS* satellites, and their contributions in exploring the upper ionosphere. The September Special Issue on Materials and Processes in Integrated Electronics was eloquent testimony to the importance and widespread use of those devices, and the importance of new medical technologies was highlighted by the Special Issue on Technology and Health Services.

Among the achievements of the decade which IEEE has recognized in its IEEE Milestones in Electrical Engineering and Computing program so far are: the integrated circuit, the SPICE circuit simulation program, *TIROS-1* satellite, the Grumman Lunar Module, the electronics in the *Mercury* space program, the first transatlantic and transpacific television signal transmissions, the *Alouette-Isis* satellites, the Shinkansen bullet train, birth of the ARPANET, the laser, the Apollo Guidance Computer, the electronics developed at Cape Canaveral for the Apollo program, the electronic wristwatch, the electronic calculator, and the liquid crystal display.

For further reading, see [5] and [6]. ■

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