

# An Anniversary to Celebrate!

**A**S THE flagship journal of the IEEE Electron Devices Society, the IEEE TRANSACTIONS ON ELECTRON DEVICES (T-ED to most of us) has enjoyed for decades, and continues to enjoy, a stellar reputation in the device community. As you may or may not be aware, January 2013 was the 50<sup>th</sup> anniversary of the IEEE TRANSACTIONS ON ELECTRON DEVICES, and February 2014 will be the 60<sup>th</sup> anniversary of its predecessor from which it was birthed, the IRE TRANSACTIONS ON ELECTRON DEVICES. Hip, hip, hooray! We thought it would be a fitting time to reflect a bit on T-ED's many accomplishments, hence this editorial.

Yes, sixty years is a long time, and a great many things of interest to the world of electron devices have transpired over that period. We have selected some important milestones from our community's shared history, things I think you will enjoy knowing, including: I) A listing of the T-ED Editor-in-Chiefs (EiCs), those fearless leaders of T-ED, II) A real treat, some personal reflections by some of those EiCs on their tenure at the helm, III) the Paul Rappaport Award Winners since its inception (the top papers selected each year since 1982 by the T-ED Editorial Board), and finally, IV) the top-25 most downloaded T-ED papers. A special presentation is in store for IEDM this December. Enjoy!

JOHN D. CRESSLER  
Editor-in-Chief, January 2012 to present  
IEEE TRANSACTIONS ON ELECTRON  
DEVICES  
Atlanta, GA

## I. A LISTING OF THE T-ED EDITOR-IN-CHIEFS

Editor-in-Chief	Dates of Service
John S. Saby	January 1954 - December 1954
Earl L. Steele	January 1955 - September 1961
Glen Wade	October 1961 - April 1971
John A. Copeland	May 1971 - January 1974
Roland H. Haitz	February 1974 - July 1977
Karl H. Zaininger	August 1977 - March 1979
Stephen Knight	April 1979 - February 1983
David Carter	March 1983 - May 1987
Serge Luryi	June 1987 - December 1989
Renuka Jindal	January 1990 - December 2000
Douglas P. Verret	January 2001 - December 2011
John D. Cressler	January 2012 - Present

## II. REFLECTIONS BY THE T-ED EDITOR-IN-CHIEFS (IN REVERSE CHRONOLOGICAL ORDER)

### A. John D. Cressler (January 2012 – Present)



So I'm the new kid on the block. I was appointed Editor-in-Chief (EiC) of T-ED on January 1, 2012. I can truthfully say that it is both an honor and a privilege to serve the EDS community in this capacity. Somehow, when they tapped me for this new role, no one bothered to tell me exactly how much work being EiC of T-ED would actually entail. Imagine! That said, I cannot complain. It is important work, and interesting work, and you get to rub elbows with the world's best and brightest. I do my EiC job with a smile on my face. Most days!

T-ED and I actually go way back. I published my first T-ED paper back in 1989, and have published 44 more papers within its hallowed covers since. I know well the rigor required to 'make it' into T-ED, and it feels great every single time that my T-ED paper comes out. In my team, we call it that "nice warm feeling." For me, T-ED has always been the most desirable venue for presenting my team's device research results. Always was, always will be. Period.

With its 60 year history, T-ED has long been, and remains to this day, the flagship journal of our EDS community. T-ED enjoys a stellar reputation for its high quality and impactful papers. In no small way this remarkable success has been due to

the able leadership of the T-ED EiCs, the Editorial Boards they have assembled (these folks do the lion's share of the work), the mountain of reviewers from our community who selflessly give their time and energy to the task at hand, and the EDS Support Staff who somehow magically step in and help get it all done. T-ED is growing, and growing quickly. In 2000 there were 533 manuscripts submitted to T-ED. In 2012 there were 1,410! This trend bodes well for our field.

Some reflections on my brief tenure? Sure. I would especially like to tip my hat to my immediate predecessor, Doug Verret. Doug served as EiC of T-ED for 11 years, a record, and handled 10,306 manuscripts over that time, resulting in 38,124 published pages. Whew, go Doug! During his tenure, the average T-ED cycle time (the date from your submission to the date your final paper appears on IEEE XPLORÉ) has been cut from over a year to roughly 4.5 months, a number which is virtually without equal among IEEE TRANSACTIONS, and something we can all take great pride in. Doug took me under his wing and taught me the ropes. My promise to him was that I would not break anything! So far, so good.

I have instituted a few modest changes to better serve the EDS community. T-ED (along with EDL and J-EDS) has created new "Memory Devices and Technology" and "Emerging Technologies and Devices" subject categories, and I have encouraged submissions in the general realm of "Device-to-Circuit Interactions." These changes are reflective of emerging trends in our field. More will no doubt come.

Finally, my special thanks go out to the following folks who help me get it all done. Sometimes it truly seems like magic, but rest assured, there is a ton of hard work (and sweat!) going on behind the scenes at T-ED! My deepest appreciation goes out to: 1) The T-ED Editorial Board, presently 43 strong and counting (peruse the T-ED inside cover some time; it is an impressive list!). You folks do the real work around here, and your dedication is truly inspiring. 2) The countless reviewers that help the editors get these 1,400 odd papers critiqued in a timely manner (peruse the December issue's "Golden List" to see who they are). Finally, 3) the support staff at EDS – Marlene James, Rosemary Schreiber, Jo Ann Marsh, Mariola Piatkiewicz and Margie Rafferty. Simply put, we couldn't do it without you. BRAVO, ladies!

#### B. Doug Verret (January 2001 – December 2011)



1) *Six Decades and Still Thriving:* It has been my singular privilege and a great honor to have served as the Editor-in-Chief of the TRANSACTIONS from 2000 to 2011. I found it to be a rewarding and satisfying experience and would do it again in a heartbeat. Despite the tedium and all the time spent in mediating disputes, cajoling editors and addressing the occasional misconduct, this was nothing compared to the opportunity to interact with some of the best scholars and researchers in our industry and the support staff in the Electron Devices Society (EDS) Office all of whom have been and are exceptionally proficient.

a) *The World of the Transactions in Year 2000:* In 2000, personal computer (PC) sales were robust and a major driver of integrated circuits with laptops about twenty-five percent of the total. It wasn't until 2003 that laptop sales first exceed those of desk top computers. It was also a time when DVD devices were popular replacing CD's, and hand-held personal data assistants and pocket cameras were the rage. The first Blackberry device, an email pager, was introduced in 1999 but the Blackberry phone had not made its appearance in 2000. It

was also the year that down-loadable digital music first appeared.

This was also the year that Bill Gates stepped down as the CEO of Microsoft Corporation; the first crew entered the international space station; the dot-com bubble burst; PC's with CPU's from both AMD and Intel broke the 1GHz barrier; the human genome was deciphered; Twitter came online; military class GPS capability was made available to the general market; and, Alferov and Kroemer won the Nobel Prize in Physics for developing semiconductor heterostructures which they shared with Jack Kilby for the invention of the integrated circuit. In the year 2000 the US unemployment rate was 4%.

b) *The Transactions Transformed:* We have come a very long way in a very short time and just as the world has changed, the TRANSACTIONS to no one's surprise, has changed with it. In 2001 we published 3060 pages. In 2011 we published 4572 pages representing an astounding compound annual growth rate of 4.1%. This was in an environment where submissions were increasing at an incredible 8.8% annually. During this same period our Impact Factor increased by nearly twenty percent. This flagship publication of the IEEE has not stagnated but has actually increased its vibrancy and relevance in a fast-changing world.

With respect to operations, major transformations transpired. First there was the migration to dedicated staff in the EDS Office of several clerical type tasks formerly handled by the Editorial Board. Second there was the migration to web-based manuscript processing which followed. The results were spectacular. The average publication time was reduced by forty percent. At the end of 2011 the average time from submission to appearance on line was slightly more than five months. Credit goes not only to the change in the mechanics of manuscript handling but also to the high quality of the Editorial Board and the EDS staff. They are as fine a group of professionals as you could ever hope for.

One of the drivers of the unprecedented increase in submissions was the rise of Asia and Europe. Annual growth rate in published manuscripts from Asia in the decade ending in 2011 was an impressive 7%, driven mostly from the Republic

of China, Mainland China and Korea. This was not accidental but was due in large part to deliberate national initiatives to emphasize technology development, the economic benefits of which are already apparent. In the same period the annual growth rate from Europe was an incredible 11%. One can see that the TRANSACTIONS, the progenitor of all IEEE publications, is even more of an international journal than when it began.

A third major change and one that affected circulation during this time was the de-coupling of subscriptions from membership in the Institute and the Society. It wasn't that long ago when all one did was pay his/her membership dues, wait for the TRANSACTIONS to arrive via snail mail then eagerly devour the contents. Historically the largest value of membership, according to polls, has been access to technical publications. Today subscriptions are purchased independently of membership, leaving Societies the challenge of defining for its prospective members exactly what the value of membership is. For subscribers, access to publications is available either in paper or electronic form or both, with the inherent advantages of the latter of a searchable database, faster access, lower cost and more frequent use of color graphics.

If one peruses what was published in 2000, there are no surprises. The dominant themes were compound semiconductor devices dominated by compounds of Al, Ga and As with a smattering of In and P. Favorite subjects were carrier mobility, dielectric reliability, doping profiles, electron traps, leakage, breakdown phenomena, Monte Carlo methods, tunneling and lots of device, noise and reliability modeling.

In 2011 there were lots of the same with new subjects emerging. GaAs papers and those dealing with Al compounds actually increased but also new compounds appeared with additional elements *viz.* Hf, Zn, Sn and N. There was also a significant increase in papers dealing with graphene, Green's function methods, HEMTs, high-k materials, wide band gap materials, TFT's, RRAMs, NAND flash, SOI devices, solar cells, FINFETs and nanowires.

*c) The Transactions of Tomorrow:* No predictions here. My crystal ball is not reliable. However one thing is clear. The digital age has been a disrupter of the publishing business across the globe. This makes for an exhilarating time for publishers but only because of the lurking terror that the old paradigms may not survive in the new age and a great deal is riding on the success of IEEE publications for the future of the IEEE. Clear trends have already emerged. Readers and authors want freshness and haven't made up their minds whether they want quality as well (not according to what they say but rather according to the choices they make). With the advent of electronic publishing accompanied by powerful search engines, comes critical questions. What is the point anymore of monthly, bi-monthly or quarterly issues? What unique purpose do special issues serve? What is the value of re-publication? (To readers there is no more obsolete an object than the cover of a paper issue.) Which business models will support these new formats?

One would think that electronic publishing would catalyze the use of multi-media content and micro-publishing. Surprisingly neither has gotten much traction to date, but not for lack of trying. Counter-intuitive as it may seem, readers seem to eschew format in favor of fast delivery and content. Even though the TRANSACTIONS has among the fastest turn-around time of IEEE monthly journals to stay competitive it will have to continue to reduce publication cycle time.

And then there is the largest disrupter of all: open access (OA). The advocates are government and other funding agencies and university libraries among others. The costs of subscriptions have sky-rocketed in the last ten years such that no single library can afford a broad offering without appropriating all the jewels of Westminster. Thus it appears that the old business model which funds publication costs through subscriptions is not sustainable. This is not only a statement about economics, but also about loss of access by scholars as libraries have had to cut their offerings.

The opposition has come mostly from publishers and some universities. They assert that the claim that OA is both cheaper and more sustainable is not borne out by the facts; to wit, some universities have already shut down Green OA sites for affordability reasons. Furthermore, it is not at all clear how the many potential authors with scarce resources will fare in an OA environment. It would be an unconscionable breach of scientific publication principles to shut these authors out.

There are many more arguments for and against OA, which are far beyond what can be enumerated in this editorial. Suffice it to say, the future of the TRANSACTIONS is tied irretrievably to how open access will play out in the coming decade. The hallmark of the TRANSACTIONS has been its "stamp of quality" which has differentiated it from the ubiquitous and growing publication noise in which we find ourselves enmeshed. OA will compound this reality. However, there is one thing of which I am confident. It will be the established journals like the TRANSACTIONS that will find the solution to maintaining quality content in this time of publishing tumult. That is what will really be worth celebrating at our next anniversary commemoration.

DOUG VERRET, (retired),  
Texas Instruments,  
Dallas, TX

C. Renuka Jindal (January 1990 – December 2000)



1) *Transactions on Electron Devices: Its Entry in the New Millennium*: Stepping into the time machine let us turn the clock back to the year 1990. This brings us to the juncture when I assumed role as Editor-in-Chief (EiC) of IEEE TRANSACTIONS ON ELECTRON DEVICES (T-ED) while still at Bell Labs, Murray Hill, New Jersey. I was handed over the baton by Serge Luryi who brought me in as an Associate Editor in 1987. In 2000 I passed on the control to Doug Verret whom I had brought in as Associate Editor in 1994. The terms I am using may seem a bit confusing. You see, when I took office, EiCs were called Editors and Editors were called Associate Editors. In 1995 I changed all that promoting all Associated Editors to Editors and Editors to Editor-in-Chiefs. In December 2000 I published an editorial [1] highlighting the progress that T-ED had made including the impact of technology. During this period, T-ED went through a *tool-build phase*. The EiC office migrated from being run by my secretary Helga Womack armed with an electric memory typewriter to a customized PC based system. I developed this fully automated system from scratch using a relational

database with custom letter generation capabilities using the Disk Operating System (DOS). Windows operating system was still in its infancy. The system ran on an AT&T 6300+ PC with a 640K RAM and a whopping 20 MB hard drive.

Recognizing the increasing quality of technical talent around the globe reflected by papers published in T-ED, I did away with the concept of regional editors from Japan and Europe. Instead, T-ED adopted the notion of recruiting the best talent in the field from around the world irrespective of geographic location. The credit for the growth of T-ED in the ensuing years goes to this concept of hand-picking editors from academia, government labs and the industry from around the globe. To recognize these individuals I established the practice of recognizing outgoing editors at the plenary session of EDS's flagship *International Electron Devices Meeting (IEDM)*. A list of colleagues that served on the editorial board under my tenure as EiC is given below. Looking at this illustrious list decades flash by in my mind. I am sure you will see many familiar names in this list most of whom are now IEEE Fellows and some have become icons in the field of Electron Devices. Hats off to these individuals.

Al F. Tasch, Jr.	James N. Hollenhorst	Mau-Chung	Robert K. Parker
Alan H. Marshak	James R. Pfiester	Michael Shur	Sandip Tiwari
April Brown	Jaroslav Hyncenek	Frank Chang	Seiji Furukawa
Bruno Ricco	Jing Ming Xu	Nick Moll	Shin-Shem Pei
Cary Y. Yang	John R. Hauser	Nobuo Kawamura	Stephen D. Senturia
Chih-Yuan Lu	Juzer M. Vasi	Pallab Bhattacharya	Stephen J. Fonash
Denny D. Tang	Kei May Lau	Paul M. Solomon	Steven E. Laux
Dimitri A. Antoniadis	Kenneth O	Paul N. Panayotatos,	T. Paul Chow
Doug Verret	Khalil Najafi	Peter E. Cottrell	Tak H. Ning
George Craford	Krishna C. Saraswat	Peter J. Zdebel	Walter F. Kosonocky
Gerold W. Neudeck	Krishna Shenai	Ping K. Ko	Werner Weber
Giorgio Baccarani	Kunio Tada,	Rajendra Singh	Yoshio Nishi
Ivor Brodie	M. Ayman Shibib	Richard B. Fair	
James A. Dayton Jr.	Mark D. Feuer	Richard J. Temkin	
James J. Coleman	Masao Fukuma	Richard True	

The diligence of the editors in selecting dedicated reviewers to monitor the quality of the manuscripts led to the success of the publication. After much debate, to recognize the reviewers, I was able to get an agreement on establishing the "**Golden List**" of reviewers. This would be an annual feature of T-ED. The first such "**Golden List**" was published in the December 1998 issue of the T-ED. Later as EDS Vice-President of publications, I extended this concept to *IEEE Electron Device Letters* with first publication of such a list in 2003. Having one's name in the EDS Golden List is becoming a symbol of achievement. To build on this further, I also instituted the idea of an annual reviewer luncheon which is now held in conjunction with the IEDM every year. Here we recognize reviewers of all EDS publications.

In response to the reviewers' comments, the effort put in by the authors was unparalleled. To recognize the authors EDS has had the prestigious Paul Rappaport since 1982. However as EiC of T-ED, I soon realized that the more complete T-ED papers had an unfair advantage over brief papers published in *IEEE Electron Device Letters (EDL)* which seldom made the award. To level the playing field, soon after I relinquished my role as EiC of T-ED and took charge as EDS Vice-President of Publications, I petitioned for the creation of the George Smith Award for EDL. The award was formally approved in 2002 [2]. I even invited George Smith who gave the first award in person at the IEDM. The rising stature of EDL is a testimony to the efforts of EiCs of EDL including the founding editor George Smith, John Brews, Yuan Taur and now Amitava Chatterjee.

Another initiative I launched in connection with the T-ED was to enforce the notion that the length of a paper should not be subject to an arbitrarily set maximum. It should be commensurate with its technical rating thus reducing the length of marginal verbose papers and saving the precious page count and boosting margins. Also T-ED was able to entertain special issues while keeping the page budget at a reasonable level. A list of special issues published during my tenure as EiC are listed below.

- High-Voltage and Power Integrated Circuits and Devices
- Vacuum Microelectronics Conference
- Megawatt Microwave Tubes for Space
- Rapid Isothermal Processing
- Fluctuation Phenomena in Electronic and Photonic Devices
- Submicron Bipolar/BiCMOS Devices and Technologies
- Short and Long-term Trends in Device Science & Technology
- Organic and Polymeric Active Devices
- Solid-state Image Sensors
- Process Integration and Manufacturability
- SOI Integrated Circuits and Devices
- Silicon Carbide Electronic Devices
- Progress and Opportunities in Photovoltaic Solar Cell Science & Engineering
- Computational Electronics
- Bipolar Transistor Technology: Past and Future Directions

As a result of these comprehensive changes in the operation of T-ED, the number of months taken to publish a paper reduced to single digits. In addition, the profitability of the publication mushroomed turning it to be the largest line item on the EDS budget supporting a myriad of activities to serve its members worldwide.

From 2000 onwards over the subsequent 13 years many of these good things have continued to mature further under the leadership of Doug Verret and now John Cressler who I appointed as EIC after a careful selection process. The size of the journal has grown substantially from publishing 2400 pages annually to whopping 4000 pages while at the same time the acceptance rate has declined from 50% to 40%. This is in spite of the spinning off of the *IEEE Journal of Photovoltaics* [3] with some consequent migration of papers. Also the editorial board has grown from 21 to over 40, which implies we are working the editors a little harder. However, as opposed to a steady increase, the generated surplus has been fluctuating over the last decade. The paper circulation, of course, has dropped significantly from its value of 7000 during the late 90's due to electronic access. Under the section entitled "The Crystal Ball" [1]. I had predicted several trends for the future. It is interesting to see where these predictions stand 13 years later.

- 1) Migration to a fully WEB-based manuscript handling system
  - Is now a reality.
- 2) Totally electronic publishing
  - While T-ED continues to honor its paper tradition, it is available in electronic form via IEEE XPLORE. However, EDS now does have its own *IEEE Journal of Electron Devices Society* [4] a solely electronic OPEN ACCESS publication.
- 3) Harnessing new technologies to help the "manual" reviewing of technical submissions *without sacrificing quality* and all at internet speed
  - While automation in the technical review has not shown promise, nonetheless all submissions to EDS publications now go through an automated plagiarism filter.
- 4) Augmenting statistics beyond publication time, circulation and page length to assess journal quality
  - Publication time continues to be an important measure. However, circulation is being largely replaced with number of downloads and the length of a manuscript has lost some of its importance in view of electronic publishing.

A distinct memory of my tenure as EiC of T-ED was the special issue of T-ED on Bipolar Junction Transistor (BJT) to celebrate its 50th anniversary. Peter Asbeck and Tohru Nakamura were the guest editors and did an excellent job in putting together a memorable issue. The special issue was actually published in November 2001. Due to the passage of time we were able to locate the only two available luminaries of the "Transistor Era" including Jim Early and Ray Warner. Both contributed to the special issue, these perhaps being their last few publications. On the lighter side, in commemoration of the BJT, I was able to persuade Ian Mackintosh, another veteran of the transistor era, to release the limerick "Hell's Bell's Laboratory for public distribution." This limerick was written in the early days of the BJT giving a snapshot of the life at Bell Labs in those days. The song can be easily found via searching the Web for the title. I recommend that you listen to it and am confident that you will thoroughly enjoy it.

Of all the disruptive changes that have rocked the publication world, OPEN ACCESS is the latest. It all started with PRIVILEGED ACCESS to masterpieces such as the Upanishads and the literature on Confucianism dating back to 1000

BCE published in ancient Hindu and Chinese cultures. With the invention of the paper in 2<sup>nd</sup> century BC in China, technology progressed migrating from hand crafted publishing using wood block printing to offset printing towards the end of the 19<sup>th</sup> century to the wide adoption of paperless WEB based publishing in the 21<sup>st</sup> century. At the manuscript generation level it moved from hand written manuscripts to manual typewriters, to memory typewriters to personal computers. It appears to me that the concept of OPEN ACCESS will continue to grow over time facilitated in part by leveraging technology to lower cost and hence price. Whether the traditional / hybrid publication model will be completely extinguished, still remains to be seen.

From 2001 to 2008, as VP of publications and then as President-Elect and President of IEEE Electron Devices Society and with help from Samar Saha, the current VP, I continued to nurture T-ED and protect its interests vis-à-vis other newly launched publications including the *IEEE Journal of Photovoltaics* [3], *IEEE Journal of Electron Devices Society* [4] and other IEEE society/council publications. T-ED is special to me and it is still going strong. I wish it many more decades of serving the global technical community.

RENUKA JINDAL,  
Junior Past President,  
IEEE Electron Devices Society,  
Department of Electrical and Computer Engineering  
University of Louisiana at Lafayette, Lafayette, LA

#### REFERENCES

- [1] R. P. Jindal, "Launching the transactions into the new millennium—A historical perspective," *IEEE Trans. Electron Devices*, vol. 47, no. 12, pp. 2247–2248, Dec. 2000.
- [2] R. P. Jindal, "George E. Smith award," *IEEE Electron Device Lett.*, vol. 23, no. 8, p. 445, Aug. 2002.
- [3] R. P. Jindal, "Capturing the solar wind," *IEEE J. Photovolt.*, vol. 1, no. 1, pp. 1–2, Jul. 2011.
- [4] R. P. Jindal, "Editorial," *IEEE J. Electron Devices Soc.*, vol. 1, no. 1, pp. 1–8, Jan. 2013.

#### D. Steven Knight (April 1979 – February 1983)



I accepted my assignment as Editor of T-ED with a certain amount of trepidation. Despite considerable effort, I had never managed to get a grade higher than a B in English in high school or college. As Associate Editor I had felt secure knowing that the Editor had ultimate oversight, but my sense of my new responsibility for language integrity made me nervous. Fortunately Bell Labs was well populated with extraordinarily articulate friends who were willing to help, many who learned English as a second or third language!

During my tenure as Editor the economy experienced two recessions; a short dip in January through July 1980 and a much deeper one in July 1981 through November 1982. I remember that institutions began to resist paying for page charges. Someone (Gene Gordon?) wrote a strong editorial pointing out that T-ED depended on page charges to be honored for EDS to remain solvent. But exceptions were made. We received a paper from a graduate student from a Chinese institution. After it was accepted the normal acceptance letter including the request for page charges was sent to the author. His reply informed us that he was unable to honor page charges at the moment but he was graduating shortly, and would sell his bicycle as a down payment on the charges! Needless to say we told him he could keep his bicycle.

Another interesting phenomenon we noticed during my tenure was the rise in paper submissions as recessions deepened. This counter cyclical behavior is ascribed to the slowdown in development pace freeing up time for writing up publication manuscripts.

STEPHEN KNIGHT, (retired),  
Director of the Office of Microelectronics Programs,  
School of Electrical and Computer Engineering, Georgia Tech,  
Atlanta, GA  
National Institute of Standards and Technology,  
Gaithersburg, MD

*E. John A. Copeland (May 1971 – January 1974)*



I became an Associate Editor of the IEEE TRANSACTIONS ON ELECTRON DEVICES (T-ED) in May 1969 under Editor Glen Wade. Rudolf S. Engelbrecht, a good friend and mentor, was Chairman of the Electron Devices Group Administrative Committee. I took the job of Editor in June 1971, and turned the responsibility over to Roland Haitz in January 1974. During this period, I was a Member of the Technical Staff at Bell Telephone Laboratories in Murray Hill, NJ.

During the time I was on the Editorial Board, the technology area being covered was in transition from vacuum electron tubes to solid-state devices and circuits. The last of the electron tubes were advanced devices such as traveling-wave tubes and magnetrons for microwave generation, and storage tubes for display.

T-ED mostly covered devices that were single active elements, and of course the physics of those devices. The *IEEE Journal on Solid State Circuits* was started in September 1966 to cover the new field of circuits using semiconductor devices, and eventually, integrated circuits. Within T-ED work was reported on bipolar and MOS transistors, and diodes for microwave and millimeter-wave generation. In the January 1970 issue, five of fifteen articles were in the latter category, covering silicon avalanche (IMPATT) diodes, GaAs Gunn, and GaAs LSA diodes (my area).

The availability of solid-state millimeter-wave radio signal sources led Bell Labs to go into final development of a multi-carrier guided millimeter-wave system. When optical fibers were received from Corning in 1970, the ramp-up to production was stopped, and device development shifted to solid-state lasers and optical detectors.

Materials development work that would lead to Liquid Crystal Displays was under way. LEDs were being made in any color you might want, as long as it was red.

The first work on Charge-Coupled Devices (CCDs) appeared in T-ED near the end of this period. The work on CCDs led not, as expected, to solid-state replacements for rotating magnetic-disk memories, but to wide-spread use as image sensors for digital cameras. The invention of the CCD device, by George E. Smith and Willard Boyle, was recognized by a Nobel Prize much later, in 2009.

Device research during the period was accelerated by the rapid publication of results in T-ED, and at the *International Electron Devices Meeting* and the *International Solid State Circuits Conference*. I am grateful for the opportunity I had to be involved with the IEEE Electron Devices Group during this exciting period.

JOHN COPELAND,  
Electrical and Computer Engineering School,  
Georgia Tech,  
Atlanta, GA

### III. THE PAUL RAPPAPORT AWARD WINNERS

The Paul Rappaport Award was established in 1984 to recognize the best paper appearing in the IEEE TRANSACTIONS ON ELECTRON DEVICES. The winner is selected by the T-ED Editorial Board and is presented annually. The recipient(s) is awarded a certificate and a check for \$2,500, which is presented at the *International Electron Devices Meeting* (IEDM) in December.



**Paul Rappaport** received the B.S. and M.S. degrees from Carnegie Institute of Technology, Pittsburgh, PA, USA, and the D.Sc. degree from Arizona State University, Tempe, AZ, USA.

He was the Director of the Solar Energy Research Institute, Golden, CO, USA, from 1977 to 1979. He was an internationally recognized pioneer in solar energy conversion and an authority on photovoltaic technology. He helped formulate the national solar energy program through service on government research advisory committees for ERDA, NASA, the National Science Foundation, and the National Academy of Sciences. He was a Vice President with the Midwest Research Institute, Kansas City, MO, USA. Before his appointment as the SERI Director, he was the Director of the Process and Applied Materials Research Center, RCA's David Sarnoff Research Laboratories, Princeton, NJ, USA. He was involved in solar cells and solar energy, with expertise in materials and process techniques. He directed RCA efforts on the video disc.

Dr. Rappaport was a fellow of the American Physical Society. He was established to recognize the best paper appearing in the IEEE TRANSACTIONS ON ELECTRON DEVICES in 1984. The winner is selected by the T-ED Editorial Board and is presented annually. The recipient(s) is awarded a certificate and a check for \$2500, which is presented at the *International Electron Devices Meeting*.

A. EDS Paul Rappaport Award Winners (1982-2012, in Reverse Chronological Order)

- 2012: K. J. Kuhn. *Considerations for Ultimate CMOS Scaling*. vol. **59**, no. **7**
- 2011: T. Grasser, B. Kaczer, W. Goes, H. Reisinger, T. Aichinger, P. Hehenberger, P.-J. Wagner, F. Schanovsky, J. Franco, M. T. Luque, M. Nelhiebel. *The Paradigm Shift in Understanding the Bias Temperature Instability: From Reaction-Diffusion to Switching Oxide Traps*. vol. **58**, no. **11**
- 2010: Y. Kato, T. Sekitani, Y. Noguchi, T. Yokota, M. Takamiya, T. Sakurai, T. Someya. *Large-Area Flexible Ultrasonic Imaging System with an Organic-Transistor Active Matrix*. vol. **57**, no. **5**
- 2009: T. Someya, T. Sekitani, K. Zaitso, Y. Noguchi, K. Ishibe, M. Takamiya, T. Sakurai. *Printed Nonvolatile Memory for a Sheet-Type Communication System*. vol. **56**, no. **5**
- 2008: K.-W. Ang, J. Q. Lin, G. S. Samudra, C.-H. Tung, N. Balasubramanian, Y.-C. Yeo. *Strained n-MOSFET with Embedded Source/Drain Stressors and Strain-Transfer Structure (STS) for Enhanced Transistor Performance*. vol. **55**, no. **3**
- 2007: A. Naeemi, J. D. Meindl. *Design and Performance Modeling for Single-Walled Carbon Nanotubes as Local, Semiglobal, and Global Interconnects in Gigascale Integrated Systems*. vol. **54**, no. **1**
- 2006: B. Lau, A. Forchel, L. Worschech, D. Hartmann. *Cascaded Quantum Wires and Integrated Design for Complex Logic Functions: Nanoelectronic Full Adder*. vol. **53**, no. **5**
- 2005: K. Gopalakrishnan, P. B. Griffin, J. D. Plummer, R. Woo, C. Jungemann. *Impact Ionization MOS (I-MOS) - Part I: Device and Circuit Simulations and Part II: Experimental Results*. vol. **52**, no. **1**
- 2004: Franco S. P. Song, J. C. Tsang, M. K. McManus, M. B. Ketchen. *Testing and Diagnostics of CMOS Circuits Using Light Emission from Off-State Leakage Current*. vol. **51**, no. **9**
- 2003: K. Uchida, J. Koga, R. Ohba, A. Toriumi. *Programmable Single - Electron Transistor Logic for future Low-Power Intelligent LSI : Proposal and Room - Temperature Operation*. vol. **50**, no. **7**
- 2002: Y. C. Yeo, V. Subramanian, J. Kedzierski, P. Xuan, T.-J. King, J. Bokor, C. Hu. *Design and Fabrication of 50-nm Thin-Body p-MOSFETS with a Silicon-Germanium Heterostructure Channel*. vol. **49**, no. **2**
- 2001: I. Kymissis, C. D. Dimitrakopoulos, S. Purusothaman. *High Performance Bottom Electrode Organic Thin-Film Transistors*. vol. **48**, no. **6**
- 2001: R. M. Warner, Jr. *Microelectronics: Its Unusual Origin and Personality*. vol. **48**, no. **11**
- 2000: D. Dutartre, M. Jurczak, D. Lenoble, J. Martins, S. Monfray, R. Pantel, M. Paoli, J. L. Regolini, P. Ribot, T. Skotnicki, B. Tormen. *Silicon-on-Nothing (SON)—an Innovative Process for Advanced CMOS*. vol. **47**, no. **11**
- 1999: P. Bhattacharya, K. K. Kamath, J. Singh, D. Klotzkin, J. Phillips, H.-T. Jiang, N. Chervela, T. B. Norris, T. Sosnowski, J. Laskar, M. R. Murty. *In(Ga)As/GaAs Self-Organized Quantum Dot Lasers: DC and Small-Signal Modulation Properties*. vol. **46**, no. **5**
- 1998: Y. Li, T.-P. Mai. *A Front-Gate Charge-Pumping Method for Probing Both Interfaces in SOI Devices*. vol. **45**, no. **6**
- 1997: D. A. Antoniadis, A. P. Chandrakasan, C. J. Vieri, I. Y. Yang. *Back-Gated CMOS on SOIAS for Dynamic Threshold Voltage Control*. vol. **44**, no. **5**
- 1996: C. J. Diorio, P. E. Hasler, C. A. Mead, B. A. Minch. *A Single-Transistor Silicon Synapse*. vol. **43**, no. **11**
- 1995: H. Lifka, G. M. Paulzen, H. G. Pomp, P. H. Woerlee, R. Woltjer. *Three Hot-Carrier Degradation Mechanisms in Deep-Submicron pMOSFETS*. vol. **42**, no. **1**
- 1994: T. Hashimoto, T. Ishii, T. Kobayashi, F. Murai, K. Seki, K. Yano. *Room-Temperature Single-Electron Memory*. vol. **41**, no. **9**
- 1993: H. Hara, H. Iwai, T. Morimoto, M. Tsuchiaki. *A New Charge Pumping Method for Determining the Spatial Distribution of Hot-Carrier- Induced Fixed Charge in p-MOSFETS's*. vol. **40**, no. **10**
- 1992: A. S. Brown, L. M. Jelloian, L. D. Nguyen, M. A. Thompson. *50-nm Self-Aligned Gate Pseudomorphic AlInAs/GaNAs High Electron Mobility Transistors*. vol. **39**, no. **9**
- 1991: H. Fukuda, A. Imai, S. Okazaki, T. Terasawa. *New Approach to Resolution Limit and Advanced Image Formation Techniques in Optical Lithography*. vol. **38**, no. **1**
- 1990: K. Najafi, K. Suzuki, K. D. Wise. *A 1024-Element High-Performance Silicon Tactile Imager*. vol. **37**, no. **8**
- 1989: J. F. Gibbons, J. L. Hoyt, C. A. King. *Bandgap and Transport Properties of Si<sub>1-x</sub>Gex by Analysis of Nearly Ideal Si/Si<sub>1-x</sub>Gex/Si Heterojunction Bipolar Transistors*. vol. **36**, no. **10**
- 1988: D. R. Ahrendt, Y.-C. S. Yu, V. F. Drobny, V. E. Garuts, R. D. Herman, E. E. Lane, J. S. Lee, E. E. Patton, T. Yamaguchi, T. H. Yuzuriha. *Process and Device Performance of a High-Speed Double Poly-Si Bipolar Technology Using Process Borosenic-Poly with Coupling-Base Implant*. vol. **35**, no. **8**
- 1987: R. B. True. *Emittance and the Design of Beam Formation, Transport, and Collection Systems in Periodically Focused TWT's*. vol. **34**, no. **2**
- 1986: B. T. Ebihara, P. Ramins. *Improvements in the MDC and TWT Overall Efficiency Through the Application of Carbon Surfaces Electrode*. vol. **33**, no. **11**

- 1985: R. Epworth, L. A. Fetter, R. E. Howard, L. D. Jackel, P. M. Mankiewich, K. S. Ralls, W. J. Skocpol, D. M. Tennant. *Single Electron Switching Events in Nanometer-Scale Si MOSFET's*. vol. 32, no. 9
- 1984: S. Asai, N. Hashimoto, K. Itoh, T. Kure, H. Sunami, T. Toyabe. *A Corrugated Capacitor Cell (CCC)*. vol. 31, no. 6
- 1983: J. Hyneczek. *Electron-Hole Recombination Antiblooming for Virtual-Phase CCD Imager*. vol. 30, no. 8
- 1982 \*: R. F. Pease, D. B. Tuckerman. *High-Performance Heat Sinking for VLSI*. vol. 2, no. 5

\* Selected by EDS Adcom (now the EDS Board of Governors (BoG)) as first Paul Rappaport Award winner. The IEEE did not approve the award until 1983.

#### IV. THE TOP-25 MOST DOWNLOADED T-ED PAPERS (2004–2012)

- I. Shcherback, T. Danov, and O. Yadid-Pecht. *A Comprehensive CMOS APS Crosstalk Study: Photoresponse Model, Technology, and Design Trends*. vol. 51, no. 12 / Downloads: 13,212.
- D. Hisamoto, W.-C. Lee, J. Kedzierski, H. Takeuchi, K. Asano, C. Kuo, E. Anderson, T.-J. King, J. Bokor, and C. Hu. *FinFET—A Self-Aligned Double-Gate MOSFET Scalable to 20 nm*. vol. 47, no. 12 / Downloads: 8,579.
- E. R. Fossum. *CMOS Image Sensors: Electronic Camera-On-A-Chip*. vol. 44, no. 10 / Downloads: 4,835.
- S. E. Thompson, M. Armstrong, C. Auth, M. Alavi, M. Buehler, R. Chau, S. Cea, T. Ghani, G. Glass, T. Hoffman, C.-H. Jan, C. Kenyon, J. Klaus, K. Kuhn, Z. Ma, B. McIntyre, K. Mistry, A. Murthy, B. Obradovic, R. Nagisetty, P. Nguyen, S. Sivakumar, R. Shaheed, L. Shifren, B. Tufts, S. Tyagi, M. Bohr, and Y. El-Mansy. *A 90-nm Logic Technology Featuring Strained-Silicon*. vol. 51, no. 11 / Downloads: 4,346.
- T. Danov, I. Shcherback, and O. Yadid-Pecht. *Study of CMOS APS Responsivity Enhancement: Ring-Shaped Photodiode*. vol. 52, no. 1 / Downloads: 3,935.
- C. P. Yue and S. S. Wong. *Physical Modeling of Spiral Inductors on Silicon*. vol. 47, no. 3 / Downloads: 3,856.
- A. J. Scholten, L. F. Tiemeijer, R. van Langevelde, R. J. Havens, A. T. A. Zegers-van Duijnhoven, and V. C. Venezia. *Noise Modeling for RF CMOS Circuit Simulation*. vol. 50, no. 3 / Downloads: 3,131.
- P. R. Chidambaram, C. Bowen, S. Chakravarthi, C. Machala, and R. Wise. *Fundamentals of Silicon Material Properties for Successful Exploitation of Strain Engineering in Modern CMOS Manufacturing*. vol. 53, no. 5 / Downloads: 3,010.
- W. Lu, P. Xie, and C. M. Lieber. *Nanowire Transistor Performance Limits and Applications*. vol. 55, no. 11. / Downloads: 2,863.
- J. Kedzierski, P.-L. Hsu, P. Healey, P. W. Wyatt, C. L. Keast, M. Sprinkle, C. Berger, and W. A. de Heer. *Epitaxial Graphene Transistors on SiC Substrates*. vol. 55, no. 8 / Downloads: 2,694.
- G. Katti, M. Stucchi, K. De Meyer, and W. Dehaene. *Electrical Modeling and Characterization of Through Silicon via for Three-Dimensional ICs*. vol. 57, no. 1 / Downloads: 2,562.
- K. Lee, I. Nam, I. Kwon, J. Gil, K. Han, S. Park, and B.-I. Seo. *The Impact of Semiconductor Technology Scaling on CMOS RF and Digital Circuits for Wireless Application*. vol. 52, no. 7. 2,544.
- J. O Song, J.-S. Ha, and T.-Y. Seong. *Ohmic-Contact Technology for GaN-Based Light-Emitting Diodes: Role of P-Type Contact*. vol. 57, no. 1 / Downloads: 2,482.
- R. Vetry, N. Q. Zhang, S. Keller, and U. K. Mishra. *The Impact of Surface States on the DC and RF Characteristics of AlGaIn/GaN HFETs*. vol. 48, no. 3 / Downloads: 2,253.
- J. Weng. *A Universal De-embedding Procedure for the "On-Wafer" GHz Probing*. vol. 42, no. 9 / Downloads: 2,175.
- H. S. Bennett, R. Brederlow, J. C. Costa, P. E. Cottrell, W. M. Huang, A. A. Immorlica, Jr., J.-E. Mueller, M. Racanelli, H. Shichijo, C. E. Weitzel, and B. Zhao. *Device and Technology Evolution for Si-Based RF Integrated Circuits*. vol. 52, no. 7 / Downloads: 2,165.
- S. Takagi, A. Toriumi, M. Iwase, and H. Tango. *On the Universality of Inversion Layer Mobility in Si MOSFET's: Part I-Effects of Substrate Impurity Concentration*. vol. 41, no. 12 / Downloads: 2,113.
- U. Russo, D. Ielmini, C. Cagli, and A. L. Lacaita. *Filament Conduction and Reset Mechanism in NiO-Based Resistive-Switching Memory (RRAM) Devices*. vol. 56, no. 2 / Downloads: 2,102.
- Y. Cheng, M. J. Deen, and C.-H. Chen. *MOSFET Modeling for RF IC Design*. vol. 52, no. 7 / Downloads: 2,077.
- D. K. Schroder and D. L. Meier. *Solar Cell Contact Resistance-A Review*. vol. 31, no. 5 / Downloads: 1,913.
- M. Meneghini, A. Tazzoli, G. Mura, G. Meneghesso, and E. Zanoni. *A Review on the Physical Mechanisms That Limit the Reliability of GaN-Based LEDs*. vol. 57, no. 1 / Downloads: 1,878.
- S. E. Thompson, G. Sun, Y. S. Choi, and T. Nishida. *Uniaxial-Process-Induced Strained-Si: Extending the CMOS Roadmap*. vol. 53, no. 5 / Downloads: 1,877.
- D. E. Carlson. *Amorphous-Silicon Solar Cells*. vol. 36, no. 12 / Downloads: 1,851.
- K. K. O, K. Kim, B. A. Floyd, J. L. Mehta, H. Yoon, C.-M. Hung, D. Bravo, T. O. Dickson, X. Guo, R. Li, N. Trichy, J. Caserta, W. R. Bomstad, II, J. Branch, D.-J. Yang, J. Bohorquez, E. Seok, L. Gao, A. Sugavanam, J.-J. Lin, J. Chen, and J. E. Brewer. *On-Chip Antennas in Silicon ICs and Their Application*. vol. 52, no. 7 / Downloads: 1,844.
- K. J. Yang; C. Hu, *MOS Capacitance Measurements for High-leakage Thin Dielectric*. vol. 46, no. 7 / Downloads: 1,744.