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MICROWAVE THEORY
AND TECHNIQUES

NEWSLETTER

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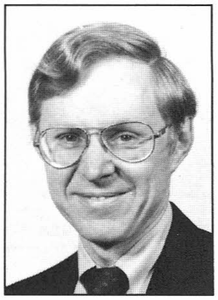


by Peter Staecker
M/A-COM, Inc.
Burlington, MA 01803

IEEE/MTT-S: Starstruck

First in June, it was Cecil B. deSwift's production of *One-Penny Opera*, a lively farce which immortalized the lifestyle of the microwave sales engineer. In a much more dramatic historical look at the beginning of microwave technology, however, be advised that NOVA will be showing *Echoes of War*, a 1-hour documentary relating the role of radar in World War II, as told by engineers of the MIT Radiation Laboratory. One particular piece of hardware produced by RadLab will be featured in this film-the SCR-584, a gun-laying radar which proved the combat effectiveness of radio detection and ranging. Last Fall, MIT's Millstone Radar site in Westford, MA was the location chosen to stage the filming of an SCR-584 tracking a P-51 Mustang, a film sequence which will be part of the *Echoes* documentary. This episode brought together a number of RadLab personnel, first to render the 584 operational, then to gather in the shadow of the giant Haystack dish to compare technologies 50 years apart. Don't miss the show, scheduled for broadcast on public television on Octoer 24, 1989. To whet your appetite, read Roger Sudbury's review of the filming of the SCR-584 in this issue.

RadLab, Continued:

It has been slightly over two years since the last gathering of local RadLab personnel, and less than two years until the official MTT celebration of the RadLab golden anniversary, to be held concurrently with the 1991 IEEE MTT-S International Microwave Symposium in Boston. We are publishing in this issue the latest list of RadLab personnel, courtesy of Ted Saad,and will mail copies of the Newsletter to all so that you can begin to make plans for the event. Please advise Ted of any changes or additions.

Long Beach to Dallas: The 1990 Symposium

Well, the Long Beach Symposium was certainly a success: we were force-fed the latest microwave technology, entertained in the extravagant style that is uniquely Californian, and through the superb financial planning efforts of Chuck Swift and his Committee, were able to generate a healthy Symposium surplus. Read Chuck's article below and meet the folks in the blue jackets. If you are wondering how such an act can be followed, check out the article by John Wassel on the Dallas meeting next May. John is already jostling our planning routine a bit, adding AP-S and URSI to the IMS/MMWMC/ARFTG crowd, pushing the TPC meeting back into December and the AdCom meeting to September. We can't wait for those uncluttered scenic views of Texas, John.

What's New?

A number of topics were discussed at the recent AdCom meeting, including

- formation of an MTT magazine
- formation of an MTT letters periodical
- expansion of production of MTT Home Videos of Emerging Technology
- selection of San Francisco as the site for the 1996 IMS

See Tatsuo Itoh's article on AdCom Highlights for further details.

MTT membership activities continue at an energetic pace. An outstanding student essay by Fredrik Rehnmark, winner of an essay contest sponsored by the Syracuse MTT/AP Chapter, appears below. The Newsletter encourages reports of similar activities at the local level.

Dr. Martin Caulton, a respected member of the MTT community, has passed away. We express our sympathy to his family.

Swan Song

The tenure of the MTT Newsletter editor is three years: long enough to try some new ideas, to understand how the system works, and to appreciate the strengths of the MTT Society. I am grateful to all those authors who make this publication one of the most useful instruments of membership services of any Society in IEEE. The mechanics of publication are still time-consuming and tedious, even in this age of computer-aided everything. To those here at M/A-COM who assisted in the editing and layout process, Priscilla Riley, Bart Addante, Mike Judge, Nancy Cassin, Peggy Eversman, and Georgie Burton, we all owe thanks. Gary Lerude will be taking over as of the next issue, Winter 1990. Send your articles to:

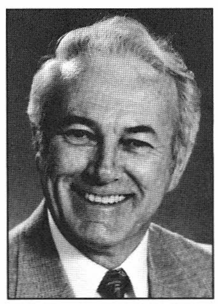
Gary Lerude
Texas Instruments, Inc.
P.O. Box 655474
M/S 402
Dallas, TX 75265

**MTT-S NEWSLETTER
COPY DEADLINE INFORMATION**

Issue	Copy Deadline*
Spring	February 28
Summer/Fall	July 2
Winter	December 1

* For special technical articles, submit 8 weeks earlier.

Division IV Report



by B. Leonard Carlson
Division Iv Director
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Two meetings of the IEEE Board of Directors have been held since I was elected as your Division IV Director on Electromagnetics and Radiation. Having been a member of the Technical Activities Board (TAB) as the EMC Society President in 1986/87, I was prepared for business as usual. However, I'm glad to report that under the guidance of Dr. Troy Nagel, the VP for Technical Activities, many innovations have been instituted to focus the TAB on those policy issues that are important to the Societies. This is possible because of the establishment of a day long Publication Workshop and Society Presidents' Workshop and

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Forum during the TAB meeting. Unlike Past Presidents' Forums the Division Directors are also asked to participate, thus providing the directors with first hand knowledge of Society problems which can be carried forward to the TAB OpCom and eventually the IEEE Board of Directors. One issue that clearly bears discussion is the relationship between the Chapters, the parent Societies, and Sections and Regions. The care and feeding of the local Chapter is the responsibility of both the TAB and Regional Activities Board (RAB). According to the IEEE guidance document entitled 'Chapter Operations—A Guide for Sections' both the TAB and RAB are considered guardians of the Chapter, i.e., 'Chapters are units within IEEE Sections formed to serve the specialized technical interest of Society members and to coordinate these with the local activities of the Sections and the broader activities of the parent Society' additionally, 'The Chapter, operating in concert with its parent Society and the Sections, plays a major role in fulfilling the objectives of the IEEE'. In other words the Chapters serve two masters, the technical Society which has the responsibility for originating the Chapter that can best serve the technical interests of its constituent members and the Section covering the geographical location of the menmbership. Both the TAB and RAB have transnational responsibilities and interests using the Chapters as vehicles of conveyance. Chapter officers should be made aware of the two masters and their role in providing support to the chapters. RAB through the geographical relationship as an overseer ensures proper operation of the chapter. The TAB on the other hand, through the parent Society, must ensure that the Chapter receives financial and technical support to ensure that adequate and quality programming are available. I know, many years ago as a Chapter chairperson, I did not know the interrelationship between the IEEE geographical section and the technical Society.

To this end the TAB and TAP OpCom passed a motion directing the RAB/TAB Chapters Committee to prepare a brief document covering the manner in which Chapters interact with Sections and Societies. The document shall include, as minimum financial resources, chain of command, and reporting requirements. Many Societies think their Chapters are alive and well because of reporting in newsletters and coordination with the Society chapter chairperson, while the Section is filing the Chapter bankruptcy papers with the regional director, because administrative requirements were not fulfilled.

There will be a Sections Congress in Toronto in October 1990; the Society Chapter Coordinator is encouraged to attend and discuss Chapter problems and provide guidance in their resolution.

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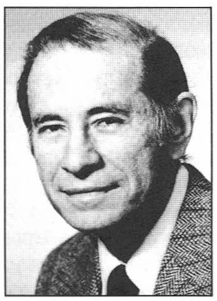

In Memory of Martin Caulton (M'61, SM'65, F'80) 1925-1989

Dr. Martin Caulton died on May 22, of heart disease complications and diabetes at Georgetown University Hospital, Washington, D.C.

He was well-known for his pioneering work in lumped-element components and integration methods at microwave frequencies, and he had a long list of accomplishments, many of which related to the MTT community:

Dr. Caulton pursued his undergraduate degree (B.S. in 1950), and graduate studies in physics at Rensselaer Polytechnic Institute, completing his doctoral research in high-energy nuclear physics under a fellowship at Brookhaven National Laboratories in 1954. He pursued post-doctoral work as a Fulbright Scholar at the Imperial College of Science and Technology, University of London, in 1954-55.

He began work on microwave tubes as a Member of the Technical Staff (1955-58) at Bell Telephone Laboratories, Murray Hill, New Jersey, where he contributed to the achievement of significantly lower-noise figures in traveling-wave tubes. From 1958 to 1960 he served in the Physics Department at Union College, Schenectady, New York, during which time he co-authored the senior-graduate textbook, *Physical Electronics*.

He joined RCA Laboratories as a Member of the Technical Staff in 1960, where his accomplishments were many. In 1961 he demonstrated and in 1965 he quantitatively verified the existence of Landau damping of waves in multivelocity electron beams and plasmas. Working on microwave solid-state devices, he contributed to the achievement and verification of transistor power beyond the cut-off frequency (1964-1965), using the collector-base capacitance as a parametric frequency multiplier.

Beginning in 1966, he helped to establish both a laboratory and the technology for the fabrication of microwave integrated circuits. He was the recipient of RCA Laboratories Achievement Awards for this work in 1968 and 1971. He is widely remembered as a key contributor to the development of lumped-element components and integration methods for use in high-power microwave devices and circuits to achieve the highest power, gain, and efficiency. In 1972 he became involved in the fabrication of microwave high-power GaAs FET amplifiers and the associated process problems of thin-film multilayered systems and paralleling microwave device arrays. He also served as project engineer in the development of hybrid integrateed CATV amplifiers for low-noise wide-band use. In the late 1970s, he developed high-power rf hybrid modules for communications, applying MIC techniques for reliable circuit fabrication. From 1979 until his retirement, he concentrated his effort on high-power low-loss PIN devices.

In 1971-1972, he was a Visiting Professor at the Technion, Israel Institute of Technology, in Haifa, Israel. Dr. Caulton also served for ten years as Adjunct Professor of Electrical Engineering at Drexel University, Philadelphia, where he taught courses in modern physics and microwave theory and techniques. he was a member of Sigma Xi, and a Fellow of the IEEE. His Fellow Citation, awarded in 1980, reads "For technical contributions and leadership in development of microwave integrated circuits and high power transistors." He was Past Chairman of the Committee on Microwave Integrated Circuits (MTT-6), served as Associate Editor of the Transactions of the MTT, and was a member of the MTT-S International Microwave Symposium TPC for many years—serving as Chairman in 1976.

Martin Caulton is survived by his wife, Lillis, whom he married in 1949 while he was still an undergraduate student, and by two sons, David and Michael.

I had the honor of collaborating with Martin Caulton, a friend and co-worker, for over 20 years. Martin was a modest person, with a tremendous desire for knowledge and a love of teaching.

He was extremely dedicated and continued to offer technical advice, using his deep understanding of microwave concepts, until a few weeks before his death. He was always willing to express his gratitude, dedicating a copy of the book he co-authored to one of his students by writing: 'To my pusher, mentor, booster, and friend.'

Arye Rosen
David Sarnoff Research Center
July 7, 1989

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Other actions taken by TAB/TAP OpCom of a proposal allowing the IEEE General Manager to expedite Chapter formation, providing the Society Presidents are notified of new Chapters on a timely basis. Currently, the Society President must approve the formation of a Chapter, insuring that the Administrative requirements are met. This new procedure means that Societies will give a priori approval, for a stated period of time.

However, the Chapter Chairperson and his or her committee must be made aware of the role of RAB/TAB in their well being. Given the short corporate memory of the IEEE volunteer structure, this needs to be an every year ongoing dialogue. If as a Chapter officer you have questions regarding the administration and fostering of your chapter, please contact your Society Chairperson or President, if all else fails, give me a call (206) 773-6297.

AdCom Highlights

by Tatsuo Itoh
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The Spring AdCom meeting was held on June 11, 1989 in Long Beach, California prior to the opening of the International Microwave Symposium. In one of two meetings held before the AdCom gathering, the Long Range Planning Committee discussed:

- the possible implementation of a quick turn-around publication. This project has been studied under the auspices of the Publications Committee which recommends start-up of a letter journal for the MTT Society.
- the possible future start-up of a mini-conference on emerging technology. These topics are important for the Society's vitality toward the year 2000 when the capturing of emerging technology is critical on a global scale.

The second meeting, that of the Budget Committee, tested an attempt to alleviate the congested agenda during the formal AdCom meeting. The Budget Committee has had to be very conservative this year due to the quickly depleting financial reserve. Only a handful of discretionary budget requests were approved for recommendation for funding to the AdCom.

The efforst of the Budget Committee were reported as one of the first items of business before the Administrative Committee. After considerable debate the 1990 budget was approved by the AdCom as recommended by the Budget Committee. The budget projects income of $1455.3K and expense of $1374.5K so that there will be a $80.8K surplus which will reverse the depleting trend of the recent societal financial picture.

The President requested two items that are of critical importance. The first is the possible participation of the MTT in the IEEE Superconducting Committee which requires a $5000 fee from each participating Society. The AdCom voted to approve this additional expense with the participation process assigned to E. Belohoubek. The second item is the possible participation of the MTT in the IEEE Region 10 Delegation. AdCom voted to send two MTT Representatives to this misison with a budget of $5000. This decision is in line with the MTT's aspiration to be involved in global activities as projected by MTT-2000. The President nominated T. Itoh and R. Sparks as the delegates.

Meetings and Symposium Chairman, M. Maury conducted the voting for the 1996 Symposium site selection. After presentations of proposals from Portland, Oregon and San Francisco, California, the vote was taken and San Francisco was selected as the 1996 site for the International Microwave Symposium.

The Membership Committee reported its tradition of excellent service and dynamic projects. Membership growth is 7.0% and 6 new Chapters were formed. The Education Committee reported selection of the recipients of undergraduate scholarships, graduate fellowships and grants-in-aid.

The Publications Committee had two major action items. The start-up of a new letter journal was proposed as endorsed by the Long Range Planning Committee. The Publication Chairman, M. Schneider, requested AdCom approval of this concept with a study of the impact on the *Transactions* in terms of income and expense to be worked out in detail by the Fall AdCom meeting. This quick publication is a mechanism to stay abreast of emerging technology with quick dissemination of the important research and technical development in the topics related to MTT's technical interest. AdCom unanimously approved the concept. The second item is the increase in production of the highly successful Home Video Tutorials of Emerging Technology. Three more tapes will be produced as approved by the AdCom.

The Long Range Planning Committee reported its activities for the past several months including the outcome of the meeting on Saturday, June 10. J. Raue reported on behalf of the Technical Planning Activities Committee the plan for a meeting on the day prior to the Technical Program Committee meeting in Dallas in December. During this meeting, chairmen or their designates of standing Technical Committees will devote one half day to presenting their view toward emerging technology in their domain of interest. The remainder of the day will be spent for discussion and formulation of a possible mechanism for a mini- conference on emerging technology.

J. Crescenzi on behalf of the Long Range Operations Activities Committee presented a working document, 'Policy and Guidelines for MTT Society Sponsorship and Endorsement of Technical Meetings, Conferences, Expositions, and Symposia.' this document should serve as a guideline for planners of meetings who seek MTT sponsorhsip. The document was approved by the AdCom.

Did You Know That . . .

. . . **the man behind McDonald's** was *52 years old* when he sold his first hamburger? He'd been a restaurant-supply salesman for 25 years. *A sample of Ray Kroc's philosophy:* The world is full of educated derelicts . . . Persistence and determination alone are omnipotent . . . Free enterprise will work if you will.

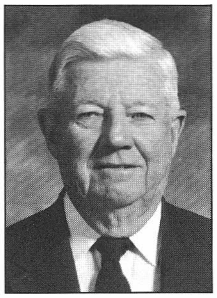
. . . **most "designer" labels** have minimal, *if any*, input from the actual designers? In general, designers contract their entire production to a less well-known manufacturer . . . who pays a royalty for the use of the famous name.

Secrets from the Underground Shopper: The Only Book To Tell You What the Retailers Won't by Sue Goldstein, Taylor Publishing Co., 1550 W. Mockingbird Ln., Dallas 75235. $8.95.

. . . **world's most expensive cities** are Tokyo and Osaka/Kobe, Japan? Using New York as a base for comparison, with an index of 100, the cost-of-living index for Tokyo is 203, and for Osaka/Kobe is 201. Tehran ranks third, at 187. *Least expensive:* Caracas, with an index reading of 32 . . . Rio de Janeiro and Sao Paulo at 33 and 34, respectively.

Survey conducted by Business International Corporation, 215 Park Ave. South, New York 10003.

1989 MTT-S Symposium Review



by Chuck Swift
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Van Nuys, CA 91411

Well, the Symposium is over, and it went about as well as I could have hoped. There was no earthquake, the weather was excellent, and people responded by making this the best attended Symposium yet. Over 2300 engineers registered for the MTT, and 1050 for the MMIC conference. To those of you who journeyed to Long Beach, thanks for coming. I strongly feel Long Beach should be considered for a return engagement for the MTT, maybe in 1999.

Those of you who know me may have asked themselves 'How did Chuck Swift get selected to be Chairman of the 1989 Symposium?' I'll let you in on a secret. It was because I ignored the first dictum I learned in the service—'Don't volunteer for anything'. Once I'd committed that error, my only redemption was to recruit a team of microwavers ignorant of this cardinal rule. It is this group, commonly referred to as the Steering Committee, I'd like to introduce you to now. They don't get nearly the attention the Chairman commands, but they are the people who guaranteed the success of the 1989 IEEE MTT-S International Microwave Symposium.

Don Parker
Dr. Don was this year's recipient of the Distinguished Service Award for his past service to the Society. One of the 'Old Elephants' (Past Presidents of the MTT), Don will chair the 1994 symposium in San Diego. As Vice-Chairman, Don was my alter ego, bringing a leavening influence to my more outrageous ideas. When he's not working on the MIMIC Program at Hughes/RSG, Don is a willing volunteer for the Church of the Latter Day Saints.

Irene Petroff
We got double duty from Dr. Petroff, as she was a member of the Technical Program Committee as well as Secretary for the Steering Committee. A former Professor at Cal State Fullerton, Irene is on the staff at Rockwell Autonetics.

Reynold Kagiwada
Here's a world class volunteer! Technical Program Chairman in Las Vegas in 1987, Reynold did a second stint in 1989. A newly elected Fellow of the IEEE, Reynold is a past editor of the MTT Newsletter, and a member of AdCom. Did I also mention he was Chairman of this year's MMWMC meeting? My only complaint about Dr. Kagiwada is TRW changed his telephone number five times since the Symposium letterhead was printed in 1988.

Pete Pusateri
A sales engineer for Cain Technology, Pete filled ne of the most demanding jobs. The Arrangements Chairman makes the events happen; he lines up sleeping rooms, schedules meeting rooms and audio-visual, arranges transportation, and on and on. For such a responsible job, a peddler seemed a natural choice. A past chairman of the Los Angeles MTT Chapter, Pete was an obvious selection.

R.E. 'Skip' Bryan
With a budget of $650,000, the Symposium needed a person to make all the columns come out even. As long as 'Skip' doesn't skip . . . I couldn't pass it up! Skip has inaugurated a most comprehensive system for tracking income and expenses, which will prove invaluable to future symposia. Skip is newly elected as Chairman of the San Fernando Valley MTT Chapter, and gets his check from Hughes Missile Systems Divison.

Maurio Maury, Jr.
All of the Steering Committee felt there was room for improvement in the program that heralds the Symposium to the membership. Our Cuban-born Cucamongan made some real innovations, starting with a four-color photo on the cover, and carried over to larger print to help out us older fellows. Mario, Jr. is a member of AdCom, a rabid sailor, yet still finds time to be active in ARFTG and President of Maury Microwave.

Ken Russell
A pilot raised in Oklahoma, Dr. Ken had to assemble all the technical papers into the Digest. Take a look at the covers, as Ken 'zooms' the reader in from space to the convention center in Long Beach. The Digest was tailored as a 'daily', with a volume dedicated to each one of the three days. Obviously, a heavy responsibility; the digests weighed 10 pounds! Ken commutes to Aerospace Corp.

Loretta Oltman
Loretta (Mrs. H. George) had participated in innumerable spouses programs, and this experience assured those who took part in this year's program of a well-balanced itinerary. The only problem was getting her off the tennis courts long enough to perform her duties as Chair------(?) of the Spouse's Program. Check one: Chairman ( ), Chairperson ( ), Chairwoman ( ).

Robert Eisenhart
Dr. Bob didn't have enough to do, shepherding the historical exhibit and the special space exhibit, he also fired up his personal computer and came up with the symposium logo. Did you catch his 'bouquet of waveguide irises'? Pretty, but not much of an odor. Bob reports to work at Hughes/MSG. Bob and his wife Nancy (Chief of Protocol) are both certified as Professional Tennis Umpires, have been chosen to work the U.S. Open this Fall.

Harvey Endler
Harvey of Systron-Donner is a pilot, jogger and skier who guaranteed me there would be no long lines at the Registration Desk. What more could one ask? If he had failed to deliver, his jogging would have come in handy as we ran him out of town.

John Horton (TRW) and Ken Conklin (Hughes)
We finally teamed up these two competing firms! John is a Past President of AdCom, and lined up the seven workshops. Ken had the responsibility for the panel sessions.

Jorg Raue and Frank Bayuk
We won't know until December when the Symposium issue of the Transactions appears what kind of job these two TRW employees did, but I have confidence it will be well done. Jorg is a member of AdCom as well. My only concern is his name is pronounced 'Yorg', and he doesn't always get my jokes. . . or is that 'yokes'?

John Kuno
This Hughesite is a past member of AdCom, Finance Chairman of the 1987 Symposium, and past Chapter Chairman of the L.A. Chapter. As I recall, John responded negatively when I requested

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his help, but I acted like I didn't understand Japanese and put him on the Committee as MMWMC Liaison, anyway.

H. George Oltman
George is 'Past' everything; AdCom President, L.A. Chapter Chairman, Hughes employee, and still serves on the Site Selection Committee for forthcoming symposia. I was motivated to invite George to serve as ARFTG Liaison to insure his wife would head up the Spouse's Program. . . but don't tell George. George is V.P. of Engineering at Tecom.

Al Clavin
Chairman of the Symposium in 1981, Past AdCom President, Fellow, Al has done it all. I didn't even have to ask Al, he volunteered! Retired and living in Del Mar, Al spent a lot of time in his Porsche driving to the meetings. 'Member At Large' means Al could answer most of the questions which came up, especially 'How was this done last time?'

Paul Greiling
Always active in MTT functions, Paul is a past member of AdCom, Distinguished Microwave Lecturer, and served on the Committee as 'Member at Large.' Paul is a member of the Staff at Hughes Research.

Steve Swift
Steve didn't have the opportunity to volunteer; I was in a position to draft him. Steve served as Arrangements Vice- Chairman, and was in charge of the Day Book to insure that no two functions were scheduled for the same room at the same time. While the Steering Committee had a large representation from TRW (8) and Hughes (6), Swift and Associates had the highest percentage (17%) of its work force serving on the Steering Committee.

Ken Yano and Michael Kim
Ken was TPC Vice-Chairman in 1987 and served in that position again. Michael presided over the 94 papers presented in the open forum. Both employees of TRW/Onderful, they were recruited by the persuasive Dr. Kagiwada.

Anyone who has ever worked on a steering committee will tell you it's a lot of work, with very little reward, except for the feeling you were part of a group responsible for putting on a successful meeting for your peers. I can testify it brought a lot of engineers from diverse companies together as a unit, making strangers into friends. So, when the Symposium comes to your area, write a note to the Chairman offering your services as a volunteer. It'll be an experience you'll remember fondly for a long time thereafter. I know on my part, I have memories for a life time.

If you'd like to share these memories, we have had a VHS tape made of some of the events. For only $19 you can get a tape with 104 minutes of Symposium events, including the Exhibitor Cocktail Party, the Awards Banquet and the 'One Penny Opera'. Just make your check out to the '1989 MTT-S Symposium', mail it to me and we'll send the tape out right away.

Reflections on the 1989 International Microwave Symposium Technical Program

by Reynold S. Kagiwada
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Reflecting back upon this year's Symposium, I am again greatly impressed by the high degree of commitment that is demonstrated by the volunteers of the Symposium Committee. They are truly the Symposium's greatest resource. They work hard solving the many minor problems so that the 1989 International Microwave Symposium could run smoothly and be a rousing success. On the Technical Program, microwave optical interactions and microwave superconductivity continued to evolve as new fields of great interest. As in previous years, the topic of monolithic ICs attracted a large number of contributed papers and listeners during the IMS. These sessions together with the Monolithic Symposium provides perhaps the most comprehensive annual update of this technology.

Over 1300 people attended the technical sessions. 19 different countries were represented and 296 papers were presented. The quality of the papers was outstanding and every session was well-attended.

The format of the technical program followed previous years which is well-suited for our Society. The ninety minute session lengths again worked well providing good homogeneous sessions. The quantity of short papers again exceeded the number of regular length papers, demonstrating their utility.

The Open Forum was extremely successful thanks to the good organization and management of Michael Kim. Due to the rigorous selection process a high standard of papers were present in both sessions. Special care was taken so there was adequate space for the eighty-nine presentations. The sessions had excellent attendance and with lively interchanges between author and attendees.

The Workshops, Panel Sessions and the Rump Session greatly enhanced the Technical Program. The registration was exceptionally high, indicating that John Horton did an outstanding job in selecting topics. Both John Horton and Ken Conklin worked hard to make these special sessions successful. Handouts at the workshops were again a big hit.

Focused Sessions were used to highlight technical areas of interests. John Horton worked very closely with Chi Lee, Ted Lukaszek, Erwin Belohoubek, and Jitendra Goel, organizers of sessions in (respectively): Optical Interaction with Microwaves, Microwave Acoustics, Superconductivity and High Power Microwaves. People enjoyed these areas of emphasis and in many cases the attendance was limited by room capacity.

The European Microwave Session featured invited papers by three well-known microwave engineers. Their papers on microwave imaging, modeling of passive components, and mm- and sub mm-wave LO sources were most effective.

For 1989 the most enthusiastic session was the Special Session honoring Dr. Seymour Cohn. The room was filled to capacity

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and at one time there was fear that this group would never leave. Peter M. LaTourrette, Kiyo Tomiyasu, George L. Matthaei, William H. Harrison and J.K. Hunton made formal presentations in tribute to Seymour.

The most inspiring presentations were given by the eminent keynote speakers which Chuck Swift worked diligently to obtain. The plenary keynote talk, 'Microwaves Among the Stars,' by Dr. Harold Rosen (Hughes Aircraft Company) provided a comprehensive review of the U.S. space program. Dr. Simon Ramo (TRW) discussed space communications as well as his career in microwaves. He stated that in his career selection process, he chose microwaves because at the time there were only a half dozen people working in the field. He therefore concluded that he could easily become an expert in the field. During his talk he conjectured that communication satellites could perhaps be replaced by reflecting signals off the ionosphere. Dr. Ramo sugested that a young engineer in his early twenties should consider this field as a career. He also said that he would be delighted if twenty years from now, a person in his early forties would report to him that he had followed his advice to a successful career.

In examining the 1989 Symposium, I believe that the Microwave Symposium has evolved into a highly successful format and it should be continued. The ninety minute sessions, short and regular papers, Open Forum, Panel Sessions, Workshops and Focused Sessions blend themselves exceptionally well. The Microwave and Millimeter-Wave Monolithic Circuits Symposium and Automatic Radio Frequency Techniques Group (ARFTG) Conference held during the same week as the Microwave Symposium give a complete and comprehensive coverage of microwaves and also should be continued.

I have found that the 1989 Symposium was an extremely rewarding experience and I enjoyed working with so many dedicated and talented people. I have received several favorable comments from the attendees about the outstanding quality of the Technical Program.

1989 Microwave and Millimeter-Wave Monolithic Circuits Symposium

by Reynold S. Kagiwada
TRW Electronic Systems Group
3117 Malcolm Ave.
Los Angeles, CA 90034

The 1989 IEEE Microwave and Millimeter-Wave Monolithic Circuits Symposium had an earth-shattering conference. A record number of one thousand fifty-one attendees (one hundred over the previous high in 1987) were treated to both an outstanding conference and a bit of California color. The Terrace Auditorium of the Long Beach Convention Center rocked gently during two papers in the opening session. The two speakers were impressed yet remained poised as they continued their presentations while the auditorium gently swayed back and forth. This Symposium was held June 12 and 13 in conjunction with the 1989 International Microwave Symposium at the Long Beach Convention Center and Entertainment Center, Long Beach.

The Monolithic Symposium activities began on Sunday, June 11, with a reception in the Hyatt Regency Seaview. This informal setting had a variety of hors d'oeuvres and cocktails where people could be seated and carry on pleasant conversations. About six hundred of the conference attendees and guests took this opportunity to socialize and have a charming evening.

The Symposium officially opened on Monday, June 12, in the Terrace Auditorium of the Long Beach Convention Center. Following the General Chairman's opening remarks, Dr. Alejandro Chu, the Technical Chairman, gave an overview of the technical program. The technical program was extremely extensive, consisting of thirty-five contributed papers and one invited paper, representing the state-of-the-art in microwave and millimeter-wave technologies. The eight sessions were all well attended and covered the areas of low noise amplifiers, monolithic power amplifiers, nonlinear circuits, advanced circuits and applications, control circuits, receivers and mixers, millimeter-wave amplifiers and broadband IC's.

The opening invited paper was on the 'Progress of MMICs in Japan,' by Masayoshi Aikawa, Hiroyo Ogawa and Takayuki Sugeta from Nippon Telegraph and Telephone Corporation, Japan. This presentation follows the theme initiated by last year's invited paper by Eliot D. Cohen (DARPA) on 'The MIMIC Program—Key to Affordable MMICs for DoD Systems,' in the United Sates. Dr. Ogawa gave an outstanding comprehensive paper on the present and future GaAs technologies' direction in Japan.

The Monday, June 12, Evening Panel Sessions to many people were the highlight of the symposium. These panels were: 'MIMIC Program Benefits to the MMIC Industry,' organized by Eliot D. Cohen (DARPA), 'FETs Beware Advancing Bipolar Technologies for High Frequency Applications: Si versus GaAs versus InP,' organized by Michael Kim (TRW) and 'Computer-Aided-Engineering for MICs and MMICs,' organized by Octavius Pitzalis, Jr., (EESOF Inc.). These panels were extremely well attended and gave the attendees an opportunity in an informal setting to get a comprehensive picture of MMIC technology. This first introduction of panel sessions to the Monolithic symposium was a roaring success and should be continued in future symposia.

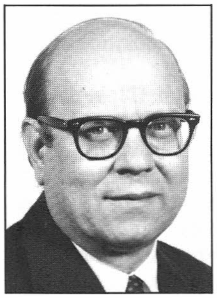
The second day's program, on Tuesday, June 13, was jointly sponsored by the MTT-S Microwave Symposium and was held at the Long Beach Convention Center with the other Microwave Symposium Sessions and Exhibition. The sessions were extremely active; however, they did not enjoy the earth movement of the previous day.

The organization and execution of a conference like the Monolithic Symposium requires the dedicated work of several individuals. For this year we were quite fortunate to have so many dedicated individuals. I would particularly like to thank the Monolithic Symposium Steering Committee, Technical Chairman Alejandro Chu, Finance Chairman Charlie Huang, MTT Liaison/Local Arrangements/Registration Chairman Octavius Pitzalis, Jr., and all the members of the Technical Program Committee. Publicity Chairman Dale Dawson who coordinated all the publicity and Hua Quen Tserng who worked with LRW Associates to publish the digest, Vice-Chairman Eric Strid for his dedicated support, Secretary William Perkins for recording the Steering Committee work, and Transaction Editor Vladimir Sokolov who enthusiastically handled reviewing and editing of the many papaers which will be published in the December Issue of the MTT-S Transactions.

The Monolithic Symposium would like to acknowledge the extra effort given to them by the Microwave Symposium Committee, particularly General Chairman Chuck Swift, Monolithic Liaison John Kuno, and Local Arrangements Chairman Pete Pusateri and Vice Chairman Steve Swift. The dedication of Larry and Margaret Whicker of LRW Associates was essential in several aspects of conference services.

In closing, I would like to thank again the many people who contributed to this outstanding symposium. I enjoyed it immensely and look forward to working with them in the future.

'Isn't That An SCR 584?'



by Roger W. Sudbury
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The story of the SCR 584 radar began with 1940 creation of the National Defense Research Council, the result of a 15 minute meeting of Vannevar Bush with President Roosevelt in 1940. When the meeting had ended, the notation 'OK FDR' was written on Bush's single page of ideas. The formation of NDRC led to a number of projects that were critical to the U.S. effort during World War II. A key project was the formation of the MIT Radiation Laboratory.

One of the three main tasks set out for the new laboratory under the direction of L.A. Dubridge was Project II, the development of a gun laying radar. This resulted in the design of the SCR 584, the first successful microwave radar with direct application for fire control and precision automatic tracking of aircraft and rockets (e.g., V-1). Creation of the SCR 584 radar for that task occurred in the Rad Lab Division 8, Fire Control and Army Ground Forces, under the leadership of Ivan A. Getting.

This was one example of the MIT Radiation Laboratory's many achievements and a part of a story that deserves retelling. Thanks to WGBH NOVA, the Rad Lab story will be available for a large national audience as a 1-hour television special, 'Echoes of War', to premiere on October 24, 1989. A brief account of events out of view of the camera will describe the important role the IEEE Microwave Theory & Techniques Society had in supporting the creation of this television program to bring the historical development of microwave radar before the general public.

How The TV Special Came About

The first question before the Steering Committee of the 1991 MTT-S Symposium (Boston) was how to celebrate the 50th anniversary of the Rad Lab. The theme was to be built around recognition of the great contributions by Rad Lab personnel, who were pioneers in our field, particularly in their scientific and engineering achievements. A small MTT group, consisting of Peter Staecker, Ted Saad, Harlan Howe, George Jerinic, and Roger Sudbury, began meeting to discuss actions that could be taken to develop this theme. As an effort was already underway to obtain audio-visual historical recordings on video tape for the MTT Society, an expansion of this ongoing effort was encouraged. Quickly this evolved into a desire for a professional quality video recording, not only for use at the Symposium and for the historical archives, but for wider distribution. A proposal for a high quality film was soon prepared, a modest budget estimated, and contact with producers of television documentaries established. When contact was made with WGBH to determine their interest in the proposal, it was with a certain amount of relief, not to mention great pleasure, to learn that they had already decided to produce such a film themselves. Their interest stemmed from earlier discussions with the MTT group relative to the merit of producing such a film. Discussions had been held with at least two people from WGBH and they had borrowed a number of books on the subject of the Radiation Laboratory from the MTT Historical Collection.

The writer, director, producer of the film was to be a Ms. Linda Garmon. Ms. Garmon had just finished a well received NOVA program on 'Superconductivity' and was already excited about producing another documentary. Suddenly, beyond expectations, a talented producer with excellent staff support and a major commitment from WGBH NOVA was undertaken to carry out this project.

With a producer as energetic as Linda Garmon and with a knowing persuasive resource in Ted Saad, other tasks still remained. Extra funds were needed for use of special film footage and a World War II radar was needed in the Boston area for a filming sequence. Efforts to undertake both tasks were soon underway with the small dynamic MTT group.

Why The SCR 584 Was Selected

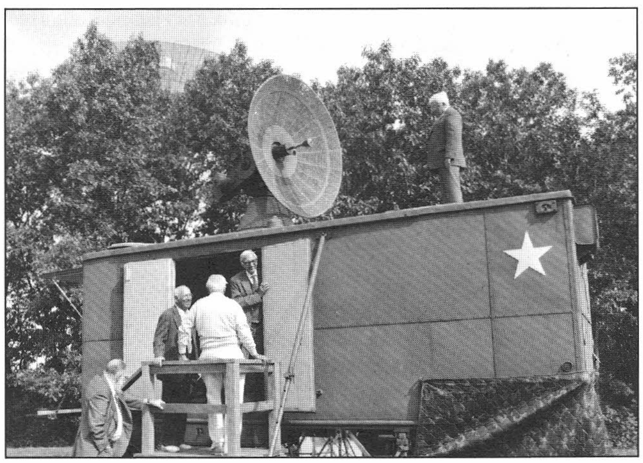
The Rad Lab designed radar selected for the documentary film sequence was the SCR 584 radar. One of the most successful and important radar developments, the SCR 584 was the first automatic tracking radar. It was designed as a mobile (10 cm) radar with a retractable mount for lowering the antenna into the trailer, capable of precision aircraft position finding and anti-aircraft fire control. Industry was called upon to handle the production, working closely with the Rad Lab. Ultimately, General Electric and Westinghouse were contracted to each build about 750 systems incorporating RCA receivers and Chrysler Corporation pedestals and gear boxes.

The SCR 584 radars contributed to the Allied success at Anzio and in North Africa and the Pacific. The radars provided coverage for the English coast and are credited with defeating the V-1 'buzz bomb' attacks. General Sir Frederick A. Pile in charge of the defense of London wrote to the Chairman of the U.S. Joint Chiefs of Staff, General George C. Marshall, 'The equipment you have sent is absolutely first class...'

An SCR 584 radar was found at the Historical Electronics Museum near Baltimore, Maryland and, with the help of Museum President Robert Dwight and Warren Cooper, it was made available for filming. This unit had been produced by Westinghouse-Baltimore in 1943. In the summer of 1988, volunteers guided by Ed Farkas at the Historical Electronics Museum began reconditioning and readying the radar for transfer to Boston.

Selecting A Site For The Film

A site atop Millstone Hill in Westford, MA, part of a field facility operated by MIT Lincoln Laboratory, had been selected for the filming location. The radar was moved by truck in September to the Westford site and assembled with the help of a volunteer museum team from Baltimore.



(L-R): Al Hill, Hank Abajian, Ivan Getting and Lee Davenport check out the packing crate while George Harris inspects the antenna, all under the watchful sidelobes of Haystack.

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ISN'T THAT AN SCR 584?
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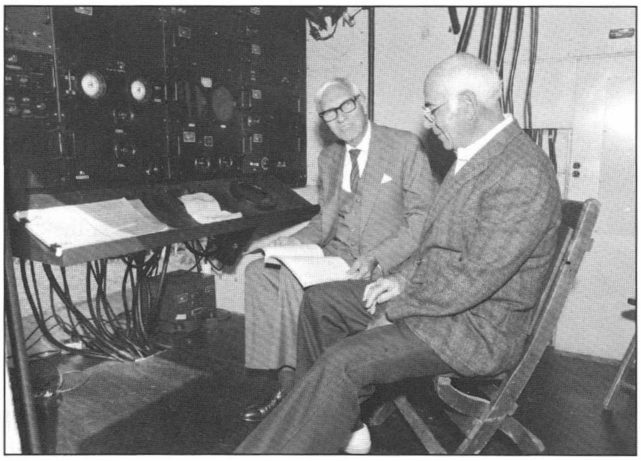
MIT Lincoln Laboratory was instrumental in providing the wide variety of equipment and services necessary for an operational radar system. Leo Sullivan added technical knowledge gained on the beaches of Anzio. Art Dyer produced his own set of original manuals, including detailed schematics. Richard Sparks organized several Raytheon employees to aid in the basic operations. More important, Clyde Brunduell made an impromptu trip to Connecticut when a cracked magnetron threatened to become a literal show stopper.

The (well-used) instruction manuals.

Reliving The Early Days

The Rad Lab story is one of people working together and dedicated to a common cause. It was said by one outsider that the 'Rad Lab ran several degrees hotter. . .' and that this had a positive effect on all organizations and people working with the Rad Lab. Even in the bringing of an SCR 584 radar back to operation, some of the Rad Lab spirit returned.

An older training film indicated that a crew of eight in World War II could install the radar and start operation in about 20 minutes. Maybe that training film would have been helpful, since the MTT crew labored for nearly a month to achieve operational status. The original documentation with its security classification now downgraded was very useful, even though the warning not to loosen the knurled knob first when changing the magnetron was read too late.



Lee Davenport (L) and Hank Abajian at the control console of the SCR-584.

Some changes were necessary to permit powering the unit from a remote motor generator running on grid power. The console had required some rewiring where connections were no longer available and the contacts with pins in others required careful positioning. In a concession to modern technology, a solid-state amplifier added gain to the signal path of the vacuum tube receiver section.

The Day Of Reckoning

On the day scheduled for filming in October, the high voltage was turned on, the magnetron modulated, and 10 cm pulses were transmitted. the off-axis dipole feed was rotating, the antenna drive caused the dish to scan, and the green glow of the received signals were clearly visible on the display as Rad Lab alumni arrived. Returning were Ivan Getting, director of the project, and his assistant, Lee Davenport. Hank Abajian, who had taken the SCR 584 radar to the Pacific theatre, and Leo Sullivan, who had operated the SCR 584 on the Anzio beach head were there. Other Rad Lab alumni who came included A.G. Hill, Ted Saad, L.D. Smullin, R.I. Hulsizer, G.B. Harris, and E. Maxwell.

During the SCR-584 shooting sequence: L-R (standing): Roger Sudbury, Lee Davenport, Linda Garmon, George Harris, Hank Abajian; L-R (sitting): Al Hill, Louis Smullin, Ivan Getting, NOVA crew member.

The P51 Mustang buzzes the Haystack antenna.

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ISN'T THAT AN SCR 584?
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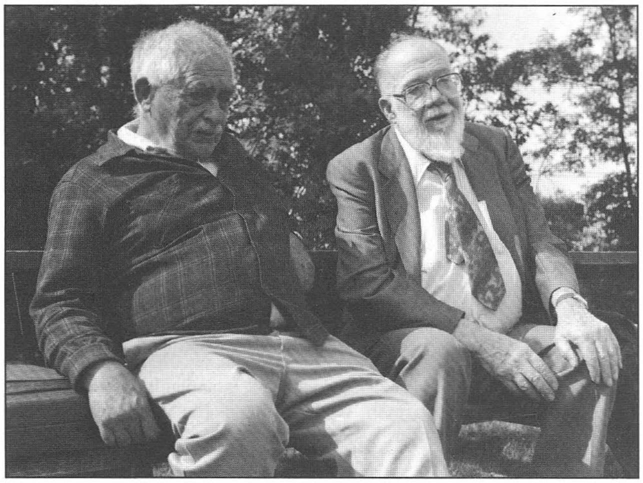
In crisp New England fall weather, the producer with her professional film crew carried out an efficiently organized schedule. During breaks in the filming, many remembrances of early days with the SCR 584 radar were shared with those whose experience was more recent. It was a rewarding event for all involved. A flyby of a vintage World War II P51 aircraft occurred, as planned, bringing an added touch of excitement.

Accolades For The MTT Team

With the filming complete, the site was dismantled, the antenna stowed, and the SCR 584 returned to the Historical Electronics Museum. While the behind-the-scenes work will not be seen on the television screen, viewing this historical documentary on the MIT Radiation laboratory will bring many rewards to the many individuals who contributed in their own way to this professional endeavor. WGBH NOVA plans to present 'Echoes of War' on the evening of October 24, 1989. Members of the IEEE and the MTT Society, in particular, look forward to this event, knowing that they have contributed to the documentation of our microwave radar history and its broad dissemination to the world.



Professors Smullin and Hill.

To assist WGBH in the funding of this project, financial contributions were obtained from the IEEE Foundation, MTT-S, AE-S, AP-S and ED-S. To acknowledge these contributions, there will be a freeze frame at the end of the film devoted to the IEEE.

Echoes of War

October 24, 1989

NOVA®

Don't Miss It!

MIT Radiation Lab's Wartime Efforts Featured in NOVA TV Program 'Echoes of War'

Technical Advice for the Program Supplied by the IEEE

NEW YORK, NY, August 18: The Institute of Electrical and Electronics Engineers, Inc. (IEEE) has served as a technical resource and has provided funding support for a 60-minute NOVA TV program entitled "Echoes of War," to air October 24 on PBS stations. "Echoes of War" focuses on the work of top scientists and engineers at the MIT Radiation Laboratory, tracing the development of radar from the onset of the war — when it was a crude early-warning device — to 1945, when it had become a sophisticated electronic eye that could track aircraft, detect submarines on the sea surface and guide bombing missions at night and in bad weather.

The IEEE Microwave Theory and Techniques Society, which was instrumental in providing technical and research support for the program, was one of several IEEE entities that contributed funding towards "Echoes of War." The IEEE Foundation and several other Institute Societies also donated funds to the project. NOVA, the award-winning weekly science and documentary series, is made possible by grants from public television stations, the Johnson & Johnson Family of Companies and by Lockheed. The series is produced for PBS by WGBH Boston. "Echoes of War" was produced for NOVA by Linda Garmon, whose program "Search for the Superconductor" is a contender for an Emmy award this year.

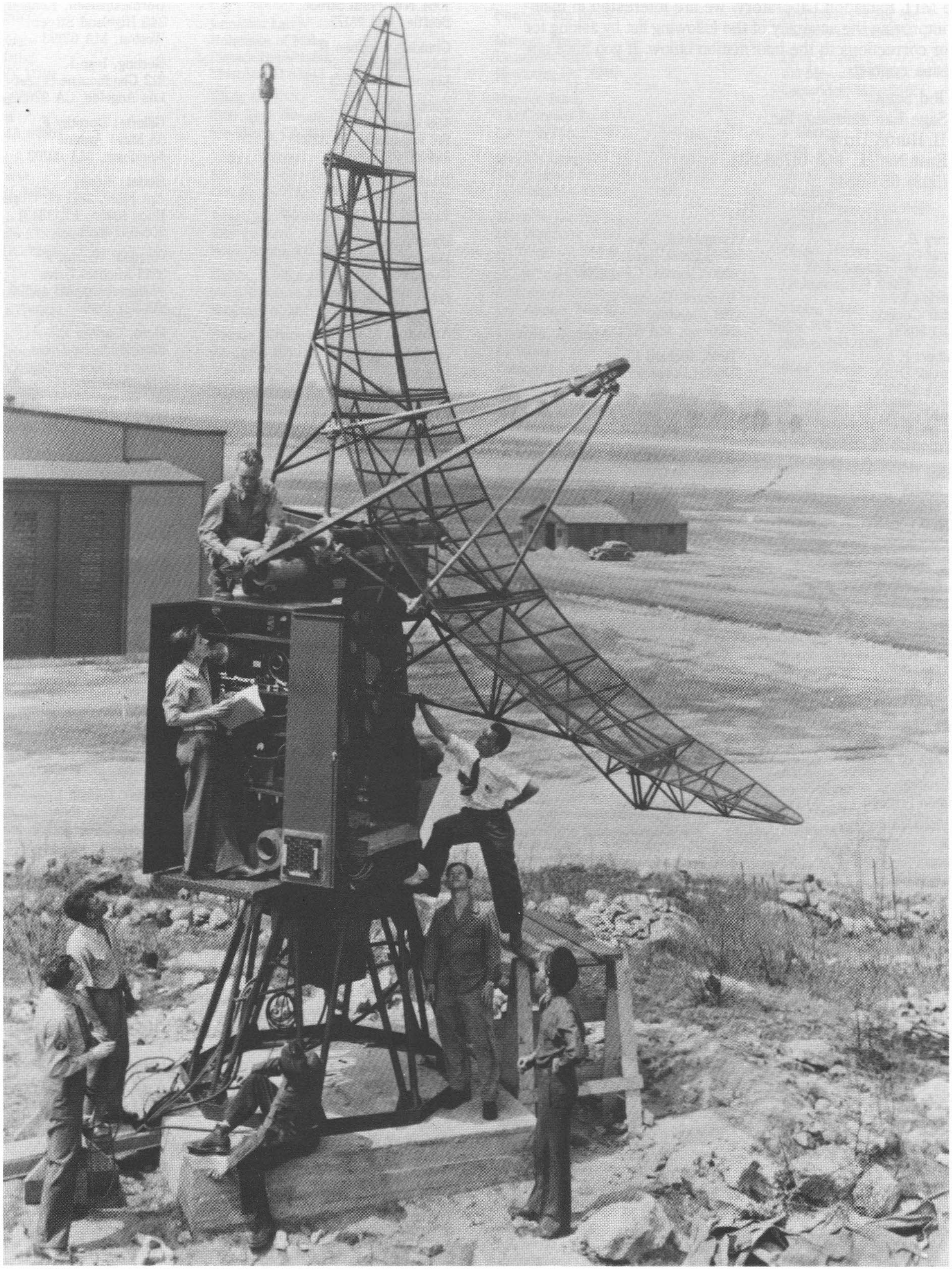
"One of the goals of the IEEE is to promote understanding of the influence of electrotechnology on the public welfare," stated V.G. Gelnovatch, president of the IEEE Microwave Theory and Techniques Society. "This program illustrates just how crucial a role radar played during WWII and how critical engineers' efforts were in developing its potential."

Perhaps the most important wartime use of radar was submarine hunting. Military historian, Alex Roland, of Duke University, underscores this point: "If England could have been starved into submission by the U-boat threat, then we would have lost a base from which to launch an invasion into Europe. It's a very real possibility that the United States would simply have had to accept a negotiated settlement with the Germans." According to one prominent RadLab physicist, I.I. Rabi, "Maybe we could have won it (the war) without the atomic bomb. . . but without radar, we could have lost it."

In order to show how a radar tracking system really works, an actual SCR-584 radar set — a system used during the war at the MIT RadLab — was rebuilt by a group of engineers, mostly retired from Westinghouse Electric Corporation with some help from Lincoln Laboratory engineers. Transported by trailer from Baltimore, where it had been on exhibit outside The Historical Electronics Museum, the refurbished system was set up at the Lincoln Laboratory in Boston, where it was filmed in an "on-the-air" demonstration of airplane tracking.

The MIT Radar research effort was also significant because it was one of the first large-scale collaborations in the U.S. between civilian scientists and the military, a forerunner to today's close collaboration on defense projects. Its accomplishment were the work of some 4,000 engineers and scientists. Eight of these went on to win the Nobel Prize, and two others became science advisors to future United States presidents.

Other IEEE Societies contributing support to "Echoes of War," in addition to the Microwave Theory and Techniques Society, include the Aerospace and Electronic Systems Society, the Antennas and Propagation Society, and the Electron Devices Society.



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In our continuing preparations for the 50th anniversary celebration of the MIT Radiation Laboratory, we are interested in maintaining or improving the accuracy of the following list by asking for additions or corrections to the information below. If you have any inputs, please contact:

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Wingate, Sidney A.
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Wood, Frederick B.
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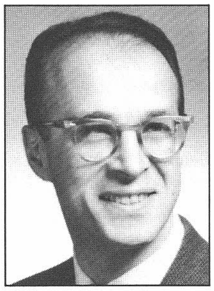
San Jose, CA 95125

Woodard, Richard H.
Box 8H
Wellfleet, MA 01778

Pioneer in the Development of Microwave Theory Receives First IEEE Heinrich Hertz Medal

Nathan Marcuvitz Honored June 2nd in San Francisco



Nathan Marcuvitz, Institute Emeritus Professor at Polytechnic University, Farmingdale, NY, received the first Heinrich Hertz Medal from the Institute of Electrical and Electronics Engineers, Inc. (IEEE) on June 2nd in San Francisco. The award recognizes outstanding achievement in the field of electromagnetic radiation, and is being bestowed on Dr. Marcuvitz for 'his fundamental theoretical and experimental contributions to the engineering formulation of electromagnetic field theory.'

During World War II Prof. Marcuvitz headed an experimental group at the MIT Radiation Laboratory working to identify properties of microwaves in various types of guiding structures. This information was critical to the development of radar systems.

After World War II, Dr. Marcuvitz concentrated on amplifying the engineering theory used to describe microwaves and on understanding their physical properties and their interaction with plasmas. Many of these improvements were incorporated by Dr. Marcuvitz into the *Waveguide Handbook*, volume 10 of the landmark MIT Radiation Laboratory Series.

Dr. Marcuvitz has been associated with the Polytechnic Institute of Brooklyn, and its successor, Polytechnic University, for over 40 years. He received his Bachelors degree (1935) and Masters degree (1941) before joining the staff at the MIT Radiation Laboratory. In 1946, he returned to the Polytechnic Institute of Brooklyn as an assistant professor; he earned his Ph.D. in 1947 and was named a full professor in 1951. In 1957 he was appointed Director of the Microwave Research Institute, and in 1961 was named Chairman of the newly-formed Department of Electrophysics. He later became Dean of Research and Dean of the Graduate Center at the Institute, and in 1965 left administration and became an Institute Professor. Dr. Marcuvitz was Professor of Applied Physics at New York University from 1966 to 1973, when he returned to Polytechnic Institute of New York.

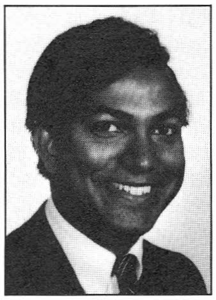
Dr. Marcuvitz is a member of the IEEE and the National Academy of Engineering. He is the author of numerous technical papers, book chapters and reports on electromagnetic and plasma wave dynamics.

Traps to avoid

☐ **Drinking cola** can cause magnesium deficiency, which increases susceptibility to heart disease and other disorders. A survey of high-blood-pressure sufferers showed that many had magnesium levels well below normal. . . *and* drank a large amount of cola. *Reason:* Cola is high in phosphoric acid, which binds with magnesium and pulls both out of the body. Most non-cola sodas use *ascorbic acid* rather than phosphoric, and don't have the same effect.

Kenneth Weaver, MD, associate clinical professor of obstetrics and gynecology, East Tennessee State University, Johnson City, quoted in *Longevity*, 1965 Broadway, New York 10023. Monthly. $24/yr.

Membership Development



by Fazal Ali
Pacific Monolithics, Inc.
245 Santa Ana Court
Sunnyvale, CA 94086-4512

1988 MTT-S Chapter Membership Results

Total MTT-S Memberhsip affiliated with Chapters was up 10.5%, more than twice the 3.4% increase in the total number of Chapters. The average MTT-S Chapter size increased by 6.8% over the 1987 average Chapter size. The MTT-Society added 2 Chapters during 1988. These statistics support the notion that our existing Chapters are doing a good job in adding Members.

Four Chapters, Atlanta, Dayton, India and UK/Ireland received Membership Development Recognition Awards at the 1989 International Microwave Symposium Chapter Chairperson's meeting.

— ATLANTA (Region 1-7 large Chapter Award)
— DAYTON (Region 1-7 small Chapter Award)
— INDIA (Region 8-10 small Chapter Award)
— UK/IRELAND (Region 8-10 large Chapter Award)

These awards, $200 check and a plaque, recognize the result of each Chapter's outstanding efforts in promoting MTT-S membership in 1988.

At the end of 1988, the MTT-Society was the 5th largest IEEE Society (among 35 Societies) with 11,750 active members and achieved our Society's growth goal of 10% for 1988. A table containing total active members by month for 1988 and for the last five years is shown below.

Month	1983	1984	1985	1986	1987	1988	Change From 1987 Total	Change From 1987 Percent	Society Growth Rank
January	6711	7085	7751	8370	9033	10063	1030	11.4	1
February	6085	6407	6971	7437	8234	8891	657	8.0	1
March	6468	6847	7465	7959	8627	9475	848	9.8	3
April	6336	6698	7356	7948	8490	9456	966	11.4	5
May	6465	6899	7512	8211	8755	9732	977	11.2	6
June	6577	7076	7728	8346	9229	9935	706	7.6	8
July	6649	7134	7770	8443	9365	10032	667	7.1	10
August	6707	7152	7827	8454	9447	10040	593	6.3	10
September	6811	7297	7943	8530	9705	10364	659	6.8	12
October	6972	7500	8150	8825	10038	10568	530	5.3	10
November	7145	7786	8475	9097	10321	11409	1088	10.5	3
December	7435	8064	8715	9445	10686	11750	1064	10.0	5

Current MTT-S Membership Status

The Society Membership has continued to increase steadily this year through May when compared on a month-by-month basis to the 1988 Membership results. The MTT-S membership growth rate (compared to the other 35 IEEE Societies) varied between fifth and tenth place for the first five months of 1989. At the end of May, the MTT-S Membership grew 6.7% when compared to the May 1988 results. This growth compares favorably to the IEEE Membership growth rate of 3.6% and to the IEEE Society Memberhsip growth rate of 6.6% for the same period. In addition, at the end of May the MTT-S was the 10th largest IEEE Society with 10,387 active members.

MTT-S IMS Membership Booth Enrolls 120 Members

The IEEE/MTT-S Membership Booth set up at the 1989 IEEE MTT-S International Microwave Symposium in Long Beach was a tremendous success. A record 120 new members enrolled with the society. Of this total, 85 members joined the IEEE in addition to the MTT-S, 13 current IEEE members took advantage of the free membership offer by the MTT-S and 22 students signed up for IEEE/MTT-S membership. Also, adding to the booth's success was servicing of many inquiries concerning current IEEE or MTT-S members. Thanks to all who participated in making this year's booth a success.

There will be a membership booth at the 1989 European Microwave Conference in London, England. The booth will be located in the registration area. Please stop by and visit with the Membership Service Committee members, AdCom members, and Chapter Chairmen who will be contributing their time to promote membership and answer questions regarding IEEE/MTT-S.

Lightwave Communications

by Reinhard H. Knerr
AT&T Bell Laboratories
555 Union Boulevard
Allentown, PA 18103
Phone (215) 439-7505

DISTINGUISHED MICROWAVE LECTURER (1988/1989)

Abstract

Lightwave communications technology has now reached a fairly sophisticated level of maturity. Applications range from multi-mode short wavelength LED systems, which can transmit at kilobits per second and are used primarily for short range applications, to long-haul single-mode laser systems, which can transmit at the rate of gigabits per second.

This talk will touch on the full range of lightwave communications applications. A short introduction to basic fiber technology will be given. Applications to optical data links and interfaces for point to point data networks, will be discussed as well as the extension of such technologies to lightwave local area networks (LANs). Different network architectures for lightwave LANs will be discussed, including the fiber distributed data interface (FDDI), and the manufacturing automatic protocol (MAP). Long haul digital systems will be mentioned, with special emphasis on the microwave aspects of gigabit systems, such as stripline and low noise GaAs preamplifier technology.

Coherent lightwave systems will be reviewed with emphasis on the equivalence between such systems and the older microwave technology. We will detail problems which have been addressed in microwave systems and which are now being encountered in coherent lightwave systems and being solved by analogy to the older microwave technology. These include techniques such as isolation, internal and external modulation schemes, low noise amplification and phase lock techniques. Emphasis will be placed on heterodyne rather than homodyne systems.

continued on page 16

LIGHTWAVE COMMUNICATIONS
continued from page 15

Because of the wide range of topics covered, the talk will be more in the nature of a review than an in-depth presentation of any given topic. Some theoretical discussion will be included, but hardware will be emphasized. We will conclude with a short look into the future, and a discussion of the fundamental problems that have yet to be solved in order to make certain exploratory systems practical.

Biography

Reinhard H. Knerr is a native of Pirmasens, Germany. He received a PhD and an MS in EE from Lehigh University, Bethlehem, PA and Dipl. Ing. degree from the Ecole Nationale Superieure d'Electrotechnique et d'Hydraulique in Toulouse, France and a BS degree from the Technical University of Aachen, Germany.

He joined AT&T Bell Laboratories as a Member of the Technical Staff in 1968. He was involved in R&D on circulators, IMPATT power amplifiers, low noise and power GaAs FET amplifiers and satellite receivers. He has published extensively in the field and holds six patents.

Knerr has supervised work in lightwave passive components, integrated optics, lightwave local area networks and lightwave data interfaces.

He is a Fellow of the IEEE and was editor of the Transactions on MTT from 1980 to 1982. He served as president of the MTT Society in 1986.

Microwave and Gigabit Superconductivity Electronics

by Arnold H. Silver
TRW Space and Technology Group
One Space Park, MS R1//2170
Redondo Beach, CA 90278
(213) 812-0115

DISTINGUISHED MICROWAVE LECTURER 1988/89

Superconductive electronics is an integrated circuit technology which can provide the highest performance detection and signal processing circuits from dc to the submillimeter-wave region and the fastest digital logic and memory. This performance is achieved by combining the fundamental properties of superconductors, the superconducting Josephson tunneling diode, and the cryogenic environment required for superconductivity.

This lecture will review the fundamental and historical development of superconductive electronics. Its inception traces from the successive discoveries of flux quantization, the Josephson effect and the SQUID (Superconducting Quantum Interference Device) in the early 1960's; its appliation is a direct consequence of the development of a thin film integrated circuit technology for computer applications. From a lead alloy technology in the 1970's, we now have a highly developed niobium circuit technology which is capable of operating at picosecond speeds and into the submillimeter-wave region.

We will discuss the performance and appliation of such components as quantum-noise limited microwave and millimeter-wave amplifiers, mixers, and video detectors, voltage-controlled oscillators, analog correlators and convolvers, and analog-to- digital converters. The recent discovery of superconductivity at temperatures as high as 95 kelvin may be herald the widespread use of superconductive circuits. Prospects for development and application of high temperature superconductive electonics, and its possible impact on semiconductor devices will be explored.

Biography

Arnold H. Silver joined TRW Space and Technology Group in 1981 after serving as Director of the Electronics Research Laboratory at the Aerospace Corporation for 10 years. Prior to that, he was with the Scientific Laboratory of the Ford Motor Company at Dearborn, MI for 12 years. He is a member of the IEEE, a Fellow of the APS, and has been active in the superconductive electronics community including service at Technical Program Chairman of the 1976 Applied Superconductivity Conference and a member of the Organizing Committees of the Workshop on superconductive Electronics and the US - Japan Workshop on Josephson Electronics.

Silver has been active in the development and application of superconductive electronics since his invention of the SQUID at Ford in the early 1960's. At Aerospace, his laboratory pioneered the development of low noise millimeter wave mixers and detectors, including the super conducting-Schottky diode and the quantum theory of superconductive Electronics Research at TRW, his group has pioneered the development of low noise microwave amplifiers and oscillators, analog-to-digital converters, a niobium-based itegrated circuit technology and now the development of a high temperature superconductive technology.

Silver received the BS, MS, and PhD degrees in Physics from Rensselaer Polytechnic Institute. His dissertation was on the application of nuclear magnetic and quadrupole resonance effects in the study of the structure of solids. He continued that research at Ford until his work on superconductive devices. He has authored more than 50 publicaitons and numerous patents.

Personal Electronics

☐ **Portable, paperless fax.** Up to 25 incoming pages can be stored on this pocket-sized machine and then viewed on a tiny TV that — believe it or not — you wear like a pair of glasses. The material can also be transferred to a computer with an adaptor. The system can send faxes that have been transferred into its memory from a computer. Great for the traveling executive.

Medbar division of Portafax. Available next year. $700.

☐ **Laptop word processor.** The first laptop dedicated word processor comes with a 50,000-character internal memory, a disc drive with storage capacity of 100,000 characters per disc and built-in software. The size of a small briefcase, the unit is battery-operated and comes with an AC adaptor. Data can be transferred to a PC. *Also included:* A tiny daisy-wheel printer.

Smith Corona PWP-270LT. Available this fall. $849.

IEEE Introduces the 'MTT Society Series' of Home Video Tutorials

Emerging Technologies

Co-produced by
Martin V. Schneider, *IEEE/MTT Society*
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Six experts present a state-of-the-art overview in five lecture videotapes

Lightwave Communications
by Reinhard H. Knerr, AT&T Bell Laboratories, Breinigsville, PA*

Lightwave communications technology has reached a fairly sophisticated level. Applications range from multi-mode, low bit rate, short wavelength, LED systems to single mode, long wavelength laser systems which can transmit information at the rate of many gigabits per second. This author discusses the full range of lightwave communications applications including basic fiber technology, applications to optical data networks, direct detection and coherent lightwave systems.

Gallium Indium Arsenide Heterostructures for Low Noise Amplification, High Speed Logic Circuits, and Lightwave Detection
by Umesh K. Mishra, Technical Staff, Advanced Devices, Hughes Research Laboratories, and April S. Brown, Outstanding Technical Achievement Award Winner, Hughes Research Laboratories, CA.

GaInAs has long been recognized for its excellent electronic properties and its wavelength compatibility with low loss optical fibers. The advent of advanced growth technologies such as MBE and MOCVD has led to the development of MODFETs and HBTs. This presentation addresses the status of the materials, device properties, circuits and applications of heterostructures based on InGaAs.

Gallium Arsenide—Key to Modern Microwave Technology
by Edward C. Niehenke, Westinghouse Defense and Eelctronic Center, Baltimore, MD*

Recent advances in microwave technology can be traced to developments in GaAs devices and circuits. GaAs has found its niche for the FET, HEMT, varactor, PIN, IMPATT and Gunn devices. The insertion of GaAs in the modern microwave system—whether communication, radar, electronic warfare, missile guidance or commercial—has improved reliability, efficiency, performance, and speed as well as extended the frequency range. GaAs is compared with other materials, its salient properties which benefit various semiconductor devices is highlighted and the latest device technology for discrete devices and monolithic circuits is reviewed.

High TC Superconductivity: Facts and Fancy
by Richard E. Howard, AT&T Bell Laboratories, Microelectronics Research Department, Holmdel, NJ

With the recent discovery of the high transition temperature superconductors, dramatic and wide-ranging claims have been made for the opening of a new era of technology. Examples that capture the imagination include high speed electronics, levitated trains, power transmission and high-field magnets for everything from controlled nuclear fusion to pollution control. While the new superconductors make the technoology more accessible, the need for cryogenic colling still limits applications. A more serious limitation is in the existing array of materials problems In this presentation, a balanced account of the potential applications for superconductivity and the problems yet to be overcome is given.

CAD of Hybrid and Monolithic Microwave and Millimeter-Wave MICs
by Rolf H. Jansen, Industrial Microwave and RF Techniques, Inc., Ratingen, West Germanay*

With the availability of transistors having useful gain n the mm-wave range, and the advanced development of GaAs monolithic MICs in the last five years, the demand for accurate and relaible CAD up to the highest frequencies is growing. The economic design of MMICs without CAD is simply impossible. Yet the development of sophisticated computer-aided design tools is far behind the pace of technology. In this presentation, the electrical phenomena which complicate the design of MICs are discussed. Also given is an overview of existing CAD packages and their specific features including linear and nonlinear CAD and the advantages and shortcomings of frequency-domain and time-domain analysis. Various MMIC designs are also demonstrated.

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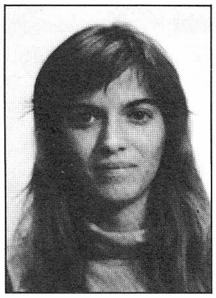
* *IEEE/MTT Society Distinguished Microwave Lecturer*

For Order Information Call IEEE Service Center, Piscataway, NJ, Phone (201) 562-5499.

MTT-S Speakers' Bureau



by April Brown
U.S. Army Research Office
Physics Division
P.O. Box 12211
Research Triangle Park, NC 27709

A new Speaker has been added to the Speakers' Bureau. Dr. Madhu Gupta is a Fellow of the IEEE and an expert in the area of noise in semiconductor devices. He will be available to speak on the 'Design of, and with, Low Noise Microwave Field Effect Transistors and MMIC's.' The abstract of the talk as well as Dr. Gupta's biography are included below. The table lists the Speakers' Bureau Members available at least through the Fall of 1989. Please encourage your Chapter Officers to take advantage of this service as soon as possible since only limited numbers of talks can be given by each of the Members. Also contact me for suggestions on new topics to be included in the future.

Design of, and With, Low Noise Microwave Field Effect Transistors and MMIC's

by Madhu S. Gupta
Hughes Aircraft Company,
Microwave Products Division
3100 W. Lomita Blvd., Torrance , CA
Phone: (213) 517-5864

ABSTRACT

The various noise generating mechanisms in MESFETs and HEMTs, and the spectra of the resulting noise, will be summarized. The noise in microwave and millimeter-wave FETs will then be modeled in terms of a noise equivalent circuit model. The measurement of the device noise, and the extraction of the model parameters from the measured data, will be discussed in detail. The specification and measurement of noise in FET circuits will then be reviewed briefly. The factors influencing the noise performance of an MMIC employing the FET will be identified, and their relative significance will be estimated. Techniques of low-noise circuit design will be discussed, along with illustrative examples of reported circuits having a low noise performance at the state-of-the-art.

Note: If a preference is known in advance, the lecture can be adapted to the audience by emphasizing one of the following areas:

(a) Design and performance of MMIC low noise amplifiers.

(b) Designing for reduced FM noise in FET oscillators.

(c) Low noise FET design, and the influence of device structure on the noise performance at device terminals.

BIOGRAPHY

Madhu S. Gupta received the Master's and Ph.D. degrees from the University of Michigan, Ann Arbor, Michigan in 1968 and 1972 respectively, where he was a member of the Electron Physics Laboratory, and carried out research on the large-signal and noise characteristics of microwave semiconductor devices.

During 1973-1979 he was first an Assistant Professor and then an Associate Professor of Electrical Engineering at Massachusetts Institute of Technology, Cambridge, Massachusetts, where he was a member of the MIT Research Laboratory of Electronics, and conducted research on microwave and millimeter-wave semiconductor devices, relating high-field transport properties, and thermal fluctuations. From 1979 to 1987 he was at the University of Illinois at Chicago, where he served as Professor of Electrical Engineering, and worked on the characteristics and limitations of electron devices that are nonlinear, noisy, and very small. During 1985-1986, he was a Visiting Professor at the University of California, Santa Barbara.. Since 1987, he has been with Hughes Aircraft Company, working at Hughes Research Laboratories, Malibu, California, and at Microwave Products Division, Torrance, California, where he is a Senior Staff Engineer and is engaged in the modeling, design and characterization of GaAs MMIC devices and circuits, and the evlauation of in-process wafers.

Dr. Gupta is a member of Eta Kappa Nu, Sigma Xi, Phi Kappa Phi, and the American Society for Engineering Eductaion, and is a Professional Engineer. He has served as the chairman of the Boston and Chicago Chapters of the IEEE Microwave Theory and Techniques Society, and of an IEEE Standards Committee. He was a Lilly Fellow during 1984-85, and was elected Fellow of the IEEE 'For contributions to the characterization and modeling of noise in high-frequency semiconductor devices and in microwave integrated circuits.' Dr. Gupta has published nearly 100 writings, including journal articles, conference and invited papers, patents, book chapters, and reviews. He is the editor of *Electrical Noise: Fundamentals and Sources* (IEEE Press, 1977), *Teaching Engineering: A Beginner's Guide* (IEEE Press, 1987), and *Noise in Circuits and Systems* (IEEE Press, 1988), and is a member of the Editorial Board of *IEEE Transactions on Microwave Theory and Techniques*.

Better Ways

☐ **To cope with territorial people** (those who fiercely defend *their* departments, etc.): Don't invade their territory. Instead, communicate via the means *they've* established (write a memo, make a phone call, set up a meeting)... acknowledge the person as *owner* of the territory by using his/her title (*Example:* You're the head of the data-processing department, and I need your help)... don't laugh—territory is survival for this type of person.

Dinosaur Brains: Dealing With All Those Impossible People At Work by Albert J. Bernstein, John Wiley & Sons, 605 Third Ave., New York 10158. $18.95.

☐ **If you think you're being followed** while driving your car, *don't* go home. Drive directly to a police station or, if that's not possible, to an open business, and call the police from there to report the incident—along with the license-plate number of the pursuer's car—if you can read it.

How to Locate Anyone Anywhere Without Leaving Home by Ted Gunderson. E.P. Dutton, 2 Park Ave., New York 10016. $8.95.

☐ **Travelers who dress** like important businesspeople generally receive preferential treatment from airline personnel. *Helpful:* Wear a suit, carry a briefcase and garment bag.

Consumer Reports Travel Letter, 256 Washington St., Mt. Vernon, New York 10533. Monthly. $37/yr.

MTT SPEAKER BUREAU (SB) / VIDEOTAPE LECTURES (VT) : SUMMARY INFORMATION					
Lecturer	**Affiliation**	**Topic**	**VT**	**SB**	**Abstract & Biography Ref (Newsletter)**
Heinrich Daembkes Phone: 49-731-392-4272	AEG Research Center Sedanstrasse 10, D-7900 Ulm West Germany	Microwave and Millimeter-Wave HEMT Devices and Circuits		X	Winter 1988
Pierre Encrenaz Phone: 33-45-347530 FAX: 33-45-342151	Observatoire de Paris 92190 Meudon, France	The Impact of Coherent Detection Techniques on Terrestrial and Planetary Atmospheric Research, and on The Discovery of Interstellar Molecules		X	Spring 1988
Fred Gardiol Phone: 41-21-472670 FAX: 41-21-4746600	Ecole Polytechnique, Dept. D'Electricite El-Ecublens, CH-1015 Lausanne, Switzerland	Microstrip Circuit Analysis: The Integral Approach		X	Winter 1988
Paul Goldsmith Phone: (413) 665-8551 FAX: (413) 665-2536	Millitech Corp. South Deerfield, MA	Quasioptical System Design for Millimeter Wavelengths		X	Summer/Fall 1988
Madhu S. Gupta Phone: (213) 517-5864	Hughes Aircraft Company Microwave Products Division 3100 W. Lomita Blvd. Torrance, CA	Design of, and with, Low Noise Microwave Field Effect Transistors and MMICs		X	Summer 1989
C. Holmes **P. Parrish** **O. Pitzalis** Phone: (818) 991-7530	EEsof Incorporated 5795 Lindero Canyon Road Westlake Village, CA 91362	GaAs FET and HEMT Modeling Circuit and System Simulation — State of the Art and Beyond		X	Spring 1988
Richard E. Howard Phone: (201) 949-5952 FAX: (201) 949-8988	AT&T Bell Laboratories Crawford Corner Road Holmdel, NJ 07793	High TC Superconductivity: Facts and Fancy	X		Winter 1989
Rolf H. Jansen Phone: 49-2101-83095 FAX: 49-2101-842391	Industrial Microwave and RF Techniques, Inc. Neanderstrassse 5 D-4030 Ratingen 1 West Germany	CAD of Hybrid and Monolithic Microwave and Millimeter-Wave MICs	X		Summer/Fall 1988
Reinhard H. Knerr Phone: (215) 297-5432 FAX: (215) 391-2570	AT&T Bell Laboratories Route 222 Breinigsville, PA 18031	Lightwave Communications	X		Summer/Fall 1988
U. Mishra Phone: (919) 737-7354 **A. Brown** Phone: (919) 549-0641	N.C. State Univ. (U.M.) Raleigh, NC 27695 Army Research Office (A.B.) Durham, NC 27709	Gallium Indium Arsenide Heterostructures for Low Noise Ampliciation, High Speed Logic Circuits, and Lightwave Detection	X	X	Summer/Fall 1988
Edward C. Niehenke Phone: (301) 765-4573 FAX: (301) 993-7432	Westinghouse Electric Corp. P.O. Box 746—M.S. 75 Baltimore, MD 21203	Gallium Arsenide—Key to Modern Microwave Technology	X		Winter 1986
Erwin Schanda Phone: 41-31-658910	Institute of Applied Physics University of Bern CH-3012 Bern, Switzerland	Remote Sensing with Microwave and Millimeter Waves		X	Winter 1988
Kurt Weingarten Phone: (415) 962-0755 FAX: (415) 962-1661	Lightwave Electronics 897-5A Independence Ave. Mountain View, CA 94043	Testing of High Speed ICs with Ultrashort Optical Pulses		X	Summer/Fall 1988
Michael Wengler Phone: (716) 275-9402 FAX: (716) 275-0135	Dept. of Electrical Engineering University of Rochester Rochester, NY 14627	Submillimeter Heterodyne Detection with Superconductive Electronics		X	Summer/Fall 1988
Bernard Yurke Phone: (201) 582-4961	AT&T Bell Laboratories 600 Mountain Avenue Murray Hill, NJ 07974	Quantum Noise in Microwave and Millimeter-Wave Electronics		X	Winter 1988

Open Letter to Chapter Chairmen

I enjoyed meeting many of our Chapter Chairmen at the recent MTT Symposium in Long Beach. We had an excellent exchange of information (and an excellent dinner) at the Chapter Chairmen's meeting. I appreciate the time each of you contributed to this. I benefitted significantly from hearing your reports and comments and I hope you also found the meeting useful.

As the new Chairman of the Chapter Activities Committee, I am looking forward to serving each of the Chapters during the coming year. I will be in contact with you via the Newsletter, direct mailings, and telephone. Hopefully, I will also be meeting most of you next year in Dallas at the 1990 Symposium. Developing these lines of communication is important to the Society. In order to make such communication easier, we will be adding members to the Chapter Activities Committee this year and making an effort to contact each of the Chapter Chairmen more frequently.

I hope that our Committee will be able to assist your Chapters in the coming months. I certainly welcome any comments or suggestions you have to guide us in this task. Some of you might also have experiences with activities that have been successful for your Chapter that you could share with other Chapter officers. Please contact me with this kind of information so that we can get the word to others who can benefit.

Mike Golio
MTT Chapter Activities
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(602) 732-2292

Thought and Action Aren't Mutually Exclusive

Scholarship Competition Essay

by Fredrik Rehnmark

Imagine this scene. An Engineer and a Philosopher sit over a game of chess in a room dimly lit by the setting sun. The Philosopher pulls his prized beard, the emblem of a lifetime of thought, out of his way as he leans over the board to pick up a black knight. He proceeds to move the knight so that it threatens a white rook.

'Yes, the move stands. It's your turn,' he advises the Engineer while hiding a sly smile.

'Indeed,' the other responds, 'you have put me in an uncomfortable situation.' One eyebrow arches slightly in annoyance.

'Verily, that was my intent from the beginning.'

The ensuing pause is rather lengthy. The Engineer ponders his predicament while the Philosopher raps his fingernails, grown long to advertise the solely mental nature of his work. Finally, the Philosopher breaks the silence, 'So you concede your own inferiority at last...and therefore your relative inessentiality.'

'I'll do nothing of the sort,' says the engineer, calmly amused.

'What!' protests the Philosopher.

'Oh! Come now, how can you be so blind?' scolds the Engineer.

The Philosopher, his face a shade of purple never achieved by most people, stands up and sends his chair lurching backward. 'Philosophy is the oldest discipline known to Man. I'll have you know that recent excavations in Asia prove that Neanderthal Man pondered-'

'I could list no less than thirty tools essential to those excavations which, but for the efforts of countless engineers, would still be wished-for figments of the imagination, crazy and intangible as opium smoke. Advise your pompous little circle of intellectual friends of that.'

'You have absolutely no right to profane the illustrious careers of the world's greatest thinkers. Thought does have to come before action, after all, and all this nonsensical prattle of yours is just a pitiful attempt to catch me off my guard.' The sun sinks below the horizon completely.

'Perhaps,' is the maddening reply. 'But I might even go so far as to mention that thought and action, independent of each other, are all but meaningless; only when coupled together do they culminate in useful ends. And that is precisely why Engineering is, and will most certainly continue to be, just as essential to the human race as Philosophy.'

The Engineer holds up a hand to forestall the Philosopher's answer. With the other hand he operates a simple toggle switch so that white light floods the now-dark room.

'Consider the electric lights above us, for instance. Without the initial idea there would be absolutely nothing to work from. But without the Engineer to design the light bulb and make it practical, we might just as well bid each other 'good night.''

The Engineer slides his rook to take a black pawn on the opposite side of the board as the Philosopher, uncharacteristically silent, watches with his mouth agape.

'Checkmate, I believe?'

If we accept that engineering is the 'art of applying science to the optimum conversion of the resources of nature to benefit man' (Encyclopedia Britannica), it certainly seems plausible that one of the aims of engineering in any nation is to raise its standard of living. History has proved that engineering performs very admirably in this respect. Heavy industrialization, in which engineering plays a crucial role, usually brings with it substantial improvement in the wealth, health, and leisure time of the people in the countries wherein it is implemented. Great Britain and the U.S. can serve as examples of this. In countries like India and China, on the other hand, where engineering doesn't play such a big role in the population's daily life, the majority of the people spend their lives struggling just to survive. I consider it a worthy goal of engineering to raise the standard of living in developing and undeveloped nations, as well as to maintain it in industrialized countries.

Engineering is not always so productive, however. Its capacity for destruction has been revealed by disasters such as Hiroshima, Chernobyl, and Pan Am Flight 103. Consider also the continuing Arms Race between NATO and the Warsaw Pact. It occurs to me that, in each of these cases, the element of 'action' shamelessly trampled its essential partner, 'thought,' and led to the unethical application of engineering. A second role of engineering in the future, then, must consist of undoing the evil perpetrated by the misguided application of that selfsame discipline in the past.

Additionally, the engineer of the future will be called on to continue providing avenues for technological progress. The U.S. government certainly pursues this goal as it spends tremendous sums of moneuy on the businesses that make accelerating progress in the arms and space race possible. The public naturally finds those products that incorporate the most technology and design to be the most impressive and will spend its money appropriately. Given our definition of engineering, it is not surprising that the businesses initiating all of this progress are engineering firms.

If the nations of the world hope to continue making advances in the future, they must continue to engineer. In many respects, the technological prowess and might of future nations will depend on the quality of their engineering. They will be able to boast of record-breaking standards of living, unsurpassed GNPs, and colonies in space because their engineers made these technological advances possible. The job of the future engineer will remain essentially unchanged from what it has been through all history: to forge practical design out of the initial idea.

Promoting Engineering Awareness

by Keith H. Snow
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The Quality of Education in the U.S.

In the June issue of the IEEE IMPACT publication, there was an article by George F. Abbott, Executive Vice-President of the IEEE, entitled 'U.S. Competitiveness and Primary Education.' In this article, Mr. Abbott focuses on the quality of elementary education-the poor quality of elementary education-in the United States today. Mr. Abbott points out that more and more college freshmen need remedial math and science to cope with rigorous engineering and science courses. He concludes his article suggesting that the IEEE, with 240,000 members in the U.S. alone, can help by approaching other technical and professional societies with our concerns. In concert with other organizations, the IEEE can publish articles and launch initiatives in state and federal legislatures to promote more rigorous pre-college education.

In fact, statistics have shown that average scores on the Scholastic Aptitude Tests (SATs), taken annually by about 1 million college-bound high school students, declined during the period from 1963-1986. Math score averages declined by 35 points and verbal score averages declined by 53 points. In an increasingly complex technological society, it is ludicrous that this should be allowed to happen, particularly in the face of technological advances being made by other highly competitive countries. Also consider that the high school drop-out rate in the U.S. is around 27% and that the fraction of university students studying engineering is only 7 in 1000. Comparatively, Japan boasts a high school drop-out rate of less than 2%. In Japan, 40 out of every 1000 university students are studying engineering.

An affiliate of the Syracuse University Electrical Engineering Department recently involved with recruitment of potential engineering students, disclosed that interested candidates were generally ignorant of college engineering curricula and future engineering career opportunities. In light of this information, these individuals are certainly unaware of many of the challenging engineering problems facing the world today and tomorrow: problems which could drastically affect the lives of us all.

An increased level of awareness of the engineering profession at all pre-college educational levels is needed. Young people want to grow up to be doctors, firemen, policemen, astronauts, or teachers, because they are exposed to these professionals on a regular basis. Although their interaction with or exposure to engineering is much more pronounced, given the combined scope of civil, mechanical, electrical, bio-medical, and chemical engineering disciplines, students know very little about engineering. More generally, as IEEE Executive Vice-President Abbott suggests, we should strive to promote pre-college education across the board.

What is an Engineer?

How acute is the engineering awareness problem? With the aid of teachers from schools in Springfield, MA, Syracuse, NY, and Washington, DC, we sampled over 200 Junior High School and High School students, asking the question, 'What is an Engineer?' Here are several typical responses:

'I have no idea what an engineer does and I don't know anyone who is an engineer. Me personally I want to be an architect but I suppose engineering can be very challenging and interesting. All I figure is that an engineer fixes broken electrical appliances. Don't be too depressed though because there are worse things such as sanitation engineers.'
High School Sophomore

'An engineer is someone who likes to calculate things to perfection. If you try to correct an engineer, they will always demand that they are correct. (I should know, my step-father is an engineer.) That's about all I know about engineers.'
High School Junior

'I have little information on what exactly engineers do, but I know that they lead a very important life. I know no engineers personally, but I know they use math very frequently so I will try just for the sake of engineers to succeed in math, my inspiration, just in case I decide to be an engineer. And the next time I meet one I'll make sure to ask him exactly what he does and what kind of grades did he get in math.'
High School Sophomore

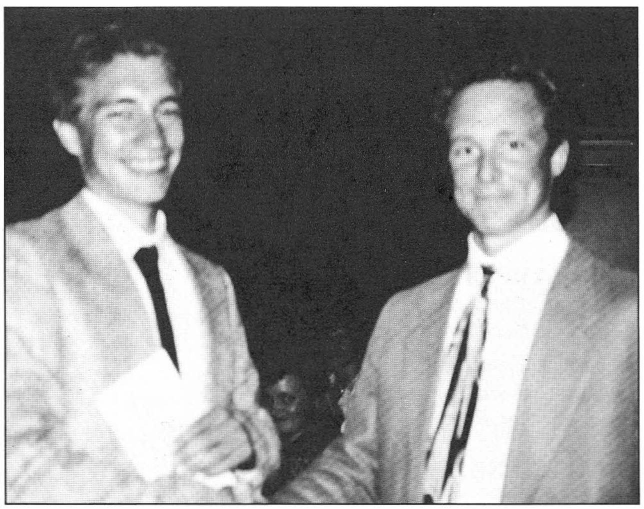
'Definition of an engineer: I don't know—O.K.?!'
High School Senior

Twenty-five percent believed an engineer drove (or worked on) a train. Twenty percent believed that an engineer worked with machinery of some kind. Thirty percent explicitly stated 'I don't know,' and the remaining twenty-five percent clearly had no idea either.

Essay Contest Rules

The Syracuse Chapter of the Microwave Theory & Techniques and Antennas & Propagation Society recently sponsored a local essay contest for Onondaga County (NY) High School seniors planning to pursue an engineering degree at an accredited College or University. The entries indicate that there are at least a few high school students who are aware of the engineering profession and its relationship to society.

The winning esay was written by Mr. Fredrik Rehnmark, a recent graduate of the Skaneateles Central High School, in Skaneateles, New York. Mr. Rehnmark plans to pursue a degree in Electrical Engineering from Cornell University beginning in September, 1989. Mr. Rehnmark received an award for $500 at the local Syracuse IEEE Fellows Night Banquet. This essay represents Mr. Rehnmark's understanding of 'How Engineering Will Direct the Future.'



Frederick Rehnmark (L) accepts winning essay award from Keith Snow at Syracuse IEEE Fellows Night Banquet.

Chapter Officers of MTT-S Chapters Formed in 1989

by Zvi Galani
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The following Chapters were formed between 1/89 and 6/89. I would appreciate receiving information about Vice-Chairpersons and terms of office. My address is listed above.

CHAIRPERSON — **VICE-CHAIRPERSON**

INDONESIA (MTT/AP/AES/COM/BT)
AdCom Liaison: R. A. Sparks
Term of Office: Unknown

Chairperson	Vice-Chairperson
Arnold Djitwatampu DirJen Posand Telecommunication Jl. Kebon Sirith 37 Jakarta 10340 Indonesia	Unknown

ITHACA (MTT)
AdCom Liaison: K. K. Agarwal
Term of Office: 1/89--12/89

Chairperson	Vice-Chairperson
Richard C. Compton Cornell University School of Electrical Engrg. Phillips Hall Ithaca, NY 14853 (607) 255-9231	Ann Robers Cornell University School of Electrical Engrg. Phillips Hall Ithaca, NY 14853

KOREA (MTT)
AdCom Liaison: R. S. Kagiwada
Term of Office: Unknown

Chairperson	Vice-Chairperson
Jung-Woong Ra Korea Adv. Inst. of Science and Technology P.O. Box 150 Cheongryang Seoul, Korea	Unknown

NEW HAMPSHIRE (MTT)
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Chairperson	Vice-Chairperson
Robert O. Geoffroy Sanders Associates, Ind. 955 Perimiter Road CS 8500 Manchester, NH 03108-8500	Unknown

CHAIRPERSON — **VICE-CHAIRPERSON**

NEW SOUTH WALES (MTT/AP)
AdCom Liaison: M. A. Maury, Jr.
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Chairperson	Vice-Chairperson
Bruce MacA. Thomas CSIRO Division of Radiophysics P.O. Box 76 Epping, NSW 2121 Australia	Unknown

NORTH ITALY (MTT/AP/ED/CAS)
AdCom Liaison: R. A. Sparks
Term of Office: Unknown

Chairperson	Vice-Chairperson
Carlo V. Naldi Politecnico di Torino Dip. Elettronica Corso Duca Degli Abruzzi, 24 10129 Torino Italy	Unknown

SAO PAULO (MTT)
AdCom Liaison: Unassigned
Term of Office: Unknown

Chairperson	Vice-Chairperson
Denise Consoni CP 8174 Escola Politecnica — USP Sao Paulo SP Brazil CEP 01051	Unknown

VIRGINIA MOUNTAIN (MTT/ED)
AdCom Liaison: R. A. Moore
Term of Office: Unknown

Chairperson	Vice-Chairperson
Inder J. Bahl ITT/GTC 7670 Enon Drive Roanoke, VA 24019	Unknown

MTT-S Chapter Meetings (1987/1988/1989)

Reporting Period: 5/9/88-6/26/89

Presented below is a list of meetings reported by 37 MTT-S Chapters (approximately 60% of the total number of MTT-S Chapters). Please help me keep up to date records of Chapter meetings by sending me a *copy* of IEEE Form L-31 after every meeting. My address, telephone number and FAX number are listed below.

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CHAPTER MEETINGS

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ALBUQUERQUE (MTT/AP/EMC)

Gardner, Robert, Mission Research Corp., 'Lightning Kiva Research,' 3/15/88. Attendance: 22.

Generosa, John, Physical Research Inc., 'Survey of High Power Microwaves,' 7/26/88. Attendance: 42.

Baum, Carl, Air Force Weapons Lab, 'Three Techniques for Monitoring Faults in Shielded Enclosures,' 9/8/88. Attendance: 18.

Burnside, Walter, Ohio State University, 'Compact Ranges and RCS Measurement Techniques,' 11/8/88. Attendance: 26.

Buttram, Malcolm T., Sandia National Laboratories, 'Pulse Power R&D at Sandia National Laboratories,' 2/21/89.

Bacon, Larry D., Sandia National Laboratories, 'High Power Microwaves R&D at Sandia National Laboratories,' 6/2/89. Attendance: 31.

BALTIMORE (MTT/AP)

Bhagot, Satindar, Univ. of Maryland, College Park, MD, 'Superconductors and High Temperature,' 2/9/88. Attendance: 26.

Hovanessian, S. A., Aerospace Corp., Los Angeles, CA, 'Synthetic Aperture Radar,' 3/16/88.

Pengelly, Raymond S., Tachonics Corp., Plainsboro, NJ, 'GaAs MMIC Applications,' 10/26/88. Attendance: 17.

Gray, Henry F., Naval Research Laboratory, Washington, DC, 'Vacuum Microelectronics,' 1/18/89. Attendance: 18.

Adam, J. D., Westinghouse Electric Corp., Pittsburgh, PA, 'MSW Channelizers and Frequency Selective Limiters,' 3/15/89. Attendance: 15.

BEIJING (MTT)

Lin, Weigan, Univ. of Electronic Science and Technology, Chengdu, People's Republic of China, 'Static Problems in Microwave Power Applications,' 5/8-11/89. Attendance: 120.

BUFFALO (MTT/AP)

Gilmour, A. S., State Univ. of New York, Amherst, NY, 'High Power Microwave Tube Technology,' 11/17/88. Attendance: 20.

CENTRAL AND SOUTH ITALY (MTT/AP)

Franceschetti, G., Univ. di Napoli, 'Elaborazioni di Segnali SAR per Televeilevamento,' 10/26/88. Attendance: 50.

Steinberg, Bernard D., Univ. of Pennsylvania, 'High Resolution Microwave Imaging,' 1/24/89. Attendance: 35.

Gwarek, W., Warsaw Univ. of Technology, Warsaw, Poland, 'Finite Difference Time Domain Analysis of Two-Dimensional Microwave Circuits,' 2/15/89. Attendance: 25.

CENTRAL NEW ENGLAND/BOSTON (MTT)

Baker, John S., Sanders Associates, 'Technology Trends in Microwave Countermeasures Sources,' 3/17/88. Attendance: 21.

Heaton, John L., Sanders Associates, 'Development and Application of Broadband MMICs,' 5/12/88. Attendance: 31.

CHICAGO (MTT/AP)

Knop, Charles M., 'A Glimpse of Antenna Technology—Past to Future,' 5/9/88. Attendance: 35.

COLUMBUS (MTT/AP)

Reber, Grote, 'Radio Astronomy—Reber's 50th Year,' 3/1/88. Attendance: 25.

Munson, Robert E., Ball Aerospace Systems, 'Microstrip Antennas - Principles and Applications,' 4/1/88. Attendance: 54.

Thiele, Gary A., University of Dayton, 'High Power Microwaves,' 4/7/88. Attendance: 25.

Senior, Thomas B. A., University of Michigan, 'Simulation of Material Effects in Scattering,' 4/21/88. Attendance: 39.

Hoots, L. Clyde, Brunswick Corp., Marion, VA, 'Introduction to Radomes,' 5/10/88. Attendance: 30.

Kildal, Per-Simon, Norwegian Institute of Technology, Trondheim, Norway, 'Artificially Soft and Hard Surfaces in Electromagnetics and Their Application,' 'Analysis of Multi-Reflector Antennas by Dynamic Ray Tracing,' 6/15/88. Attendance: 32.

Wohlleben, Rudolph, Max Planck Institute for Radio Astronomy, Bonn, West Germany, 'Feed Systems for the 100 Meter Eiffelberg Radio Telescope,' 6/17/88. Attendance: 34.

Luebbers, Raymond, EE Dept., Pensylvania State University, 'Application of GTD to Prediction of Terrain Effects on Radio Propagation Path Loss,' 6/20/88. Attendance: 30.

Ryan, Charles, Georgia Tech Research Institute, Atlanta, GA, 'Electromagnetic Scattering from Aircraft Ducts and Other Inlets,' 6/23/88. Attendance: 42.

Kraus, John, Ohio State University, Columbus, OH, 'Antennas, Our Electronic Eyes and Ears on the World,' 10/11/88. Attendance: 173.

Bhasin, Kul B., NASA Lewis Research Center, Cleveland, OH, 'High Frequency Solid State Electronics: Integration of GaAs, Photonic and Superconducting Technologies,' 10/27/88. Attendance: 21.

Sandor, Ed, Rogers Corp., Chandler, AZ, 'Microwave Properties of Materials,' 11/2/88. Attendance: 31.

Shupe, David M., Allied-Signal Aerospace Co., Columbia, MD, 'New High-Speed Devices Based on the InGaAs/InAlAs/InP Heterojunction Technology,' 11/10/88. Attendance: 15.

Mills, Robert, Ohio State University, Columbus, OH, 'What Is a Photon?,' 12/1/88. Attendance: 47.

Steinberg, Bernard D., Univ. of Pennsylvania, Philadelphia, PA, 'High Resolution Microwave Imaging,' 2/8/89. Attendance: 39.

Felsen, Leopold B., Polytechnic University, Farmingdale, NY, 'Gaussian Beams: They Aren't What They Used To Be,' 2/23/89. Attendance: 50.

Felsen, Leopold B., Polytechnic University, Farmingdale, NY, 'Complex Source Pulsed Beams: A New Analytical Tool for Pulsed Focused Propagation and Diffraction,' 2/24/89. Attendance: 39.

Filipsson, Gunnar, Saab Missiles, Sweden, 'Attenuation of Surface Waves on a Metal Plane,' 3/7/89. Attendance: 24.

Tai, Chen-To, Univ. of Michigan, Ann Arbor, MI, 'A Systematic Treatment of Vector Analysis,' 3/28/89. Attendance: 54.

Schuermeyer, Fritz, Wright Patterson AFB, Ohio, 'Advances in Heterostructure FET Technology for Digital Applications,' 3/30/89. Attendance: 22.

DALLAS (MTT)

Blanchard, A. J., University of Texas at Arlington, Arlington, TX, 'Wideband Polarimetric Inverse Synthetic Aperture Radar,' 8/29/88. Attendance: 42.

Steinberg, Bernard D., Univ. of Pennsylvania, Philadelphia, PA, 'High Resolution Microwave Imaging,' 11/9/88.

Itoh, Tatsuo, Univ. of Texas at Arlington, Arlington, TX, 'Microwave and Millimeter Wave Research in the University of Texas at Arlington,' 1/13/89. Attendance: 17.

Eastman, Lester, Cornell University, Ithaca, NY, 'High Performance Heterojunction FETs,' 4/20/89. Attendance: 25.

DAYTON (MTT/AP)

Volakis, John L., Univ. of Michigan, Ann Arbor, MI, 'Conjugate Gradient—Fast Fourier Transform Techniques: Applications to Electromagnetic Radiation and Scattering,' 12/15/88. Attendance: 24.

Boerner, W. M., Univ. of Illinois-Chicago, Chicago, IL, 'Recent Advances in Radar Polarimetry,' 1/24/89. Attendance: 15.

Steinberg, Bernard, Univ. of Pennsylvania, Philadelphia, PA, 'High Resolution Microwave Imaging,' 2/8/89. Attendance: 20.

Gupta, Inder, Ohio State University, Columbus, OH, 'Adaptive Arrays for Satellite Communication,' 3/29/89. Attendance: 23.

Kouyoumjian, Robert, Ohio State Univ., Columbus, OH, 'History and Significance of the IEEE Fellow Award,' 4/11/89. Attendance: 83.

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CHAPTER MEETINGS
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Menza, Dean, Pacific Missile Test Center, Pt Mugu, CA, 'Focused Microwave Imaging Techniques,' 5/22/89. Attendance: 29.

FINLAND (MTT/AP)
Gupta, Ramesh K., COMSAT, Clarksburg, MD, 'System Applications of GaAs MMICs,' 9/9/88. Attendance: 45.

Olver, A. D., Queen Mary College, London, England, 'Millimeter Wave Systems—Past, Present, and Future,' 12/19/88. Attendance: 42.

Maas, Stephen A., Aerospace Corp., Los Angeles, CA, 'Optimization of Diode Mixers and GaAs MESFET Amplifiers by the Volterra Series,' 5/29/89. Attendance: 38.

FRANCE (MTT)
Itoh, Tatsuo, Univ. of Texas, Austin, TX, 'Integrated Millimeter Wave Components Using Quasi-Optical Design Combined With Planar Structures,' 2/24/89.

Sorrentino, Roberto, Univ. Degli Studi, Rome, Italy, 'Modeling of Microwave and Millimeter Wave Passive Components,' 5/26/89. Attendance: 24.

HOUSTON (MTT/AP/ED/MAG)
Clarricoats, Peter, Queen Mary College, London, England, 'Satellite Communications and the Fiber Optics Challenge,' 11/4/88. Attendance: 63.

Tai, Chen-To, Univ. of Michigan, Ann Arbor, MI, 'A Systematic Treatment of Vector Analysis,' 12/2/88. Attendance: 31.

Pai, David M., Univ. of Houston, Houston, TX, 'Electromagnetic Analysis and Computation of Integrated Circuits,' 1/27/89. Attendance: 19.

Munson, Robert E., Ball Aerospace Corp., Boulder, CO, 'Microstrip Antennas: Principles and Applications,' Braginski, A. I., Westinghouse Research and Development Center, Pittsburgh, PA, 'Applied Superconductivity: A Dream or a Reality,' 4/24/89. Attendance: 52.

LOS ANGELES (MTT)
Smith, Andrew, TRW Space and Technology Group, Redondo Beach, CA, 'Microwave Applications of Superconductivity,' 4/19/88. Attendance: 103.

MILWAUKEE (MTT/ED)
Patterson, John, Midwestern Relay, Milwaukee, WI, 'Technology, Economics and Service—Some Thoughts on the Current Telecommunications Marketplace,' 10/21/87. Attendance: 24.

Ishii, Thomas, Marquette University, Milwaukee, WI, 'High Speed Deep Space Communications,' 11/18/87. Attendance: 69.

Sandor, Ed, Rogers Corp., Minneapolis, MN, 'Characteristics of Teflon Printed Circuit Materials,' 10/26/88. Attendance: 18.

Brauer, John, MacNeal-Schwendler Corp., Milwaukee, WI, 'Finite Element Analysis of Microwave Devices,' 4/19/89. Attendance: 14.

MONTREAL (MTT/AP)
Hovanessian, S. A., Aerospace Corp., Los Angeles, CA, 'Sensor Systems—From Microwave to Electro-Optical,' 5/19/88.

NEW JERSEY COAST (MTT/ED/LEO)
Brown, A. S., U.S. Army Research Office, Research Triangle Park, NC, 'GaAs Materials and Characterization,' 9/27/88. Attendance: 43.

Kaminow, I. P., AT&T Bell Laboratories, Holmdel, NJ, 'Photonic Local Networks,' 11/17/88. Attendance: 26.

Swartz, R. G., AT&T Bell Laboratories, Holmdel, NJ, 'High Speed Integrated Circuits,' 1/26/89. Attendance: 14.

Lin, S. H., Lee, T. C., Bell Communications Research, Red Bank, NJ, 'Multipath Fading for Line-of-Sight Microwave Radio,' 2/21/89. Attendance: 30.

Cox, Don, Bell Communications Research, Red Bank, NJ, 'Portable Digital Radio,' 4/20/89.

Wilson, R. W., AT&T Bell Laboratories, Holmdel, NJ, 'Interstellar Molecular Clouds,' 5/25/89. Attendance: 32.

NEW YORK/LONG ISLAND (MTT)
Lee, Chi H., University of Maryland, 'Measurement of Monolithic Millimeter Wave Circuits by Picosecond Optical Electronic Sampling Techniques,' 9/14/88. Attendance: 12.

Longo, Frank, Hypres Inc., 'Time Domain Reflectometry,' 11/22/88. Attendance: 13.

NORTH JERSEY (MTT/AP)
Ivanek, Ferdo, Communications Research, Palo Alto, CA, 'Technological Progress in Terrestrial Digital Microwave Communications,' 5/19/88. Attendance: 33.

Schinneler, Ron, ITT, 'MMIC Technology,' 9/21/88. Attendance: 48.

Tucker, Rodney, AT&T Bell Laboratories, Holmdel, NJ, 'Microwave and Millimeter Wave Modulation of Semiconductor Lasers,' 2/16/89. Attendance: 61.

Rohde, U., Compact Software, 'Optimization of Nonlinear Circuits,' 5/18/89. Attendance: 64.

ORLANDO (MTT/AP)
Steinway, Bill, Coleman Research, Orlando, FL, 'Mine Detection Using Radar,' 10/21/88. Attendance: 13.

Clarke, R. H., Imperial College, London, England, 'The Angular Spectrum Used in Antenna Measurement, Radar Scattering and Optical Device Design,' 1/30/89. Attendance: 22.

Tucker, Rodney, AT&T Bell Laboratories, Holmdel, NJ, 'Microwave and Millimeter Wave Modulation of Semiconductor Lasers,' 2/16/89. Attendance: 47.

OTTAWA (MTT/AP)
Berolo, O. and Borkowski, P., Communication Research Center, Shirley Bay, Ottawa, Ontario, Canada, 'Semiconductor Compounds,' 11/29/88. Attendance: 25.

PHILADELPHIA (MTT/AP)
Brookner, Eli, Raytheon Co., Wayland, MA, 'Radar—Past, Present and Future,' 9/15/88. Attendance: 39.

Jaggard, Dwight L., University of Pennsylvania, Philadelphia, PA, 'Fractals as New Tools for Electromagnetics,' 10/11/88.

Snow, Keith H., General Electric Co., Syracuse, NY, 'Recent Advances in GaAs Technology,' 11/17/88. Attendance: 9.

Schwering, Felix K., US Army Electronics Command, Fort Monmouth, NJ, Millimeter Wave Antennas,' 1/19/89. Attendance: 15.

Fante, Ronald L., MITRE Corp., Bedford, MA, 'Review of Open Literature Techniques for Radar Cross Section Reduction,' Belohoubek, Erwin, SRI David Sarnoff Laboratories, Princeton, NJ, 'Importance of High Tc Semiconductors for Microwaves,' 2/21/89. Attendance: 34.

Hartman, R. E., Flam & Russell, Inc., Horsham, PA, 'Radar Cross- Section Measurements,' 4/11/89. Attendance: 36.

Engheta, Nader, Univ. of Pennsylvania, Philadelphia, PA, 'Chirality in Electromagnetics: Principles and Applications,' 5/16/89.

PHOENIX (MTT/AP/ED/EMC)
Southwick, Roger, EMC Consulting, 'Theory of EMI Signal Measurement Applications to Automation,' 5/26/88. Attendance: 9.

El-Ghazaly, Samir M., Arizona State University, 'Traveling-Wave Inverted-Gate Field-Effect Transistors,' 9/20/88. Attendance: 26.

Alvarez, A. R., Aspen Semiconductor, San Jose, CA, 'An Overview of BiC-MOS Technology and Applications,' 10/17/88. Attendance: 32.

Hashemi-Yeganeh, Shahrokh, Arizona State University, 'Analysis of Untilted Slots Excited by Tilted Wires,' 11/15/88. Attendance: 18.

Tsui, Raymond K., Motorola Inc., Tempe, AZ, 'Molecular Beam Epitaxy: An Overview and Device Applications,' 1/24/89. Attendance: 25.

Burnside, Walter D., Ohio State University, Columbus, OH, 'Compact Ranges and RCS Measurement Techniques,' 2/15/89. Attendance: 55.

Kosonocky, Walter F., New Jersey Institute of Technology, Newark, NJ, 'Infrared Image Sensors with Schottky-Barrier Detectors,' 3/22/89. Attendance: 15.

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Bennett, W. Scott, 'Neglected Aspects in Radiated Emissions Measurements' 3/29/89. Attendance: 15.

Goronkin, Herb, Motorola Phoenix Corp. Research Labs, Tempe, AZ, 'Instabilities in Compound Semiconductor Field Effect Transistors,' 5/18/89. Attendance: 30.

PRINCETON (MTT/AP/ED)
Hammer, Jacob, David Sarnoff Research Center, Princeton, NJ, '2D Surface Emitting Laser Diode Array,' 10/20/88. Attendance: 6.

Simonis, George, Harry Diamond Labs, Adelphi, MD, 'Optoelectronic Generation, Control, and Distribution of Microwaves,' 4/13/89. Attendance: 20.

RIO DE JANEIRO/BRAZIL (MTT/AP/ED)
Conrado, Luiz F., 'Conversion Characteristics Analysis of Dual Gate FETs,' attendance: 14. De Salles, Alvaro A., 'Introduction to Gigabit Logic in GaAs,' attendance: 12. Brandao, Paula A., 'Design and Characterization of DR Filters at 900 MHz,' attendance: 11. Castro, Renato M., Ruiz, Fernando D., 'Introduction to Monolithic Microwave Integrated Circuits,' attendance: 13. Speakers' affiliation: Catholic University, Rio de Janeiro, Brazil. 8/15/88.

Carvalho, Maria C., 'Determination of Semiconductor Lasers Dynamic Characteristics,' attendance: 12. Rocco, Maria Thereza, 'GaAlAs Semiconductor Lasers,' attendance: 8. Barbosa, Luciana, Martinez, Maria A., 'Low FM Noise Oscillators at 2 and 5 GHz,' attendance: 12. Mosso, Marbey M., 'Circuit Theory of Dual Mode Filters,' attendance: 11. Speakers' affiliation: Catholic University, Rio de Janeiro, Brazil. 8/22/88.

Conrado, Luiz F., 'Upconversion from 70 MHz to 4 GHz Using a Dual Gate FET,' attendance: 11. De Salles, Alvaro A., 'Quasi-Planar Structures on GaAs Substrates,' attendance: 10. Mosso, Marbey M., 'Modulator for Laser Diodes at 0.03—3 Gbit/s Band,' attendance: 8. Brandao, Paula A., 'Study of Cylindrical Cavities for Application in DR Filters,' attendance: 6. Speakers' affiliation: Catholic University, Rio de Janeiro, Brazil. 8/29/88.

Carvalho, Maria C., 'Theoretical Studies of the DC and Dynamic Characteristics of a InGaAsP Laser,' attendance: 9. De Salles, Alvaro A., '5 to 1 GHz Downconverters and Self-Oscillating Mixers,' attendance: 9. Mosso, Marbey M., 'Soldering Techniques for Microwave Circuits,' attendance: 9. Martinez, Maria A., 'Coupling Through Iris Between Cylindrical Waveguides,' attendance: 6. Speakers' affiliation: Catholic University, Rio de Janeiro, Brazil. 9/5/88.

SAN FERNANDO VALLEY (MTT)
Eliott, Scott, Hewlett-Packard Co., 'SAW Devices—A Tutorial,' 9/16/87. Attendance: 38.

Whelehan, James, Eaton-AIL, 'Noise Figure Tutorial,' 11/18/87. Attendance: 60.

Robertson, Ralston, Hughes, 'Transmitter for SAR,' 3/16/88. Attendance: 34.

Estreich, R. Donald, Hewlett Packard Co., 'Nonlinear CAD for MMICs,' 5/18/88. Attendance: 46.

Polczynski, Chris, Lockheed ASC, 'Application of Fiber Optics and Integrated Optics for Aircraft,' 1/19/89. Attendance: 35.

Keythley, Gary, Amplica, 'Microwave Component Integration Using Coplanar Waveguide,' 3/16/89. Attendance: 38.

Berson, Bert, Berson Associates, 'Strategies for Microwave and Millimeter Wave Packaging,' 5/18/89.

SANTA CLARA VALLEY/SAN FRANCISCO (MTT)
Majewski, Marian, Univ. of California, Santa Barbara, 'Effects of Optical Illumination on Microwave MESFET and MODFET Characteristics,' 5/12/88. Attendance: 21.

SEATTLE (MTT/AP)
Staecker, Peter, M/A-COM Inc., Burlington, MA, 'Millimeter Wave Solid State Transmitters,' 1/21/88. Attendance: 11.

Ivanek, Ferdo, Communications Research, Palo Alto, CA, 'Microwave Digital Communications,' 2/24/88. Attendance: 14.

Hovanessian, S. A., Aerospace Corp., Los Angeles, CA, 'Sensor Systems—From Microwave to Electro-Optical,' 4/28/88. Attendance: 27.

Leader, Raymond, Meteor Communication Corp., 'Meteor-Burst Communications,' 5/10/88. Attendance: 6.

Virtue, M., Wallace, J., Boeing Electronics, Seattle, WA, 'Millimeter Wave Network Analyzer Measurements,' 10/5/88. Attendance: 6.

Hiller, Gerald, M/A-COM, Burlington, MA, 'Microwave Semiconductor Diodes Fundamentals and Applications,' 12/7/88. Attendance: 11.

Wallace, J., Virtue, M., Harvey, D., Boeing Electronics, Seattle, WA, 'Millimeter Wave Network Analyzer Measurements,' 1/11/89. Attendance: 12.

Khanna, A. P. S., Avantek Inc., Santa Clara, CA, 'Recent Advances in Microwave Oscillators,' 2/16/89. Attendance: 25.

DiPiazza, Gerald, M/A-COM Inc., Chelmsford, MA, 01824, 'Microwave Modules—Promising New Initiatives,' 4/18/89. Attendance: 11.

ST. LOUIS (MTT/AP/ED)
Tijhuis, Anton G., Delft Univ. of Technology, The Netherlands, 'Global Techniques for Solving Time-Domain Electromagnetic Scattering Problems,' 10/11/88. Attendance: 6.

Myer, Jeannine A., McDonnell Douglas Astronautics Co., St. Louis, MO, 'Scattering from Flat Plates,' 11/15/88. Attendance: 9.

Lazechko, William D., Central Microwave Co., St. Louis, MO, 'High Power Microwave Amplifier Design,' 12/6/88. Attendance: 16.

Munson, Robert E., Ball Aerospace, Broomfield, CO, 'Microstrip Antennas: Principles and Applications,' 2/13/89. Attendance: 19.

Schwering, Felix K., US Army Electronics Command, Fort Monmouth, NJ, 'Millimeter Wave Antennas,' 3/13/89. Attendance: 22.

SWEDEN (MTT/AP)
McIsaac, Paul, Cornell University, Ithaca, N.Y., 'Symmetry Analysis of Microwave Structures,' 5/30/88. Attendance: 13.

Rutledge, David, California Institute of Technology, Pasadena, CA, 'Millimeter Wave Integrated Circuits,' 9/21/88. Attendance: 25.

Katehi, Linda, Univ. of Michigan, Ann Arbor, MI, 'Problems in Microstrip and Slot Antennas,' 5/25/89. Attendance: 17.

SWITZERLAND (MTT/AP)
Clarricoats, P. J. B., Queen Mary College, London, England, 'Reflector Antennas for Satellite Systems,' 4/22/88. Attendance: 12.

Clarricoats, P. J. B., Queen Mary College, London, England, 'Satellite Systems and the Optical Challenge,' 4/25/88. Attendance: 23.

Pozar, David, Univ. of Massachusetts, Amherst, MA, 'Spectral Domain Moment Method for Printed Antennas,' 4/29/88. Attendance: 9.

Pozar, David, Univ. of Massachusetts, Amherst, MA, 'Feeding Techniques for Microstrip Antenna Element,' 5/6/88. Attendance: 9.

Mosig, Juan, Ecole Polytechnique Federale de Lausanne, Lausanne, Switzerland, 'Analyse d'Antennes Microruban de Forme Arbitraire Avec la Methode des Moments,' 5/20/88.

Pozar, David, Univ. of Massachusetts, Amherst, MA, 'Mutual Coupling in Microstrip Arrays,' 6/3/88.

Pozar, David, Univ. of Massachusetts, Amherst, MA, 'Analysis of Infinite Arrays of Microstrip Antennas,' 6/17/88.

SYRACUSE (MTT/AP)
Windyka, John, General Electric Co., Syracuse, NY, 'Applications of MMIC Technology,' Adams, Steve, General Electric Co., Syracuse, NY, 'C-Band Phase and Gain Control MMIC,' 9/14/88. Attendance: 28.

Harrington, Roger, Syracuse University, Syracuse, NY, 'Electromagnetic Analysis of Printed Circuits,' 10/13/88. Attendance: 53.

Nachampkin, Jack, Lockheed Missile and Space Co., 'K-Space Electromagnetics at Lockheed Missile and Space,' 10/26/88. Attendance: 23.

Schaubert, Daniel, Univ. of Massachusetts, Amherst, MA, 'Printed Circuit Antennas,' 12/2/88. Attendance: 28.

Von Puttkamer, NASA Goddard Space Flight Center, Washington, DC, 'Engineering in Space—The Next Twenty Years,' 2/22/89. Attendance: 60.

Skolnik, Merrill, Naval Research Laboratories, Washington, DC, 'Impulse Radar,' 4/12/89. Attendance: 82.

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TOKYO (MTT)
Saad, Theodore S., Sage Laboratories, Natick, MA, 'The History of MIT Radiation Laboratory,' Kobayashi, Yoshio, Saitama University, Urawa Saitama 338, Japan, 'Dielectric Resonators and Their Application to Compact Filters,' 3/13/89. Attendance: 38.

TUCSON (MTT/AP/EMC)
Eldon, Bud, Past President IEEE, 'What the IEEE Can Do for You,' 4/24/86. Attendance: 33.

Mense, Allen, Chief Scientist, 'Strategic Defense Initiative (SDI),' 5/28/86. Attendance: 32.

Kohlbacher, Howard, Tucson PACE Chairman, 'Education—The Key to America's Future,' 11/25/86. Attendance: 26.

James, Clint, Kitt Peak, 'Multiple Mirror Telescopes,' 12/12/86. Attendance: 50.

Swift, Calvin, Univ. of Massachusetts, Amherst, MA, 'Advanced Sensors for Microwave Remote Sensing,' 3/19/87. Attendance: 26.

Weaver, Albert, Univ. of Arizona, 'Super Collider Super Conductor,' 5/26/88. Attendance: 28.

Bronaugh, E. L., Electro-Metrics Inc., Amsterdam, NY, 'Scan Speed Limits in Automated EMI Emission Measurements,' 'Testing to Military Specifications with Automated Test Equipment,' 10/13/88. Attendance: 18.

TWIN CITIES (MTT)
O'Clock, George, Mankato State Univ., Mankato, MN, 'Satellite Microwave Systems,' 2/20/88. Attendance: 28.

Gill, George, Millitech Corp., 'Monopulse Antenna Techniques,' 3/19/88. Attendance: 35.

Larson, Joel, Hewlett-Packard Co., 'Measurement Techniques Using the HP8510 Network Analyzer,' Kotz, Eugene, Kotz Graduate School, 'Engineering Management is the Focus,' 4/23/88. Attendance: 22.

Fryklund, David, M/A-COM Inc., 'MMIC Component Design and Application,' 5/21/88. Attendance: 26.

Gopinath, Anand, Univ. of Minnesota, 'High Frequency GaAs PIN Diode Switch Design,' 11/19/88. Attendance: 24.

WASHINGTON/NORTHERN VIRGINIA (MTT)
Horton, John, TRW, Redondo Beach, CA, 'Microwave Technology in Major Systems; Systems Overview,' 10/11/88. Attendance: 60.

Schrank, Helmut, Wetinghouse Electric Corp., Baltimore, MD, 'Microwave Technology in Major Systems; Antenna Technology,' 11/16/88. Attendance: 65.

Whelehan, J. J., Eaton/AIL, Melville, NY, 'Microwave Technology in Major Systems: Front End Design Technology,' 12/13/88. Attendance: 68.

Eisenson, Henry, Sciteq, San Diego, CA, 'Microwave Technology in Major Systems: LO/Synthesizer Technology,' 1/10/89. Attendance: 59.

Thal, Herb, General Electric Co., Philadelphia, PA, 'Microwave Technology in Major Systems: Filter/Multiplexer Technology,' 2/14/89. Attendance: 45.

Thomas, Henry J., Raytheon Co., Wayland, MA, 'Microwave Technology in Major Systems: Transmitter Technology,' 3/14/89. Attendance: 25.

Berg, Rex, Hewlett Packard Co., Loveland, CO, 'Microwave Technology in Major Systems: Automated Systems Testing,' 4/11/89. Attendance: 23.

WEST GERMANY (MTT/AP)
Doring, H., Technische Hochschule Aachen, Aachen, West Germany, 'Klystron and Gyrotron, a Survey (in German),' Hochschild, G., Kernforschungszentrum Karlsruhe Gmbh, Karlsruhe, West Germany, '150 GHz Gyrotron Experiments in the Nuclear Research Center Karlsruhe (in German),' 12/18/87. Attendance: 38.

LECTURES GIVEN BY DISTINGUISHED MICROWAVE LECTURERS

Columns: 1. Chapter. 2. Date. 3. Attendance.

David K. Barton
1987/1988 Distinguished Microwave Lecturer
ANRO Engineering Consultants
5 Militia Drive, Lexington, MA 02173
Phone (617) 862-3000
'Technology Trends in Microwave Radar'

Buffalo	02/18/88	17
Los Angeles	05/17/88	95
Milwaukee	02/17/88	65
Montreal	06/02/88	
New York/Long Island	05/11/88	33
St. Louis	05/16/88	
Tucson	01/21/88	23
Twin Cities	09/21/88	32

Rolf H. Jansen
1987/1988 Distinguished Microwave Lecturer
Industrial Microwave and RF Techniques Inc.
Neanderstrasse 5, D-4030 Ratingen 1, West Germany
Phone: 49-2102-83095
'CAD of Hybrid and Monolithic Microwave and Millimeter-Wave MICs'

Buffalo (Video Tape)	05/09/89	10
Finland	03/22/88	42
Milwaukee (Video Tape)	03/15/89	8
Ottawa	04/19/88	40
Spain	10/14/88	32
Twin Cities	10/15/88	35

Reinhard H. Knerr
1988/1989 Distinguished Microwave Lecturer
AT&T Bell Laboratories, 555 Union Blvd., Allentown, PA 18103
Phone: (215) 439-7505
'Lightwave Communications'

Albuquerque	10/10/88	16
Buffalo	09/08/88	30
Columbus	03/09/89	25
Finland	04/06/89	84
Los Angeles	06/21/88	37
Milwaukee	04/20/88	47
Santa Clara Valley/San Fran.	06/23/88	36
St. Louis	09/30/88	
Sweden	04/04/89	20
Tucson	09/29/88	31

Arnold H. Silver
1988/1989 Distinguished Microwave Lecturer
TRW Space & Technology Group, One Space Park, Redondo Beach, CA 90278
Phone: (213) 812-0115
'Microwave and Gigabit Superconductive Electronics'

Buffalo	10/25/88	55
Dallas	08/31/88	30
Milwaukee	04/18/89	70
New Jersey Coast	10/28/88	22
Ottawa	04/19/89	33
Phoenix	10/11/88	24
San Fernando Valley	11/17/88	42
Seattle	11/03/88	25

John H. Bryant
1986/1987 Distinguished Microwave Lecturer
University of Michigan, Ann Arbor, MI
Phone:

Tucson	01/15/87	38

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Edward C. Niehenke
1986/1987 Distinguished Microwave Lecturer
Westinghouse Electric Corp., Baltimore, MD 21203
Phone: (301) 765-4573
'GaAs—Key to Modern Microwave Technology'

France (Video Tape)	05/26/89	24
Tucson	02/19/87	23

LECTURES GIVEN BY MEMBERS OF THE SPEAKERS' BUREAU

Columns: 1. Chapter. 2. Date. 3. Attendance.

Fred E. Gardiol
Ecole Polytechnique Federale, CH-1015 Lausanne, Switzerland
Phone: 41-21-472670
'Microstrip Circuit Analysis: The Integral Approach'

Sweden	09/07/88	17

Charles Holmes, Peter Parrish and Octavius Pitzalis, EESOF, Inc.,
5795 Lindero Canyon Road, Westlake Village, CA 91362
Phone: (818) 991-7530
'GaAs and HEMT Modeling, Circuit and System Simulation: State of the Art and Beyond'

Dallas	01/26/89	55
North Jersey	05/18/89	64
Phoenix	04/13/89	21
San Fernando Valley	09/22/88	48
Seattle	03/16/89	25

Umesh K. Mishra
North Carolina State University, Raleigh, NC 27695
Phone: (919) 737-7354
April S. Brown
U.S. Army Research Office, Physics Division, P.O. Box 12211
Research Triangle Park, NC 27709
Phone: (919) 549-0641
'Gallium Indium Arsenide Heterostructures for Low Noise Amplification, High Speed Logic Circuits, and Lightwave Detection'

Buffalo (April S. Brown)	05/09/89	10

Erwin Schanda
Institute of Applied Physics, University of Bern, CH-3012 Bern, Switzerland

Phone: 41-31-658910
'Remote Sensing with Microwaves and Millimeter Waves'

Syracuse	05/09/89	

Michael J. Wengler
University of Rochester, Rochester, NY 14627
Phone: (716) 275-9402
'Submillimeter Heterodyne Detection with Superconductive Electronics'

Ithaca	02/14/89	60
North Jersey	04/13/89	21
Princeton	03/02/89	12
Syracuse	02/08/89	18

Bernard Yurke
AT&T Bell Laboratories, 600 Mountain Ave., Murray Hill, N.J. 07974
Phone: (201) 582-4961
'Quantum Noise in Microwave and Millimeter-Wave Electronics'

Columbus	05/02/89	25
Sweden	05/24/88	24

Oxley Named GEC Gold Medal Winner

The General Electric Compny of England (GEC) has awarded Terence H. Oxley the 1988 Nelson Gold Medal Award for his outstanding achievements in the Microwave Field. Mr. Oxley's award citation reads, 'His engineering skills, innovative thinking and concentration on designing for simple, robust manufacturing systems have helped keep GEC products in the forefront for more than 30 years.' The award represents the highest honor bestowed by GEC for outstanding technical merit and personal performance and achievement. Up to five awards are made per year. Recipients are selected from all GEC activities, involving many disciplines and approximately 250,000 employees.

Terry Oxley joined the GEC Hirst Research Centre (HRC) in 1946, after service in the Royal Navy, and has been involved in the microwave field of semiconductor and circuit technology since 1950. His specialist area has been microwave and millimeter wave receivers. He has been in the technological forefront of this field, from the microwave point-contact diode to the current advanced microwave and millimeter wave integrated circuits, for the last 30 years.

At Hirst Research Centre, Terry led research teams involved in semiconductor diodes and MICs. He served as a Section Head and Department Head, building a business base in MICs which was made into a product line in 1980 at Marconi Electronic Devices, Ltd. (formerly AEI Semiconductors, Ltd.) at Lincoln. Terry served as Development Manager until 1985, when he transferred to Marconi Research Centre at Baddow. He was Microwave Research Manager at MRC until his retirement in 1988.

T. Oxley has authored/co-authored more than 100 papers and has edited several books. He has served on many IEE and IEEE committees, including the MTT-16 Microwave Systems Committee, and the Military Microwave conference held in London. He received Her Majesty's Silver Jubilee Medal in 1977 for his advancements in Microwave Components. Terry and his wife, Hilde, currently live in Halam, Southwell in Notinghamshire.

GEC Chairman Lord Jim Prior (left) presents the 1988 GEC Nelson Gold Medal Award to Terry Oxley (April 12, 1988).

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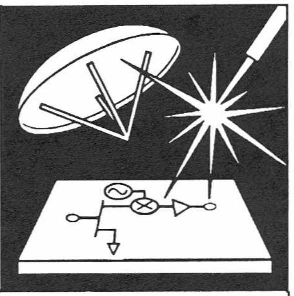
1990 IEEE MTT-S International Microwave Symposium



May 8-10, 1990
Dallas, Texas

MERGING TECHNOLOGIES FOR THE '90s

FIRST CALL FOR PAPERS

The 1990 IEEE MTT-S International Microwave Symposium theme is "Merging Technologies for the 90's." To emphasize this trend, the Microwave Symposium will be held jointly with the IEEE Antennas and Propagation/International Union of Radio Science (URSI) Symposium. Because of the early Symposium date (May 8-10, 1990), please make special note of the paper submission deadline. To allow the presentation of papers in the format best suited to each, the program will consist of three categories of papers: full length, short, and open forum. Full length papers report results of significant advances in microwave technology. Short papers are typically a refinement in the state of the art. The open forum provides an opportunity for authors to present theoretical and experimental material in poster format, display hardware, perform demonstrations, and answer questions in an informal atmosphere. The Technical Program Committee will try to abide by the preferences of authors but reserves the right to place the paper in the category it considers most appropriate.

Papers are solicited describing original work in the microwave field. A list of suggested topics is given below, but papers concerned with other aspects of microwave theory and techniques will be considered.

1. Microwave Superconductivity
2. Biological Effects and Medical Applications
3. Computer Aided Design
4. Solid State Devices and Circuits
5. Microwave Systems
6. Computational Microwave Techniques
7. Microwave Acoustics
8. Microwave and Millimeter Wave Packaging
9. Lightwave Technology
10. Low Noise Techniques
11. Opto-Electronics Technology
12. Microwave and Millimeter Wave Integrated Circuits
13. Communication Systems
14. Field and Network Theory
15. Passive Components
16. Phased and Active Array Techniques
17. Submillimeter Wave Techniques and Devices
18. High Power Devices and Systems
19. Measurement Theory and Techniques
20. Manufacturing Methods
21. Other (Suggested Topics)

A prospective author is required to submit:

1. 15 copies of a 500-1,000 word summary with supporting illustrations which should include a concise statement of what is new and the potential application.

2. 10 copies of a 30-50 word abstract.

3. A separate sheet with the complete mailing address of the author and a statement categorizing the submitted paper as full length, short, or open forum and specifying the number of the topic area they wish to present their papers in. Submissions must be received by **November 14,1989.** Late submissions will be returned unreviewed.

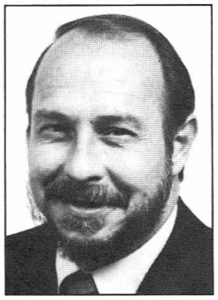
Mail submissions to: **Tatsuo Itoh/Randall Lehmann**
c/o LRW Associates
1218 Balfour Drive
Arnold, MD 21012

Authors will be notified of the status of their submissions by January 5, 1990. Authors of accepted papers will receive copyright release forms and instructions for publication and presentation.

Final manuscripts will be required in early February 1990.

Note: *Authors are cautioned to obtain all required company & government clearances prior to submittal. A statement signed by the authors stating that such clearances have been obtained must accompany the finalmanuscripts of papers to be published in the Symposium Digest.*

1990 IEEE MTT-S International Symposium



by John Wassel
Chairman, 1990 IMS
Steering Committee
Texas Instruments, Inc.
13510 North Central Expressway
P.O. Box 655474, MS 245
Dallas, TX 75265

'Fort Worth is where the West begins and Dallas is where the East sorta peters out' as an old saying from Texas folklore goes. The Technical Program Committee (TPC) and the MTT-S AdCom will have a chance to experience a little bit of both cities when we meet in December 1989. We will be meeting at the DFW Hilton Executive Center located about two miles north of the DFW Airport on 12 December 1989 for the TPC and 12-13 December 1989 for the MTT-S AdCom. This deviates from the normal routine because we sought to make the travel as easy as possible for the participants. Free pickup will be provided from the airport to the DFW Hilton. I think everyone will be pleased with the rural setting of the DFW Hilton. A dude ranch is located just next to the Hilton and horseback riding will be available in addition to all the amenities of the DFW Hilton. It promises to be a pleasant diversion from the usual TPC meeting arrangements. Hopefully, the weather in December will be mild and the attendees will have a chance to enjoy the magnificent vistas of Texas which are remarkablty free of unsightly hills and trees that can tend to clutter the view in other less scenic areas of the United States.

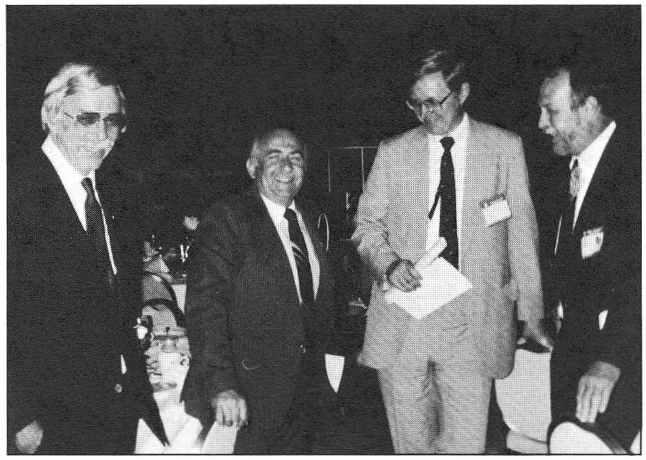
The DFW Airport is situated on the dividing line between Tarrant (Fort Worth) and Dallas counties. this site was chosen after a lengthy negotiation lasting over ten years. The Mayors of the two cities finally agreed to a compromise weighted in Fort Worth's favor—that is, the center of the traffic roadway is located in Tarrant county about one-half mile from and parallel to the Tarrant-Dallas county line and well over half of the DFW Airport is in Tarrant county. Amon Carter, then Mayor of Fort Worth and also Publisher of the Fort Worth Star Telegram newspaper, had a long standing feud with Ted Dealey, Publisher of the Dallas Morning News, and both gentlemen were involved in the preliminary discussions to build a regional airport. Both Carter and Dealey were determined that neither city would yield any advantage to the other and it wasn't until in the 1960's when Eric Jonsson, former Chairman of Texas Instruments, was elected Mayor of Dallas and made the vital concessions leading to the DFW Regional Airport.

Amon Carter was crusty to an extreme degree. For example, whenever the talks were held in Dallas, he brought his lunch in a paper sack, carried a canteen of water, and refused to pay for parking in Dallas lest he might contribute something to Dallas' economy. Other Dallas members tried to retaliate in kind when the talks were held in Fort Worth but Amon Carter always had something in reserve to upstage their efforts. Ironically, Amon Carter suffered and died of a heart attack while driving in Dallas on Stemmons Expressway which was named for one of Carter's mortal enemies in Dallas.

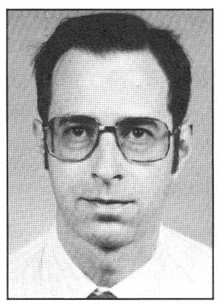
Of course, both cities are now very proud of the DFW Airport and I hope you'll enjoy your Dallas visit a bit more by knowing something of the history.

On a closing note, the 1989 IEEE MTT IMS in Long Beach was a smashing success. The reasons were graciously shared with the Dallas Steering Committee Members at a luncheon meeting with the 1989 Steering Committee Members during Microwave Week in Long Beach and we came back to Dallas loaded with good ideas and suggestions. Chuck Swift had recorded his daily travails in organizing the symposium and has been most generaous in sending them to the next Steering Committee Chairmen. I plan to do the same and will title my observations 'swifties' just as Chuck so modestly did. Chuck's 'swifties' have proved invaluable to us in our planning sessions.

And I'd also like to introduce you to some of the future IMS personnel. The photo below was taken after the Awards Banquet in Long Beach and shows from left to right, George Vendelin who helped organize the successful bid for the 1996 IMS to be held in San Francisco, Jerry Hausner who is Chairman of the 1992 IMS in Albuquerque, Peter Staecker who is Chairman of the 1991 IMS in Boston, and me for Dallas in 1990. Needless to say, we all need your continuing support to emulate the success of Long Beach.



Automatic RF Techniques Group News



by Raymond W. Tucker, Jr.
Rome Air Development Center
RADC/RBCM
Griffis AFB, NY 13441-5700

The Automatic RF Techniques Group (ARFTG) is an independent professional society that is affiliated with MTT-S as a conference committee. ARFTG's primary interests are in computer-aided microwave analysis, design and measurement. ARFTG holds two conferences each year, one in conjunction with the MTT-S International Microwave Symposium, and a second in the late Fall.

34th ARFTG Conference Announcement

The Automatic Radio Frequency Techniques Group will hold its 34th Technical Conference on November 30 and December 1, 1989

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AUTOMATIC RF TECHNIQUES GROUP NEWS
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at the Westin Cypress Creek Hotel in Fort Lauderdale, Florida. The focus topic for this conference will be:

ON-WAFER TESTING:
METHODS CALIBRATION
MEASUREMENT TIME AND STANDARDS

Papers on other topics will be considered. For further information, see the Call For Papers elsewhere in this issue.

This ARFTG Conference promises to be outstanding, with an excellent Technical Program, Exhibits and Awards Banquet—plan to attend!!

33rd ARFTG Conference

The Automatic Radio Frequency Techniques Group held its 33rd Technical Conference on Thursday, June 15 and Friday, June 16, 1989 in conjunction with the International Microwave Symposium in Long Beach, California. All ARFTG Conference activities took place at the Sheraton Long Beach Hotel. Mark Roos, Roos Instruments, served as the conference chairman. There were twelve manufacturer's exhibits displaying automated measurement hardware and software at this conference.

At the ARFTG Awards Banquet, Sadig Faris received the ARFTG Automated Measurements Technology Award for his application of superconductivity to automated measurements carried to the millimeter range, and Gunther Sorger was presented the ARFTG Automated Measurements Career Award for his career of meritorious achievement and outstanding contributions to the field of precision measurement and metrology.

The focus topic for this conference was Microwave Automated Test Equipment as a Productivity Multiplier. The following papers were presented:

'60 GHz Test Fixture,' W. Oldfield, Wiltron

'A Microstrip Fixture Design for Power GaAs FETs,' R. Lane, California Eastern Labs

'Calibration and Measurement of Ceramic Microstrip Circuits Using a Wafer Probe Station,' J. Wallace and G. Ellis, Boeing Technology Center

'Time Domain Reflectometry Applied to MMIC Passive Component Modeling,' U. Pisani, Politechnico Di Torino

'Recent Trends in Microwave ATE Systems,' C. Morgan, Tektronix

'Automated T/R Module Testing for the Shuttle Imaging Radar,' V. Hirsh and T. Miers, Ball Communications Systems Division

'A Fully Automated Single Connection T/R Module Tester,' G. Sloan and J. Simons, Sandia

'High Throughput, Multi-Function On-Wafer Test System,' G. Lewis and R. Sweeney, ITT

'Development of Waveguide Dual Six-Port Systems in the Range 18-50 GHz,' C. Weil, F. Marler, J. Major, M. Weidman, and D. Russell, NIST

'Noise Characterization System,' B. Pastori and G. Simpson, Maury Microwave

'General Purpose Automatic Microwave Measurements,' H. Stinehelfer, Made-It-Associates

'Waveguide Calibration of Vector Automatic Network Analyzers,' P. Gianfortune, M. Radmanesh, and G. Simpson, Maury Microwave

'Non-Linear Analysis and Simulation of a FET Oscillator,' M. Odyniec, Hewlett-Packard

Join ARFTG

ARFTG brings you the latest techniques in RF, Microwave and Millimeter Wave Analysis, Design and Measurements. State-of-the-Art papers are presented twice a year. If you are involved in automated techniques, come and join your peers and keep current with our ever-evolving technology. For more information on ARFTG, write: ARFTG, RR-1, Box 204A, AVA, NY 13303.

Second International Workshop on Millimeter Waves

by Tatsuo Itoh

The Second International Workshop on Millimeter Waves was held in Perugia, Italy on April 19-21, 1989. It was organized by Professor Roberto Sorrentino of the Univeristy of Rome Tor Vergata and Professor Luciano Palmieri of the University of Perugia, assisted by Dr. Giovanni Schiavon. Dr. Sorrentino also arranged the technical program. The workshop was sponsored by the IEEE Central and South Italy Section and the IEEE MTT-S Central and South Italy Chapter and financed by the University of Rome Tor Vergata, University of Perugia and a number of Italian industries.

The workshop was attended by about 65 engineers from Italy as well as from other parts of Europe including Spain, the U.K., W. Germany, Poland, Yugoslavia and France. On the first two days, fourteen invited speakers from Europe and the U.S. made 45-minute presentations followed by discussions on topics ranging from numerical modeling to active devices to system applications. On the third day, the speakers and participants were divided into three groups for intense discussions on modeling aspects, devices and circuit technology, and system applications. After about 100 minutes of heated discussion in each group, summaries were presented by the session chairmen of the groups at the closing session.

Perugia, the site of the workshop, is located 160 km north of Rome and, with its Etruscan and Roman history, has a unique Middle Ages and Early Renaissance character. The workshop was held at one of the oldest universities in Europe. The local arrangements were carried out smoothly, and in spite of a heavy technical content, participants enjoyed a relaxed atmosphere including a fabulous banquet and other social programs.

It was felt that the level of technical discussion was much higher than at the first workshop, held in Rome in 1986. This indicates technical advances and increased interest in the European community in the area of millimeter waves. Overall, the workshop was more than a success. The organizers in Italy deserve recognition for their hard work.

PROGRAM CONTENT

1. **Linear and Nonlinear Field Modeling in the Time Domain,** Wolfgang J.R. Hoefer, University of Ottawa, Canada
2. **Full Wave Analysis and Modeling for CAD of Millimeter Wave MMIC's: Progress and New Concepts,** Rolf H. Jansen—Plessey Research, England
3. **Recent Development of Planar Quasi-Optical Integrated Circuits,** Tatsuo Itoh—University of Texas at Austin,Austin,TX, USA
4. **Millimeter Wave Device Characterization and Modeling,** Yi-Chi Shih—Hughes Aircraft Company, Torrance, CA, USA

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AUTOMATIC RF TECHNIQUES GROUP

CALL FOR PAPERS

The Automatic RF Techniques Group will hold its 34th Conference on November 30, and December 1, 1989, at the Westin Cypress Creek in Fort Lauderdale, Florida. The theme for the Conference is:

ON-WAFER TESTING:

METHODS, CALIBRATION, MEASUREMENT TIME & STANDARDS

The development of MMIC design technology has created the challenge of on-wafer testing. The search is on to develop test methods (invasive and non-invasive) that may eventually be traceable to national standards and that can be performed in a repeatable and timely manner.

Papers are solicited that cover such areas as software, hardware and techniques associated with on-wafer testing. Some suggested topics could include:

- **Calibration & Measurement Techniques for**
  - **network analysis**
  - **noise parameters**
  - **power measurements**
- **Development of On-Wafer Standards/NIST Consortium**
- **New Product Development**

Other topics will also be considered.

Authors are requested to submit a one page abstract and summary which provides sufficient technical content to make a fair evaluation. Accepted papers will be presented by the author at the conference and published in the ARFTG digest. The presentations shall be 25 minutes in length. Overhead and 35mm projectors will be available to the presenter.

Two copies of the abstract and summary must be received not later than Friday, September 15, 1989.

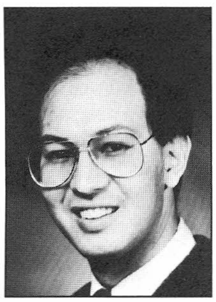
Please mail all papers to the Technical Programs Chairman:

Kevin Kerwin
Hewlett Packard
1412 Fountain Grove Parkway
Santa Rosa, CA 95403

2ND INTERNATIONAL WORKSHOP
continued from page 30

5. **Power Field Effect Transistors in Millimeter Wave Range: Perspectives and New Structures,** Yves Crosnier—Universite de Sciences et Techniques, Villeneuve d'Ascq, France
6. **Solid State Oscillators in the Millimeter Wave Range,** Helmut Barth—AEG, Ulm, West Germany
7. **Superconducting Devices and Quantum-Well Diodes in Low-Noise Heterodyne Receivers,** Eric Kollberg—Chalmers Unviersity of Technology, Goteborg, Sweden
8. **Recent Developments in Millimeter-Wave Antennas,** Arthur A. Oliner—Polytechnic Institute of New York, USA
9. **Applications of Millimeter Waves in Satellite Communication Systems,** Francesco Carassa—Politecnico di Milano, Italy
10. **Space System Applications of Millimeter Waves,** Giorgio Perrotta—Selenia Spazio S.p.A., Roma, Italy
11. **Ground-Based Radiometric Observations of Millimeter Wave Radiation—A Comparision of Measurements and Theory,** Ed R. Westwater—NOAA/WPL, Boulder CO, USA
12. **Passive Millimeter Wave Imaging—A Tool for Remote Sensing,** H. Suess—DFVLR/NE-HF, Oberpfaffenhofen, West Germany
13. **Status of Millimeter Wave Radar and Seeker Applications,** James C. Wiltse—Georgia Institute of Technology, Atlanta, GA, USA
14. **Millimeter Wave System Design and Application Trends in Europe,** Holger Meinel—AEG, Ulm, West Germany

Meetings of Interest



by Frank Occhiuti

GENERAL INTEREST

MIDCON '89. Sept. 12-14, O'Hare Exposition Center, Rosemont, IL. Contact: Ms. Alexes Razevich, Electronic Convention Mgmt., 8110 Airport Blvd., Los Angeles, CA 90045. (213) 772-2965.

NORTHERN ELECTRIC SHOW & CONVENTION (NORTHCON '89). Oct. 17-19, Portland Memorial Coliseum, Portland, OR. Contact: Ms. Alexes Razevich, Electronic Convention Mgmt., 8110 Airport Blvd., Los Angeles, CA 90045. (213) 772-2965.

WESTERN ELECTRIC SHOW & CONVENTION (WESCON '89). Nov. 14-16, Moscone Center Brooks Hall/Civic Auditorium, San Francisco, CA. Contact: Ms. Alexes Razevich, Electronic Convention Mgmt., 8110 Airport Blvd., Los Angeles, CA 90045. (800) 421-6816.

AEROSPACE MILITARY

13TH INTERNATIONAL CONGRESS ON INSTRUMENTATION IN AEROSPACE SIMULATION. Sept. 18-21, DFVLR Research Center, Gottingen, West Germany. Contact: K.A. Butefisch, DFVLR, Bunsentr. 10, 2400 Gottingen, West Germany.

COMMUNICATIONS

INTELEC—INTERNATIONAL TELECOMMUNICATIONS CONFERENCE. Oct. 15-18, Congress Center, Florence, Italy. Contact: Mr. G. Pagliai, ISPT, Viale Europa, 190, I 00144 Roma, Italy 39 6 54604663.

1989 IEEE MILITARY COMMUNICATIONS CONFERENCE — MILCOM '89. Oct. 16-19, Stouffer's Bedford Glen Hotel, Bedford, MA. Contact: Richard W. Coraine, 1001 Boston Post Rd., Marlborough, MA 01752. (508) 490-1287.

1989 GLOBAL TELECOMMUNICATIONS CONFERENCE — GLOBECOM '89. Nov. 27-30, Loew's Anatole Hotel, Dallas, TX. Contact: Harold Sobel, Rockwell International Corp., P.O. Box 10462, Dallas, TX 75207. (214) 996-5881.

COMPUTERS

9TH SYMPOSIUM ON COMPUTER ARITHMETIC. Sept. 6-8, Sheraton Miramar Hotel, Santa Monica, CA. Contact: Algirdas Avizienis, University of California at Los Angeles, Computer Science Dept., 3732 Goelter Hall, Los Angeles, CA 90024. (213) 825-3028.

INTERNATIONAL CONFERENCE ON COMPUTER DESIGN: VLSI IN COMPUTER AND PROCESSORS-ICCD '89. Oct. 2-4, Hyatt Regency Hotel, Cambridge, MA. Contact: Giovanni DeMicheli, Center for Integrated Systems, Stanford University, Stanford, CA 94305. (415) 725-3632.

ELECTROMAGNETICS & OPTICS

2ND INTERNATIONAL CONFERENCE AND WORKSHOP ON ELECTROMAGNETIC COMPATIBILITY. Sept. 12-16, Bangalore, India. Contact: Col. (Dr.) G.Kl. Deb, Electronics and Radar Development Establishment, CV Ramen Nagar, Bangalore 560 093 India.

INSTRUMENTATION

IMTC/90 — IEEE INSTRUMENTATION & MEASUREMENT TECHNOLOGY CONFERENCE. Feb. 13-15, 1990, San Jose, CA. Contact: Robert Myers, Conference Coordinator, Myers/Smith, Inc., Los Angeles, CA. (213) 287-1463.

MICROWAVES & ANTENNAS

19TH EUROPEAN MICROWAVE CONFERENCE. Sept. 4-7, London, England. Contact: N. Nazoa, Secretary, 1989 European Microwave Conference, ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey, KT22 7SA, England

2ND INTERNATIONAL SYMPOSIUM ON RECENT ADVANCES IN MICROWAVE TECHNOLOGY. Sept. 4-8, Beijing, China. Contact: Banmali Rawat, Technical Program Committee Chairman, EE/CS Computer Science Department, University of Nevada, Reno, NV 89557-0030. (702) 784-6927.

TRENDS IN RADAR SYSTEMS, TECHNIQUES AND TECHNOLOGY TO THE YEAR 2000 AND BEYOND (Workshop). Sept. 4-8, Davos, Switzerland. Contact: Eli Brookner, Raytheon Co., Wayland, MA 01778. (508) 440-5636 or (617) 862-7014.

1990 ASIA-PACIFIC MICROWAVE CONFERENCE — APMC '90. Sept. 18-21, Sunshine City Convention Center Tokyo, Tokyo, Japan. Contact: Prof. Tsukasa Yoneyama, Chairperson, Steering Committee, APMC '90, c/o Business Center for Academic Societies Japan, 3-23-1 Hongo, Bunkyo-ku, Tokyo 113 Japan, tel. no. +81-3-817-5831.

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MEETINGS OF INTEREST
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11TH ANNUAL ANTENNA MEASUREMENTS TECHNIQUES ASSOCIATION (AMTA) MEETING. Oct. 9-13, Double Tree Inn, Monterey, CA. Contact: Dale Wilson. (408) 742-9377.

RF EXPO EAST '89. Oct. 24-26, Trop World, Atlantic City, NJ. Contact: Kristen Hohn, Cardiff Publishing Co., 6300 S. Syracuse Way, Suite 650, Englewood, CO 80111. (303) 220-2600; (800) 525-9154.

GOMAC '89 (GOVERNMENT MICROCIRCUIT APPLICATIONS CONFERENCE). Nov. 7-9, Orlando, FL. Contact: Randolph A. Reitmeyer, GOMAC-89 Technical Program Chairman, USA LABCOM, Electronics Technology & Devices Laboratory, Attn: SLCET-1, Fort Monmouth, NJ 07703-5000. (201) 544-3465.

34TH IEEE-MTTS AUTOMATIC RF TECHNIQUES GROUP CONFERENCE. Nov. 30-Dec. 1, Westin Cypress Creek, Fort Lauderdale, FL. Contact: Kevin Kerwin, Technical Programs Chairman, Hewlett Packard, 1412 Fountain Grove Parkway, Santa Rosa, CA 95403.

5TH NATIONAL CONFERENCE ON MICROWAVE TECHNIQUES (MITEKO '90). Apr. 23-26, 1990, Pardubice, Czechoslovakia. Contact: Miroslav Cepcar, Organizing Secretary, Dum techniky CSVTS, trida Miru 113, 532 27 Pardubice — CSSR. tel. no. 25 221-4.

1990 IEEE INTERNATIONAL RADAR CONFERENCE. May 7-10, 1990, Arlington, VA. Contact: Robert T. Hill, RADAR-90, c/o ITT Defense, 1000 Wilson Blvd., 30th Floor, Arlington, VA 22290-3905. (703) 247-2971.

XXIII GENERAL ASSEMBLY OF THE INTERNATIONAL UNION OF RADIO SCIENCE (URSI). Aug. 28-Sept. 5, 1990, Prague, Czechoslovakia. Contact: Prof. V. Zima, Institute of Radioengineering and Electronics, Czechoslovak Academy of Sciences, 182 51 Praha 8, Czechoslovakia.

INTERNATIONAL CONFERENCE ON MILLIMETER WAVE & MICROWAVE (ICOMM'90). Nov. 21-23, 1990, Dehradun, India. Contact: Dr. A.S. Bains, Convener, ICOMM-90, Defence Electronics Applications Laboratory (DEAL), Post Box 54, Raipur Road, Dehradun - 248001, India. tel. no. 0135-27083.

POWER

INTERNATIONAL CONFERENCE ON ELECTRICAL ENERGY SYSTEMS. Sept. 24-27, North Carolina A&T State University, Greensboro, NC. Contact: Ashok Kumar, Electrical Engineering Dept., McNair Hall, North Carolina A&T State University, Greensboro, NC 27411. (919) 334-7760.

NORTH AMERICAN POWER SYMPOSIUM — NAPS '89. Oct. 9-10, University of Missouri at Rolla. Contact: Earl Richards, Room 122, Electrical Engineering, University of Missouri at Rolla, Rolla, MO 65401. (314) 341-4524.

1989 JOINT POWER GENERATION CONFERENCE — JPGC '89. Oct. 22-26, Hyatt Regency Hotel, Dallas, TX. Contact: Marisa Scalice, ASME, 345 E. 47th St., New York, NY 10017. (212) 705-7053.

SOLID STATE

1989 IEEE GAAS IC SYMPOSIUM. Oct. 22-25, Sheraton Harbor Island Hotels, San Diego, CA. Contact: Kenneth Sleger, Code 6852, US Naval Research Laboratory, Washington, DC 20394. (202) 767-3894.

GaAs MANTECH CONFERENCE. Oct. 24-26, San Diego, CA. Contact: Jan Speed, Courtesy Associates, Suite 300, 655 Fifteenth Street, N.W., Washington, D.C. 20005.

1989 IEEE INTERNATIONAL ELECTRONICS DEVICES MEETING. Dec. 3-6, Washington, DC. Contact: James C. Sturm, Dept. of Electrical Engineering, Princeton University, Princeton, NJ 08544. (609) 452-5610.

1990 INTERNATIONAL RELIABILITY PHYSICS SYMPOSIUM. Mar. 26-29, 1990, New Orleans Marriott Hotel, New Orleans, LA. Contact: Alfred L. Tamburrino, Member, Board of Directors, RADC/RBRP, Griffiss AFB, NY 13441-5700. (315) 330-2813.

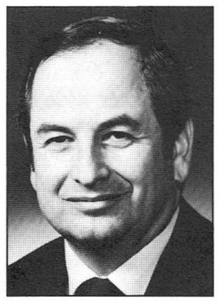
MISCELLANEOUS

SECOND INTERNATIONAL CONFERENCE ON ENGINEERING MANAGEMENT. Sept. 10-13, Sheraton Centre Hotel, Toronto, Canada. Contact: Brian L.G. Lechem, Chairman, Conference Organizing Committee, 245 Fairview Mall Drive, Suite 600, Willowdale, Ontario, Canada M2J 4T1.

1989 IEEE ULTRASONICS SYMPOSIUM. Oct. 4-6, Le Grand Hotel, Montreal, Quebec, Canada. Contact: Narendra K. Batra, Code 6385, Naval Research Laboratory, Washington, DC 20375-5000. (202) 767-3505.

1989 CONFERENCE ON ELECTRICAL INSULATION AND DIELECTRIC PHENOMENA. Oct. 29-Nov. 1, Xerox, Conference Center, Leesburg, VA. Contact: Prof. Reuben Hackman, Dept. of Electrical Engineering, University of Windsor, Windsor, Ontario. N9B 3P4 Canada. (519) 253-4232.

Special Articles for the MTT Newsletter



by Zvi Galani
Raytheon Co.
Mail Stop CF1-49
Hartwell Road
Bedford, MA 01730 U.S.A.

The MTT Newsletter staff is very interested in obtaining feature articles dealing with current topics in the technical and professional areas of interest to MTT members. The idea is to provide the members with a general understanding of the topic and its significance in current and future activities in the microwave field. I would like to emphasize, however, that these special articles will cover topics in a broad, general sense. Specific design techniques and applications will be covered in papers appearing at the MTT Symposium and in the Transactions.

If you know of a topic that is current and/or you are willing to contribute an article to the Newsletter, please contact me or the Newsletter editor, D. Gary Lerude.

This issue features the article "Transmission Line Transformers" by Jerry Sevick. It presents a tutorial and a comparison of various techniques, some of which are published for the first time.

A feature article on beamed power is in the process of preparation for a future issue of the Newsletter.

The editorial staff of the Newsletter hopes that these articles will be informative and useful to the MTT-S community.

Your comments and suggestions are welcome.

Transmission Line Transformers

by Jerry Sevick
32 Granville Way
Basking Ridge, NJ 07920
(201) 766-6122

ABSTRACT

The transmission line transformer first appeared after World War II. Since its inception, the device has been widely used because of its inherent wide bandwidth capability. It differs completely from the conventional transformer because energy is mainly transmitted to the output circuit by a transmission line mode instead of by flux linkages. Until the publication, in 1987, of the author's book, *Transmission Line Transformers* [1], little practical design information was available. Feedback from the first edition led to more analytical and design information which is included in the second edition. This paper is a digest of some of the more important sections of the second edition.

INTRODUCTION

There are two basic methods for constructing broadband, impedance-matching transformers. One employs the conventional transformer that transmits the energy to the output circuit by flux linkages; the other uses the transmission line transformer to transmit the energy by a transverse transmission line mode. With techniques exploiting high magnetic efficiency, conventional transformers have been constructed to perform over wide bandwidths. Losses on the order of one decibel can exist over a range from a few kilohertz to over 200 MHz. Throughout a considerable portion of this band, the losses are only 0.2 dB. On the other hand, transmission line transformers exhibit far wider bandwidths and much greater efficiencies. The stray inductances and interwinding capacitances are generally absorbed into the characteristic impedance of the transmission line. As such, they form no resonances that could seriously limit the high-frequency response. Here the response is limited by the deviation of the characteristic impedance from the optimum value; the parasitics not absorbed into the characteristic impedance of the transmission line; and, in some transformer configurations, the length of the transmission line. With transmission lines, the flux is effectively cancelled out in the core and extremely high efficiencies are possible over large portions of the pass band—losses of only 0.02 to 0.04 dB with certain ferrite core materials. Therefore, the power ratings of transmission line transformers are determined more by the ability of the transmission lines to handle the voltage and current than by the size and conventional properties of the core.

The earliest presentation on transmission line transformers was by Guanella in 1944 [2]. He proposed the concept of coiling transmission lines to form a choke that would reduce the undesired mode in balanced-to-unbalanced matching applications. Before this time, this type of device, known as a balun, was constructed from quarter- or half-wavelength transmission lines and, as such, had very narrow bandwidths. By combining coiled transmission lines in parallel-series arrangements, he was able to demonstrate broadband baluns with ratios of $1{:}n^2$ where n is the number of transmission lines. Other writers followed with further analyses and applications of the balun transformer introduced by Guanella [3-9]. In 1959, Ruthroff published another significant work on this subject [10]. By connecting a single transmission line such that a negative or a positive potential gradient existed along the length of the line, he was able to demonstrate a broadband 1:4 balun or ***unun*** (unbalanced-to-unbalanced) transformer. He also introduced in his paper, the hybrid transformer. Many extensions and applications of his work were published and are included in the reference list [11-29].

In the process of designing matching networks for short vertical antennas in the HF and VHF bands, a literature search provided little specific design information on transmission line transformers. Information was lacking regarding: choices between Guanella and Ruthroff transformers, fractional-ratio transformers, ferrites and efficiency, rods versus toroids, types of windings, and high and low impedance limitations. Since a single source of information did not exist, and considerable new information had been obtained by the author, it was decided that publication of a book was in order. From the feedback comments on the first edition, and from further information gained by the author in designing new transformers, a greatly revised edition followed. This paper presents digests of four of the more important topics in the second edition. They are: the basic building block, Guanella transformers, Ruthroff transformers, and fractional-ratio transformers.

THE BASIC BUILDING BLOCK

The single bifilar winding, shown in Figure 1, is the basic building block for the understanding and design of all transmission line transformers. Higher orders of windings (trifilar, quadrifilar, etc.) also perform in a similar transmission-line fashion and will be discussed in the section on fractional-ratio transformers.

The circuit of Figure 1 can perform four different functions depending upon how the outout load, R_L, is connected. The functions are: a) a phase-inverter when a ground is connected to terminal 4, b) a balun when a ground is at terminal 5 or left off entirely (a floating load), c) a simple delay line when a ground is at terminal 2, and d) a 'boot-strap' when $+V_1$ is connected to terminal 2. The operation of these four functions can be explained by simple transmission line theory and the choking reactance of the transmission lines. This choking reactance, which isolates the input from the output, is usually obtained by coiling the transmission line around a ferrite core or by threading the line through ferrite beads. The objectives, in practically all cases, are to have the characteristic impedance Z_O, of the transmission lines equal to the value of the load, R_L, (which is called the optimum characteristic impedance) and to have the choking reactance of the transmission lines much greater than R_L (and hence Z_O). Meeting these objectives results in a 'flat' line and hence maximum high frequency response and

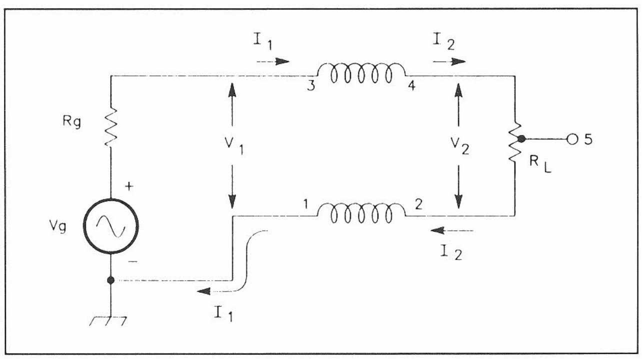


FIGURE 1. The Basic Building Block

Artwork for this article was provided by The ARRL, Newington, CT, and appears in the author's book Transmission Line Transformers, *the second edition of which is scheduled for publication in 1989.*

continued on page 35

TRANSMISSION LINE TRANSFORMERS

continued from page 34

maximum efficiency since conventional transformer currents are suppressed. In the final analysis, the maximum high frequency response is determined by the parasitics not absorbed into the characteristic impedance of the line and the efficiency by the properties of the ferrites when used in *transmission line transformer* applications.

A further understanding of transmission line transformers can be gained by noting the longitudinal potential gradients that exist with the circuits of the following four:

a) *Phase-inverter*

By connecting a ground to terminal 4, a negative potenial gradient of $-V_1$ is established from terminal 3 to 4. The gradient from terminal 1 to 2 is $-V_2$. For a matched load, $V_1 = V_2$. If the reactance of the windings (or a straight transmission line with loaded beads) is much greater than R_L, then only transmission line currents flow and terminal 2 is at a $-V_2$ potential. When the reactance is insufficient, a shunting, conventional current will flow from terminal 3 to 4 resulting in a drop in the input impedance and the presence of flux in the core. As the frequency is decreased, the input impedance approaches zero.

b) *Balun*

By connecting a ground to terminal 5, a negative potential gradient of $-(V_1 - V_2/2)$ is established from terminal 3 to 4 and $-V_2/2$ from terminal 1 to 2. With a matched load, $V_1 = V_2$ and the output is balanced to ground. When the reactance fails to be much greater than R_L, conventional transformer current will flow and eventually, with decreasing frequency, the input impedance approaches $R_L/2$. When the load is 'floating,' the currents in the two windings are always equal and opposite. At very low frequencies, where the reactance of the windings fails to be much greater than R_L, the isolation of the load is inadequate to prevent conventional transformer current (which could be an antenna current) when the load is elevated in potential. This bifilar balun, which was first proposed by Guanella [2], is completely adequate for most 1:1 balun applications when the reactance of the windings (or beaded straight transmission lines) is much greater than R_L.

c) *Delay Line*

By connecting the ground to terminal 2, the potentional gradient across the bottom winding is zero. With a matched load, the gradient across the top winding is also zero. Under these conditions, the longitudinal reactance of the windings plays no role. The transmission line simply acts as a delay line and does not require winding about a core or the use of ferrite beads. This delay function plays a most important role in obtaining the highest frequency response in unbalanced-to-unbalanced transformers.

d) *Boot-strap*

Probably the most unlikely circuit schematic with the basic building block is the one where $+V_1$ is also connected to terminal 2. By this type of connection, a positive potential gradient of V_1 is established across the bottom winding and of $+V_2$ across the top winding. When the bottom of R_L is connected to ground, instead of to terminal 2, a voltage of $(V_1 + V_2)$ exists across its terminals. This 'boot-strap' connection, in which the transmission line shares a part of the load, is the way Ruthroff [10] obtained his 1:4 unbalanced-to-unbalanced transformer.

GUANELLA TRANFORMERS

Guanella's investigation [2] was directed toward developing a broadband transformer for matching the balanced output of a 100-watt,push-pull, vacuum-tube amplifier to the unbalanced load of a coaxial cable. The objective was to match a balanced impedance of 960 ohms to an unbalanced impedance of 60 ohms (16:1 ratio) from 100 MHz to 200 MHz. His experimental data, with a 53-ohm resistor as a load, showed a deviation of less than 10 percent from the theoretical value over this frequency range. Guanella accomplished this by incorporating four 240-ohm transmission lines in a series-parallel arrangement resulting in a high impedance, 16:1 balun. His technique of essentially summing in-phase voltages at the high impedance side of the transformer had been overlooked by the author (and probably by others) as is evidenced by the scarcity of information on his designs in the literature. This section presents an analysis of his transformers and explains the advantages of his technique in transformers for high power and high impedance levels.

Figure 2 is a schematic of Guanella's 1:4 transformer. The two transmission lines are in parallel on the low impedance side and in series on the high impedance side. With the single connection to ground, as shown in Figure 2, the transformer performs as a step-up balun with a floating load. With the ground connected to terminal 2 instead of the 1,5 terminal, it performs as a step-down balun with a floating load. The high frequency performance is determined, in large measure, by the optimization of the characteristic impedance of the transmission lines. From the symmetry of the schematic, it is quite evident that each transmission line sees one-half of the load, R_L. Therefore, for flat lines, and hence maximum high frequency response, the optimum value of the characteristic impedances is $Z_O = R_L/2$. Without any other parasitics which are not absorbed into the characteristic impedance, this transformer (as Guanella stated in his paper) yields a 'frequency independent transformation.' Using straight, beaded lines, or having sufficient separation between bifilar windings on a core, results in near-ideal transformers.

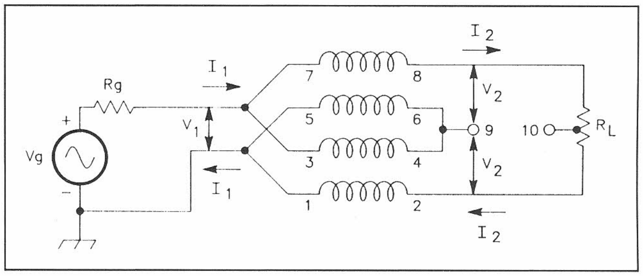


FIGURE 2. The Guanella 1:4 Transformer

With two transmission lines, as in Figure 2, the input impedance at the low side is

$$Z_{in} = Z_O/2 \frac{[Z_L/2 + jZ_O \tan \beta l]}{[Z + jZ_L/2 \tan \beta l]} \quad (1)$$

where Z_O = the characteristic impedance
Z_L = the load impedance
l = the length of the transmission line
β = $2\pi/\lambda$, where λ = the effective wavelength in the transmission line.

With the optimum value of $Z_O = R_L/2$ for a resistive load, Equation (1) reduces to

$$Z_{in} = R_L/4 \quad (2)$$

With more than two transmission lines, it can be shown that Equation (2) becomes

$$Z_{in} = R_L/n^2 \quad (3)$$

where n is the number of transmission lines. It can be seen by inspection, that when looking in at the high impedance side,

$$Z_{in} = n^2 R_L \quad (4)$$

where R_L would be the low impedance on the left side in Figure 2.

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TRANSMISSION LINE TRANSFORMERS

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The low frequency analysis of the Guanella 1:4 transformer, which is not quite as obvious as the high frequency analysis, presents some interesting and important results. The low frequency model is shown in Figure 3. It represents the case where energy is no longer transmitted from input to output by a transmission line mode. The low frequency response is highly dependent upon where the ground connections are made in Figure 3 and whether one or two cores (or beaded lines) are employed. The more common cases are as follows:

a) *Baluns with floating loads*
A single ground at terminal 1,5 (as shown in Figure 3) or at terminal 2, results in either a step-up or step-down balun with the lowest frequency response of all the cases. As with conventional transformers, it is determined by the magnitude of the so-called magnetizing inductance as compared to the impedance of the generator. When the inductive reactance is much greater than R_g, conventional current is suppressed and energy is mainly transmitted by the efficient transmission line mode. If a single toroidal core has the four windings (in a series-aiding direction), the maximum inductance is realized for the number of turns employed. By using two cores, and the same number of turns, the inductance (and hence, low frequency performance) is reduced by a factor of two. With toroidal cores, the low frequency performance is directly related to the permeabilty of the material. Transformers with rod cores do not enjoy this advantage [1]. In power applications, the author has found nickel-zinc ferrites with permeabilities less than 300 to yield the highest efficiencies. Impedance levels greater than 100 ohms favor permeabilities of 125 and less.

b) *The 1:4 unun (unbalanced-to-unbalanced) Transformer*
Since the Guanella transformer adds in-phase voltages, it also offers the best high frequency response in an unun application. There are two methods for converting the Guanella transformer (which is basically a balun) into unbalanced use; one involves using two separate cores and the other, adding in series, an additional 1:1 balun for isolation. With two grounds, one at terminal 1,5 and the other at terminal 2, it is apparent that a short circuit exists on winding 1-2 and hence, also on winding 3-4. If a single core is used, windings 5-6 and 7-8 are also shorted and the low frequency response is very poor and generally unacceptable. With two separate cores, the inductances of windings 5-6 and 7-8 (which are in series-aiding) determine the low frequency response. Windings 1-2 and 3-4 only act as a delay line. As was explained before with the basic building block, since no potential difference exists between the input and output terminals of the bottom transmission line in Figure 2, the core is no longer needed and can be replaced by a non-magnetic form for mechanical purposes. Figure 4 is a photograph of three 1:4 step-down transformers designed to match 50 ohms unbalanced, to 12.5 ohms unbalanced from 1.5 MHz to over 30 MHz. The transformer on the left has 7 turns of 22-ohm coaxial cable on 1 1/2-inch OD, 250L toroids (μ = 250). Experimentally it was found that the optimum performance with low-impedance coaxial cable or stripline is obtained when the characteristic impedance is about 90 percent of the theoretical value. Its high frequency response extends beyond 100 MHz. The power rating is 5 kW of continous power. The middle transformer has 14 bifilar turns of 14-gauge wire on 3/8-inch diameter rods of no. 61 ferrite (μ = 125). It is capable of handling 1 kW of continuous power. The transformer on the right has 25 bifilar turns of 18-gauge on 1/4-inch diameter rods of no. 61 ferrite (μ = 125). It is capable of handling 100 watts of continuous power. The impedance ratios of both rod transformers are still constant up to 50 MHz. As mentioned above, if only balun operation is required, then the number of turns on the transformers in Figure 4 could be reduced by some 30 percent and still maintain the same low frequency responses. With fewer turns, the wire transformers (in particular) would have higher frequency responses because of reduced parasitics.

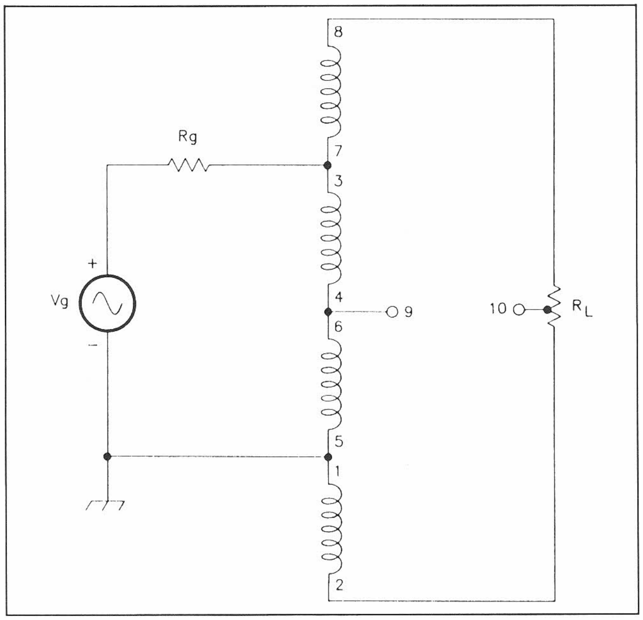

FIGURE 3. Low frequency model of the Guanella 1:4 transformer

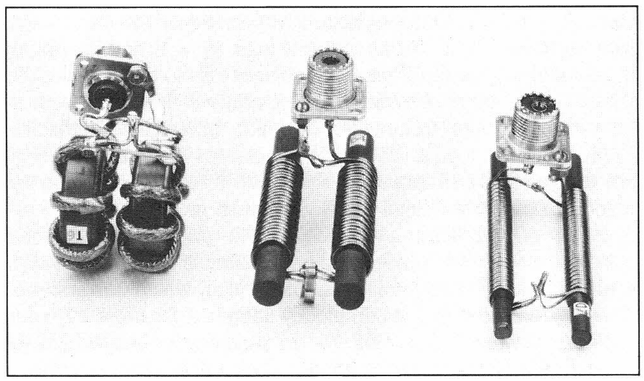

FIGURE 4. Three Guanella 1:4 unbalanced-to-unbalanced transformers designed to match 50 ohms to 12.5 ohms from 1.5 MHz to over 30 MHz

c) *Grounded baluns and hybrids*
Grounding terminals 1,5 and 10 (when $Z_O = R_L/2$), results in the output being balanced to ground. The top of R_L is $+V_2$ and the bottom $-V_2$. From Figure 2, it can be seen that the input and output voltages on the top transmission line are the same. Thus the top windings have no potential gradients from input to output. Further, the bottom two windings have a negative gradient of $-V_1$. This is just the opposite of the unun case, where the bottom transmission line had the zero potential gradient and the top transmission line, a positive $+V_1$ gradient. As in the unun case, if both transmission lines are wound on one toroid, an extra 1:1 balun, in series on the low impedance side, would be needed for isolation (the ground at terminal 1,5 is, of course, removed). If two cores are used, the top core in Figure 2 only plays a mechanical role since the low frequency reponse is now determined by the inductive reactances of windings 1-2 and 3-4. The low and high frequency responses are the same even when a balancing resistor is connected between terminals 9 and 10 as in the symmetrical hybrid case.

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TRANSMISSION LINE TRANSFORMERS

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By connecting three or more transmission lines in parallel-series arrangements, very broad bandwidth ratios of 1:9, 1:16, etc. are possible. In these cases, separate cores are usually required for best low frequency performance. Figure 5 shows schematics of the high and low frequency models of the Guanella 1:9 transformer. Like the Guanella 1:4 transformer, the best low frequency performance occurs when the transformer is connected as a bilateral, 1:9 balun with a floating load, i.e. either terminal 1,5,9 (as in Figure 5) or terminal 2 is grounded. But the more interesting case is when the transformer performs as a 1:9 unun (both terminals 1,5,9 and 2 are grounded). In this configuration, the top transmission line in Figure 5(a) has a gradient of $2V_1$ across its input and output terminals, the middle transmission line has V_1 across its terminals, and the bottom transmission line, zero voltage. Thus the optimum choice in toroids (or beads) would be ferrites for the top transmission line with a permeability twice that of the middle transmission line. As in the 1:4 case, the bottom transmission line requires no longitudinal reactance, and hence no core or beads. By connecting a 1:1 balun in series at the low impedance side, and removing the ground at terminal 1,5,9 (and using three cores), an improvement of about a factor of two can be realized on the low frequency response. Another interesting case is when the output voltage is balanced to ground, i.e. grounds are both on terminals 1,5,9 and 13. In this configuration, the bottom transmission line in Figure 5(a) has a negative gradient of $-3/2V_1$, the middle transmission line of $+V_1$ and the top transmission line of $+1/2V_1$. For best low frequency performance in this case, three cores should be used. Further, the core for the bottom transmission line should have an appropriately higher permiability.

Transformers with ratios of 1:16 and 1:25 can also be designed to perform over wide bandwidths because of the modular nature of Guanella's technique. For example, matching 50 ohms to 800 ohms (1:16) requires an optimum characteristic impedance of 200 ohms for the transmission lines. This is about the upper limit that can be obtained in power applications with toroids having outside diameters of about 2.5 to 3 inches.

Matching 50 ohms, unbalanced, to 600 or 1000 ohms, balanced and floating (which is about the upper-practical limit), requires impedance ratios of 1:12 and 1:20, respectively. These can be obtained by using fractional-ratio ununs in series with Guanella baluns. The 50:600-ohm balun can be realized with a 1:1.33 step-up unun in series with a 1:9 balun or a 1.33:1 stepdown unun in series with a 1:16 balun. If the need is for a 50:600-ohm unun, which is more difficult to construct, then the fractional ratio ununs should be replaced with fractional-ratio baluns (which can be realized on a single core). The 50:1000-ohm transformation can be accomplished by using a 1.25:1 step-down unun (or balun) in series with a 1:25 balun.

Figure 6 shows two examples of 50:600-ohm ununs. They are designed to cover 3 MHz to 30 MHz. The unun on the left, with the 4-stack balun, is rated at 200 watts of continuous power. The unun on the right, with the 3-stack balun, is rated at 1 kilowatt of continuous power.

RUTHROFF TRANSFORMERS

Ruthroff presented, in his classical 1959 paper [10], another technique for obtaining a 1:4 impedance transformation. It involved summing a direct voltage with a delayed voltage which traversed a single transmission line. Since his investigations involved small-signal applications, he was able to use very small, high permeability cores and fine wires. His manganese-zinc cores ranged only from 0.175 to 0.25 inches in O.D. and from 1600 to 3000 in permeability. His conductors, which were twisted in order to control the characteristic impedance, were only 37- and 38-gauge wires. Since the transmission lines were very short under these conditions

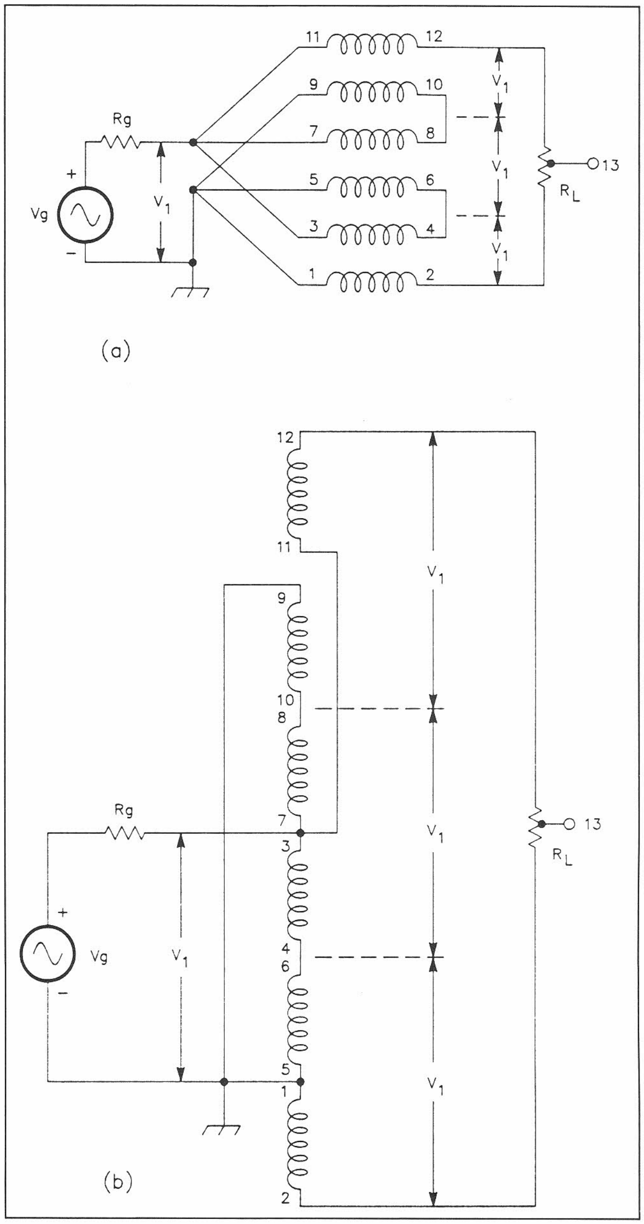

FIGURE 5. The Guanella 1:9 Transformer: (a) high frequency model, (b) low frequency model. It is assumed that $Z_0 = R_L/3$ and therefore V_2, the output of each transmission line, equals V_1.

(therefore little phase-shift between the summed voltages), he was able to demonstrate passbands essentially flat from 500 kHz to 100 MHz.

From the feedback on the first edition of the author's book [1], it became apparent that Ruthroff's 1:1 balun left an important question unanswered; namely, the function of his 'third' wire. This section will describe his 1:4 unun, 1:4 balun, and 1:1 balun and address the question of the 'third' wire.

Figure 7 shows schematics of the high and low frequency models of Ruthroff's 1:4 unun. The high frequency model shows that a building block is connected in the 'boot-strap' configuration. Unlike Guanella's model, which can practically be analyzed by inspection, Ruthroff resorted to the following loop and transmission line equa-

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TRANSMISSION LINE TRANSFORMERS

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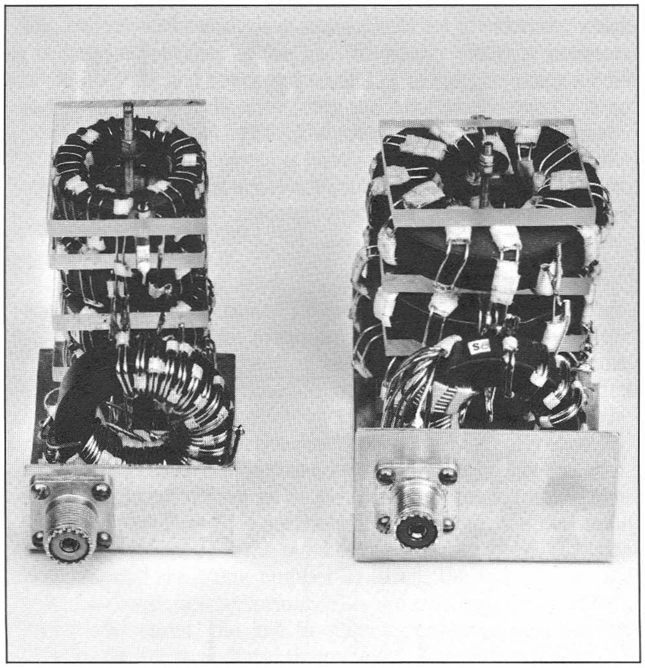

FIGURE 6. Two Examples of 50:600-Ohm Guanella ununs. The transformer on the left has a 1:16 balun in series with a 1.33:1 step-down balun. The transformer on the right has a 1:9 balun in series with a 1:1.33 step-up balun.

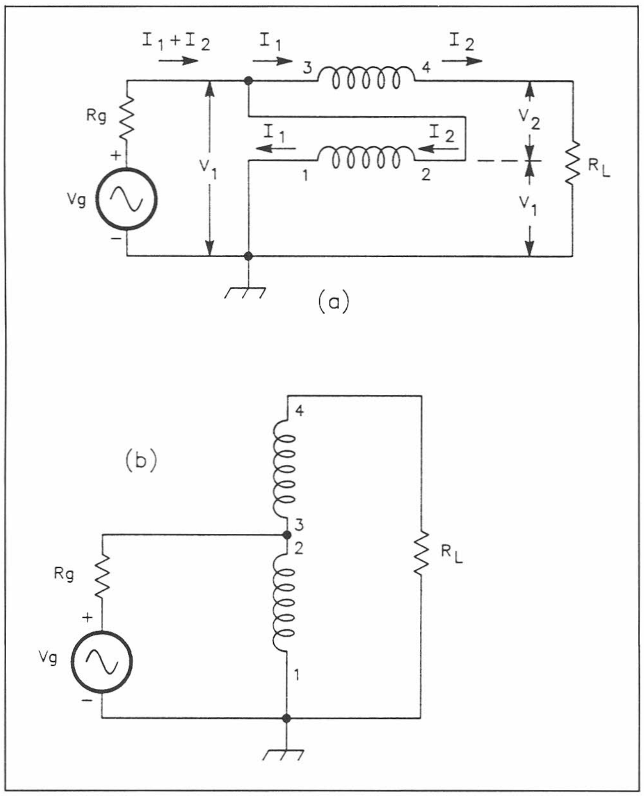

FIGURE 7. Ruthroff's 1:4 unbalanced-to-unbalanced transformer: (a) high frequency model, (b) low frequency model.

tions to solve for the power in the load and hence transducer (insertion) loss:

$$V_g = (I_1 + I_2) R_g + V_1$$
$$I_2R_L = V_1 + V_2$$
$$V_1 = V_2 \cos \beta l + jI_2Z_O \sin \beta l$$
$$I_1 = I_2 \cos \beta l + jV_2/Z_O \sin \beta l \quad (5)$$

He also found that the maximum transfer of power occurs when $R_L = 4R_g$ and that the optimum value of the characteristic impedance is $Z_O = 2R_g$. Figure 8 shows the loss as a function of the normalized line length and for various values of the characteristic impedance, Z_O. Even with the optimum characteristic impedance, the loss is found to be 1 dB when the line is a quarter-wavelength and infinite when it is a half-wavelength. Figure 8 thus shows the value of keeping the transmission lines as short as possible with Ruthroff's 1:4 unun. The low frequency model, which is the same as that of an autotransformer, is handled in the conventional way; i.e., the reactance of a single winding, at the lowest freqency of interest, should be much greater than R_g. This condition assures the transmission of energy to the output circuit by the efficient transmission line mode.

Figure 9 shows the high and low frequency models of his 1:4 balun. The high frequency model shows that a direct voltage $+V_1$ is added to $-V_2$ from a building block connected as a phase-inverter. It can be shown that the high and low frequency response is the same as his 1:4 unun. Two other comments can be made regarding this approach to a 1:4 balun. They are:

1) Unlike Guanella's balun, this one is unilateral; i.e., the high impedance side is always the balanced side.

2) When the center of the load, R_L, is grounded, the high frequency response is greatly improved. The balun now performs as a Guanella balun which sums two in-phase voltages.

Figure 10 shows the high frequency models for the Ruthroff 1:1 balun when using a toroid or a rod. As can be seen with the toroidal version (Figure 10(a)), a potential gradient of $-V_1$ exists across windings 3-4 and 5-6 in series. Thus the top of R_L is at $+V_1/2$ and the bottom at $V_1/2 - V_2$ with respect to ground. The third winding, 5-6, he noted in his 1959 paper [10], was necessary to complete the path for the magnetizing current. With out it, the transformer becomes a Guanella 1:1 balun. From recent discussions with Ruthroff and others, it was agreed, that if the reactances of windings 1-2 and 3-4 are much greater than R_L, thus isolating the output from the input, the third wire plays no role in the balun

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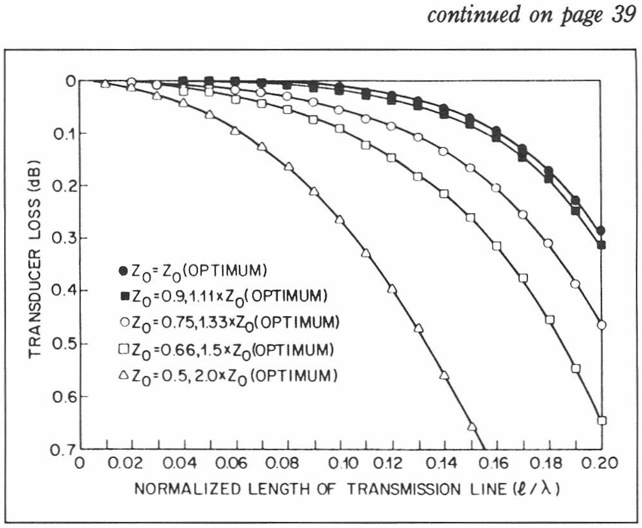

FIGURE 8. Loss as a function of normalized transmission line length in a Ruthroff 1:4 unun for various values of characteristic impedance, Z_O.

TRANSMISSION LINE TRANSFORMERS
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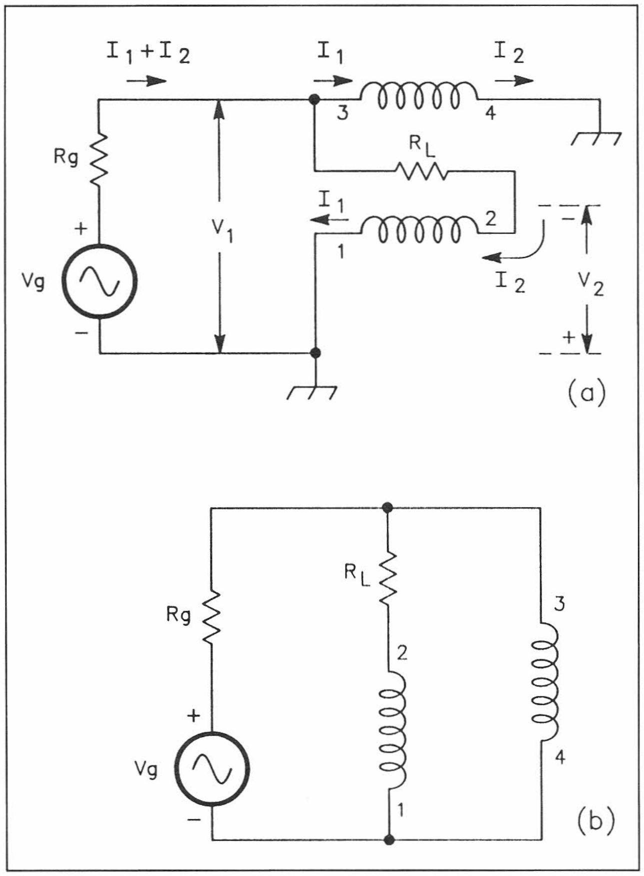

FIGURE 9. Ruthroff's 1:4 balun: (a) high frequency model, (b) low frequency model.

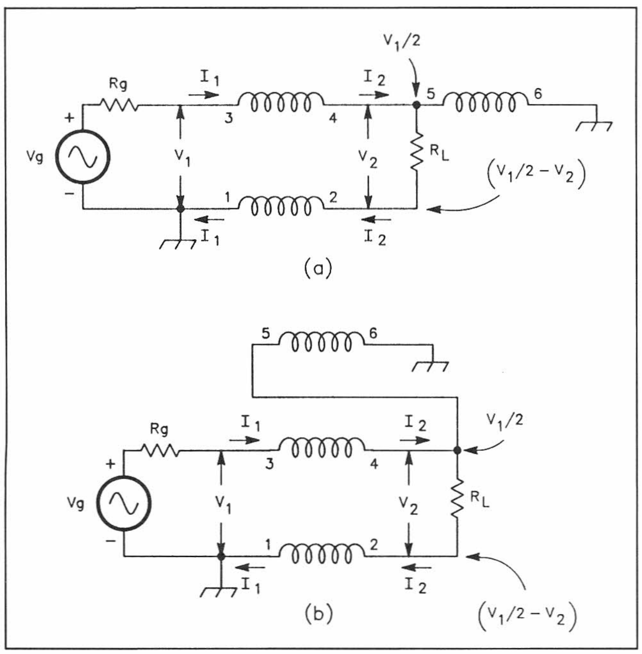

FIGURE 10. High frequency models of Ruthroff's 1:1 balun: (a) toroidal version, (b) rod version.

operation. If necessary, the center of the load, R_L, could be grounded, yielding an ideal balanced-to-ground output. Conversely, if the frequency is lowered to the point where R_L is much greater than the reactance of the windings, the input impedance approaches zero. Ruthroff's 1:1 balun has been constructed as a trifilar winding on ferrite rods and used successfully in matching coaxial cable to the balanced input of dipole antenna systems in the HF band. Since these baluns are tightly wound (no space between adjacent turns), the third wire mainly acts as an electrostatic shield and raises the characteristic impedance from about 25 ohms to about 45 ohms with 14-gauge wire. A bifilar balun with appropriate insulation and spacing between adjacent bifilar turns would be a better alternative [1].

FRACTIONAL-RATIO TRANSFORMERS

Little information has been available [17,18] on the characterization and practical design of transmission line transformers with impedance ratios other than 1:1, 1:4, 1:9, and 1:16. Many important applications can be found for efficient, broadband transformers with impedance ratios in the range of 1:1.36 to 1:3. These applications include both balun and unun (unbalanced-to-unbalanced) designs. In the author's case it was unun designs for matching coaxial cable to shortened verticals over a low-loss ground system.

The first attempt by the author, at a fractional-ratio design, was a tapped, Ruthroff 1:4 unun. It yielded acceptable performances at the 1:1.36 and 1:3 ratios but lacked in efficiency and bandwidth at around the 1:2 ratio [1]. The second attempt used higher-order windings (trifilar, quadrifilar, etc.) on a single core. These transformers proved much more effective and are reported in this section. The first design was concerned with obtaining a 1:2 unun. After trying various configurations with higher-order windings, the circuit in Figure 11(a) evolved. This transformer can be said to combine the techniques of both Guanella and Ruthroff. With a simple analysis they are: a) 'boot-strap' connections which create potential gradients of $V_1/2$ (from input to output) on all three windings, and b) an output voltage which is the sum of one delayed voltage and two direct voltages. Since the output voltage is $3/2V_1$ in the passband, the impedance transformation ratio is $(3/2)^2$ or 1:2.25. With the output voltage being 3/2V , the output current is then $I_2 = 2/3I$ and the two windings 1-2 and 3-4 effectively cancel out the flux in the core due to the current in winding 5-6. This transformer can be tapped in order to obtain a ratio near 1:2 and still possess the qualities of a transmission line transformer. With a tap on the top winding, 5-6, the output voltage becomes

$$V_2 = V_1 (1 + n/2N) \qquad (6)$$

where n = number of turns from terminal 5
N = total number of turns in winding 5-6.

Since the impedance ratio is $(V_2/V_1)^2$, a ratio of 1:2 can be achieved (quite satisfactorily) if n/2N approaches 0.4. Figure 12 shows an example of a tapped, trifilar transformer. As can be seen, at the optimum impedance level of 100:50-ohms, losses less than 0.04dB exist across most of the passband. By interleaving winding 5-6 between windings 3-4 and 1-2, the optimum impedance level decreases to 50:25-ohms because the characteristic impedance is reduced by having two conductors on each side of winding 5-6. But in the case of tight windings on a rod (no space between adjacent trifilar turns), the optimum level with 14- or 16-gauge wire is at about 50:25-ohms. In a more rigorous analysis, the phase and magnitude of the output of the transmission line composed of windings 5-6 and 3-4 has to be taken into account. Also at the low frequency end, it can be seen from Figure 11(a), three windings are now in series-aiding thus allowing for shorter transmission lines over bifilar windings for the same low-frequency reponse.

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Figure 11(b) shows the schematic of a quintufilar unun. Since the ratio of the output to input voltage is 5/4, the transformation now becomes $(5/4)^2$ or 1:1.56. The low-frequency model now has five windings in series-aiding. Therefore even shorter transmission lines can be used and still maintain the same low-frequency response.

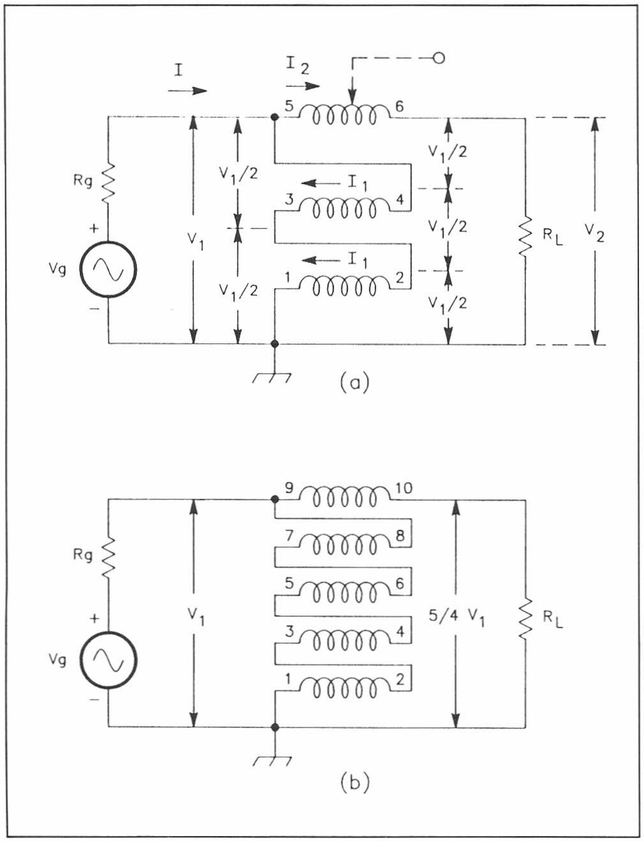

FIGURE 11. Two fractional-ratio unbalanced-to-unbalanced transformers: (a) 1:2.25 ratio, (b) 1:1.56 ratio. The voltages shown assume short, optimized transmission lines.

Other higher-order transformers, including one with seven windings (septufilar), have been constructed and found to perform very successfully. Several general relationships have been developed for this class of transformers. For the ununs used directly (without tapping), the transformation ratio, ϱ, is

$$\varrho = [y/(y - 1)]^2 \qquad (7)$$

where y is the number of windings.

For ununs that are tapped on the top winding, as in Figure 11(a), the ratio is

$$\varrho = [1 + n/N(1/(y - 1))]^2 \qquad (8)$$

where n = number of turns from the input terminal (as terminal 5 in Figure 11(a) and 9 in Figure 11(b)
N = total number of turns in the top winding
y = number of windings.

From Equation (7), various ratios from 4, 2.25, 1.78, 1.56, 1.44, and 1.36 are available without tapping and can be completely adequate in most cases. Whether Equation (7) or (8) is used, it can be shown that the larger the number of windings, the shorter the lengths of the windings (for the same low-frequency response), and the higher the frequency response. This is somewhat akin to the gain-bandwidth figure of merit for transistors. In this case it is the impedance ratio-bandwidth product.

These higher-order transformers also lend themselves to other interesting applications. For example, if an input connection is also made to terminal 7 in Figure 11(b), two broadband ratios of 1:1.56 and 1:2.78 become available. If winding 9-10 is interleaved between windings 5-6 and 3-4, and winding 7-8 interleaved between windings 3-4 and 1-2, the two ratios can be optimized for 50-ohm (on the right side) operation. Figure 13 shows such a broadband, dual-ratio transformer. Using the same technique with a quadrifilar transformer yields two broadband ratios of 1:4 and 1:1.78. Further, these two transformers can be connected in parallel on their 50 ohm sides resulting in four, independent, broadband ratios.

Another interesting application is the fractional-ratio balun also shown in Figure 13. Here, a 2.25:1 trifilar unun is connected in series with a 1:1 balun using 22-ohm coaxial cable. This transformer can match a 50-ohm cable directly to the popular Yagi beam antenna.

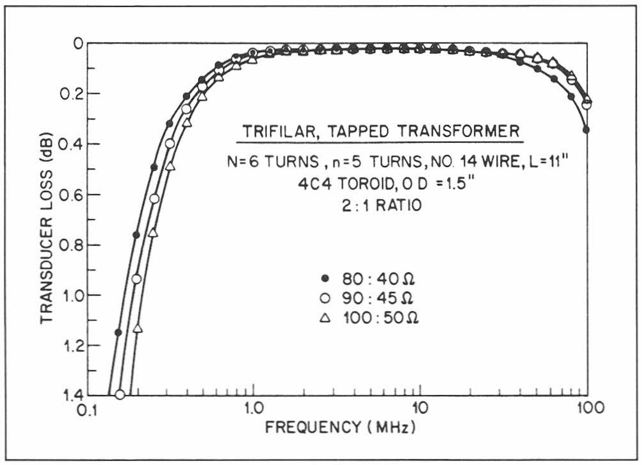

FIGURE 12. Loss versus frequency for a tapped trifilar transformer at the 2:1 impedance ratio and at three impedance levels.

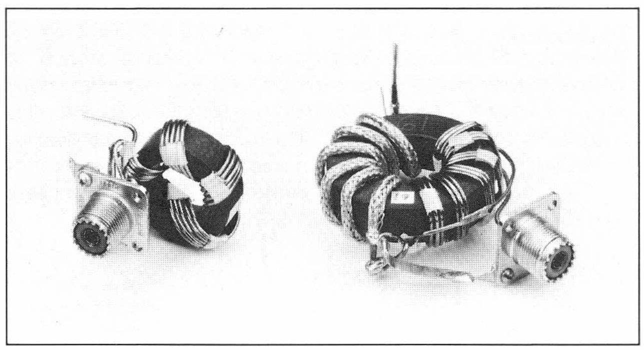

FIGURE 13. Two higher-order winding transformers. On the left, a dual-output unun with broadband ratios of 1:1.56 and 1:2.78. On the right, a step-down balun with a 2.25:1 ratio.

CONCLUSIONS

The results of the author's investigations have shown that:

1) Guanella's transformers have the greater bandwidths and higher impedance-level capabilities. Ruthroff's transformers (except for his 1:1 balun) have the advantage of simplicity.

2) The transmission line transformer is incredibly efficient, broadband, and flexible and has been sorely lacking in characterization and practical designs.

3) Further work is needed on ferrite materials for transmission line transformers, effects of parasitics, and discrepancies with theory when using low-impedance stripline and coaxial cable.

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Biography

Jerry Sevick received the M.S. and Ph.D. degrees from Harvard University in 1950 and 1952 respectively. His thesis was concerned with the back-scattering cross section of coupled antennas.

He taught Physics at Wayne State University from 1952 to 1956. He then joined the Device Development Department at AT&T Bell Laboratories. His early work was involved with high frequency germanium and silicon transistors. Later he supervised groups in integrated circuits, reliabilty, applications engineering, and high-speed PCM. From 1970 to 1985, he served as Director of Technical Relations, acting as a liason between the technical staff and outside organizations. He retired in 1985. It was his interest in Amateur Radio that launched Dr. Sevick into experiments with transmission line transformers. In the course of designing networks to match coaxial cables to short ground-mounted vertical antennas, the transmission line transformer was looked at as a possible vehicle. Since a literature search provided little information on specific designs, he undertook the characterization and design of transformers for low impedance applications. This then led to other studies resulting in the publication of his book Transmission Line Transformers published by The Amateur Radio Relay League, Inc.

Dr. Sevick is a member of IEEE, Sigma Xi, and Sigma Pi Sigma. While he was chairman of the Transnational Relations Committee of IEEE in 1977, the first technical exchanges were arranged with the People's Republic of China.

Did You Know That . . .

. . . **67% of American adults** are overweight? This is the largest proportion recorded. . .*ever.*

The Prevention Index. survey by *Prevention*, 33 E. Minor St., Emmaus, Pennsylvania 18098. Monthly. $13.97/yr.

. . . **The average working mother** works 13 to 15 hours a week more than her husband in combined job and home-making duties?

Sociologist Arlie Hochschild, quoted in *Life*, Rockefeller Center, New York 10020. 13 issues. $32.50/yr.

. . . **disposable diapers** make up 16% of the refuse picked up by garbage trucks?

King County Nurses Association, Seattle, reported in *Edell Health Letter*, 475 Gate Five Rd., Sausalito, California 94965. Monthly. $24/yr.

. . . **squashing a yellowjacket** can be dangerous if you're near the nest? *Reason:* A dying yellowjacket releases a substance that alerts other yellowjackets within a 15-foot radius, and they'll come to the victim's aid within 15 seconds.

National Pest Control Association, 8100 Oak St., Dunn Loring, Virginia 22027.

. . . **the handicapped's** high unemployment rate is expected to drop in the next decade? *Prediction:* Employers will turn to the handicapped to meet widespread shortages, especially among younger workers.

. . . **Carbonless copy paper** could be life-threatening to certain individuals. *Problem:* Chemicals in the paper can cause swelling of the larynx, which can result in asphyxiation in allergic individuals. *Protection:* If you notice a reaction to the paper (usually a rash, occuring within 30 minutes of contact) avoid using carbonless paper. Allergic reactions can intensify with repeated exposure. *Self-defense:* Use regular carbon paper or make photocopies.

Thomas B. Casale, MD and colleagues, University of Iowa College of Medicine, department of internal medicine.

. . . **Poison ivy/poison oak cure** is on the horizon. Products containing organoclays, silicates found in low concentrations in deodorants, seem to keep the plants' poison from penetrating the skin. *Protection available now:* Spray deodorant on shoes and clothes (*not* on face) before going into the woods. . . cleanse areas exposed to the plants with rubbing alcohol and rinse with cool water. *Warning:* Soap and hot water as well as touching other body parts with the infected area spread the oil.

William L. Epstein, MD, dermatology professor, University of California, San Francisco.

Book Review

Adaptive Antennas, Concepts and Performance, *by R.T. Compton, Jr., Prentice-Hall, 1988, xii +488, $53.00, ISBN 0-13-004151-3*

Professor R.T. Compton's new book *Adaptive Antennas* is a very welcome addition to the books and literature on this subject. It presents a very clear exposition on this broad complex subject. Professor Compton has taken great pains in achieving clarity and accuracy. Covered in extensive detail are primarily the Widrow Least Mean Square (LMS) and the Applebaum adaptive arrays in their many useful forms. A great portion of the material is based on the author's own work which is the result of many years of experience, both theoretical and practical with hardware. The author successfully achieves his goal of unifying the antenna, communications and feedback control aspects of the subject. The book can be used easily either by the graduate student or the working engineer. Little background beyond undergraduate courses in electrical engineering is needed including some elementary random variables, what a Hermitian matrix is, what eigenvectors and eigenvalues are and what matrix coordinate transformations look like. The feedback control and antenna material (e.g. Poincare sphere) are explained in the text. The book lays a good foundation for those desiring to do independent analysis on their own problems. Although the major emphasis in the book is on communication system adaptive arrays, the radar engineer will find the book very useful as well.

Where does this book fit in relative to the Monzingo and Miller[1] and Hudson[2] books? I would recommend reading the Compton book first, the Monzingo and Miller book second and the Hudson book third. For those who have already read the Monzingo and Miller and/or Hudson books I would still strongly recommend the Compton book. It contains material not covered in the Monzingo and Miller or Hudson books. Furthermore, those subjects covered in the Monzingo and Miller and/or Hudson books are covered from a different point of view in the Compton book which the reader will find very useful. the Monzingo and Miller and Hudson books are not replaced by the Compton book, because they cover material not covered in the Compton book. finally, for those wanting just a quick overview introduction to the subject Chapters 12 and 11 of Steinberg's book[3] are still useful, the latter chapter describing some of the author's own work on radio cameras imaging as well as retrodirective arrays such as Van Atta's.

A summary of the contents of the chapters of the Compton book is now given. Chapter One gives a little historical background information by way of introduction. Chapter Two covers in great detail the Widrow LMS, Applebaum and Shor adaptive arrays. The discrete as well as continuous LMS and Applebaum adaptive arrays are covered. The relationship between the LMS and Applebaum adaptive arrays is given.

Chapter Three covers the issues of the effect on the adaptive array performance of its degrees of freedom, the signal and interference bandwidth, and the array element antenna pattern (including polarization characteristics). Chapter Four discusses further factors effecting the array performance. Covered are the effects of the array feedback loop bandwidth (including time delay effects), the effects of base-band offset voltages at the output of the loop multiplier (as well as techniques for avoiding the deleterious effects of such offset voltages), the effects of the saturation of the control loop weights, the important issue of the randomness of the steady state loop weights (known as loop noise or weight jitter). Finally, the spread of the eigenvalues of the array covariance matrix are discussed for both the case of zero bandwidth and non-zero bandwidth interference. A large spread of the covariance matrix eigenvalues has the deleterious effect of causing the array to have a poor transient response. Chapter Five discusses four methods for avoiding this deleterious effect. These are the modified LMS loop, the Gram-Schmidt processor, the recursive least-square algorithm, and the sample matrix inversion method.

Chapter Six concentrates on the Applebaum adaptive array. It starts off by relating the fully adaptive Applebaum array to the common sidelobe canceler. Next a beam space version of the Applebaum array is given. This is followed by a discussion of the deleterious effects of errors in the steering vector in a communication system Applebaum array for which the desired signal is present. The subject of the addition of constraints on the array gain is next covered. Finally the operation of the Applebaum array in the power inversion mode is described. In this mode the knowledge of the direction from which the desired communication signal is arriving is not needed nor is it necessary to have any knowledge of the desired signal waveform, specifically no reference signal is needed as is the case for the Widrow LMS array.

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Press Release

The IEEE PRESS, book publishing division of the Institute of Electrical and Electronics Engineers, Inc., announces the publication of *Numerical Methods for Passive Microwave and Millimeter Wave Structures*, edited by Roberto Sorrentino. This book of selected reprints is published under the sponsorship of the IEEE Microwave Theory and Techniques Society.

Recent advancews in microwave technology, such as monolithic circuits and the use of millimeter waves, require highly sophisticated numerical techniques, which have thus become an indispensable tool for the modern microwave engineer. Many different methods have been developed since the advent of computers, each having its own advantages and disadvantages a well as ranges of applicability.

Numerical Methods for Passive Microwave and Millimeter Wave Structures is composed of a rich collection of papers consisting of overviews, tutorials, and seminal papers as well as the most recent contributions on nunmberical computation. It introduces the reader to ten representative numerical techniques, ranging from finite difference to spectral domain methods.

By providing critical information on numerical methods, the reader is able to make a well-reasoned choice of the method best suited for the problem at hand. Emphasis is given to problems involving modern planar and quasi planar structures, as well as more conventional structures.

Those with an interest in the fields of microwaves and electromagnetics will find this volume an invaluable source of information.

Numerical Methods for Passive Microwave and Millimeter Wave Structures (Order Number: PC02402) contains 496 pages and is priced at $74.95 ($56.20 for IEEE members). The book may be ordered from the IEEE Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331. Make check payable to IEEE. Please add the following shipping and handling charges: for orders totaling $1.00 to $50.00, add $4.00; $50.01 to $75.00, add $5.00; $75.01 to $100.00, add $6.00; $100.01 to $200.00, add $8.00; over $200.00, add $15.00. Credit card orders (MasterCard, VISA, American Express, and Diners Club) are accepted for orders over $10.00.

BOOK REVIEW
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The final chapter, Chapter Seven, deals with techniques for generating the reference signal in LMS arrays for practical communication systems. The generation of reference signals for systems having four types of modulations are discussed. These are spread spectrum with biphase modulation, coded amplitude modulation (AM), spread spectrum with quadriphase modulation and finally binary frequency shift keying (FSK). the first three modulations use a pseudonoise (PN) code as a tagging modulation on the desired signal. The book in addition has an Appendix A on the Hilbert transforms and analytic signals and an Appendix B on quadrature hybrids.

My one criticism for the book (a minor one) is that it would have been useful to have a list of symbols, even though generally I could find where the symbols were defined without too much difficulty. Such a list could be easily added in a future printing.

In conclusion I recommend this book very highly, it is well worth reading and rereading.

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Reviewed by Dr. Eli Brookner

Dr. Eli Brookner is a Consulting Scientist at the Raytheon Co. Equipment Division in Wayland, MA. He is editor and principal author of *Radar Technology* and *Aspects of Modern Radar*, both published by Artech House. His area of expertise is Radar, a topic on which he has lectured extensively.

Comments about Time Domain Techniques in Electromagnetics

by Fred Gardiol, Professor, Laboratory of Electromagnetism and Acoustics (LEMA) Ecole Polytechniquek Federale de Lausanne, EL-Ecublens, CH-1015 Lausanne, Switzerland

Nowadays, electromagnetic wave propagation and scattering are studied directly in the time-domain, whereas previously one used to consider sine wave excitations and Fourier transformations into the frequency-domain. Time-domain approaches are certainly much closer to the physical reality, but how do they deal with propagation within (or with scattering from) material media, since material properties are dispersive (frequency-dependant), at least over parts of the frequency spectrum? It is not obvious that time-domain approaches can determine the resulting distortion of the signal.

This question was raised on several occasions, and rather conflicting answers were received in the past. In order to clarify the situation, an **'open question to time-domain experts'** appeared in the IEEE MTT-S Newsletter of the Summer 1988, in the IEEE AP-S Newsletter of October 1988 and in the URSI News Supplement to the URSI Information Bulletin of September 1988. I received several extremely interesting answers, that showed that this matter had not been overlooked. I wish here to thank their authors, namely Professor T. Wong of the IIT Center in Chicago, Dr. B. Blevins of the New Mexico State University, Dr. E. Miller of the General Research Corporation, Professor R. Luebbers of Penn State, Dr. F.M. Tesche of E-Systems, Greenville, TX, Dr. C.C. Lin of Dornier Systems, Friedrichshafen, Germany, and Professor G. Kristensson of the Royal Institute of Technology, Stockholm. Professor W. Hoefer, of the University of Ottawa preferred to send his reply directly to the MTT Newsletter, that published it in the Winter 1989 issue (he gave me a copy shortly before publication).

I summarized in the following lines the basic problem, together with the most significant information received, listing also the publications sent to me and the addresses of researchers presently involved in it (where readers interested in more details may hopefully gather further information).

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COMMENTS ABOUT TIME DOMAIN
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The response of material media to electromagnetic excitations always depends somewhat on frequency: this is a basic fact of physics, that cannot be overlooked. Even so-called 'lossless dielectrics' are approximately lossless ***only over certain ranges of frequency.*** The lossless dielectric is typically a frequency domain concept, and there is no such thing as a lossless dielectric in the time domain. Actually, all the phenomena that give rise to dielectric polarization are frequency-sensitive, because the dipoles formed by molecules, ions or electrons can only align themselves with the electric field when the latter does not move too fast. The resulting dependence, as a function of frequency, is a succession of 'plateaux' where the permittivity remains approximately constant and real, separated by transition regions where resonances or relaxation phenomena produce strong changes of permittivity associated with absorption peaks (1). The real and the imaginary parts of the complex permittivity are related through the Kramers and Kronig relations, that ensure that the response is causal, i.e. that the effect does not occur before the cause (2). Disregard of such requirements led in the sixties to considerable discussion over the so-called 'thermodynamic paradox' in magnetized ferrites, until it was pointed out that a 'strictly lossless ferrite' would be a non-causal medium (3). Some materials exhibit more complex frequency-dependences, it was found in particular that the conductance in many dielectrics follows a ω^m behavior, with m in the vicinity of 0.8 (4).

In the frequency domain, the displacement phasor-vector is simply proportional to the electrical phasor-vector, with a proportionality factor that can become complex

$$\underline{\vec{D}}\ (\omega) = \underline{\varepsilon}\ (\omega)\, \underline{\vec{E}}\ (\omega) \qquad (1)$$

in the time domain, on the other hand, the corresponding relationship can only be expressed by a convolution

$$\vec{D}\ (t) = \int_0^t \varepsilon\ (\tau)\ \vec{E}\ (t - \tau)\ d\tau \qquad (2)$$

where $\varepsilon\ (\tau)$ is the inverse Fourier transform of $\varepsilon\ (\omega)$. Convolutions can be incorporated into time-domain algorithms, at least in principle, but this considerably increases the complexity of the mathematical resolution. In many situations, it is actually more economical to solve the problem in the frequency domain, and then to determine the time-domain response to any excitation by taking the inverse Laplace or Fourier transforms (5). This is however not possible when the problem is nonlinear.

Mathematical techniques were developed for materials whose frequency dependence can be approximated by a pole series, which has an associated exponential time behavior. The research work in this area was carried out by Dr. R. Holland at applied Physics (5353 Wyoming Blvd., NE, Suite 3, Albuquerque, NM 87109) and by Dr. H. Mohannadian at the Rockwell Science Center (1085 Camino de los Rios, Thousand Oaks, CA 91360). The approach followed is most interesting, even if it is limited to a particular class of materials, but the mathematics become rather involved.

The Finite Difference Time Domain (FDTD) formulation requires the permittivity, permeability and conductivity to be constant quantities: this approach is rigorous when propagation in vacuum with perfect conductor boundaries is considered, but provides only an approximation for dielectrics (in this case, a frequency- domain concept is used in a time-domain analysis...). The traditional formulation was extended to include the time-domain convolution, resulting in the (FD)2TD, standing for 'Frequency- Dependent Finite Difference Time Domain' by Professor R. Luebbers and his team at the E.E. Dept., Pennsylvania State University, University Park, PA 16801. Their approach is particularly well suited for massive parallel computer architectures. The technique was successfully applied to a gaussian pulse impinging on an air-water interface. Comparison with the standard RDTD method clearly shows what error can be made when the frequency dependence is not considered—even when precautions are taken to consider small parts of the spectrum at a time. I can only hope that these results will soon be published, because this is the approach that appears to be the most general.

The reflection from a real metal boundary, over which the surface impedance varies as $\omega^{0.5}$, was considered by Tesche, also by solving a convolution integral involving a distribution function (6). Scattering by a flat plane and a cylinder were considered, and the results used to analyze the propagation on a wire above a lossy ground plane. The author indicates that, while the process is simple to describe mathematically, the numerical implementation of the technique presents a difficulty: due to the presence of the convolution function, the entire past time history of the response function must be retained and re-used at each time step. This can increase considerably both the time and the storage required.

Finally, according to Hoefer, the TLM (Transmission Line Matrix) method is also capable of handling both the frequency-dependant reflections from real metal surfaces and the propagation through materials exhibiting resonances (7). It appears however that this was not done as yet. The TLM method is also a technique well suited for array processors.

One may of course argue that to consider all materials as being lossy and dispersive in the time-domain is an unnecessarily harsh requirement, and that in many situations the lossless dielectric approximation would be quite adequate. This is certainly true when the excitation has a limited spectrum width that falls within the frequency band over which the dielectric is lossless. This would be the case when using a finite-risetime pulse, for instance a gaussian pulse. On the other hand, one should be particularly careful when considering impulse responses.

As a preliminary conclusion, it is clear that time-domain approaches can handle dispersive propagation and reflection. However, this entails a significant increase in the mathematical complexity of the treatment, which requires the evaluation of a convolution integral. This appears to be somewhat problematic when looking for analytical solutions, but can apparently be incorporated more easily into a discretized approach.

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To submit candidate canonical problems, or for additional information, contact:

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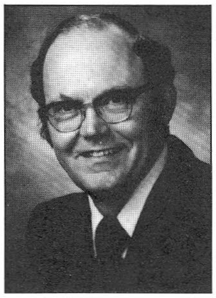

by E.K. Miller
General Research Corporation
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Santa Barbara, CA 93111

MiniReview
PT EXPRESS, Liberty Labs, Inc., P.O. Box 8268, Cedar Rapids, IA 52408, Tel. (319)390-3646.

Michael W. Howard, President of Liberty Labs, recently sent me a copy of his software package *PT Express*. The package sells for $99.95 and can be ordered by phone using your MC or VISA. It is a 'TSR (Terminate & Stay Resident) program for solving engineering problems and equations relating to EMC and other engineering principles,' and is designed for IBM PC/XT/AT/PS2 and compatibles. It provides 4 main functions which are:

Conversions — unit conversions of any type of units.

Equations — automatic solving of commonly used equations placed in a programmable database.

Math with Plotting Capability — calculates and plots equations on the CRT display.

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PT Express comes with pre-prepared templates in each of these areas and allows the user to customize or enter new routines via their favorite word-processing package. It is essentially equivalent to an online handbook, calculator and plotter designed for EMC Engineers and Technicians working with EMC requirements and equations. The program provides instant access through a series of Hot keys to pop up needed tables (e.g., FCC Part 15-J, VDE 0871); performs necessary conversions; or handles equations needing evaluation. In Macintosh parlance, *PT Express* would be called a desk accessory.

The program comes with a well-prepared, spiral-bound 5 inch x 8.5 inch user's manual having six sections, three appendices and an index. Equations and tables, to a maximum of 19 can be added and edited by the user to develop a more personalized version. It requires DOS version 2.0 or higher, and supports the CGA, VGA, and EGA monitors. Function selection and data entry are made via menus under cursor control. Editing is done in a BASIC-like manner on text files which are then converted to data files using COMPRESS. Functions available for equation evaluation include arc tangent, tan, cosine, sine, exponential, natural and base-10 logarithms, square and square root, and absolute. If your work requires it, this kind of software product can be of great help and a timesaver. Incidentally, you might like to know that Liberty Labs has recently assumed publication of the bimonthly publication *Electromagnetic News Report*.

WHY NOT CONSIDER APL?
Professor Douglas B. Miron, South Dakota State University, Brookings, SD 57007-0194.

Pros and Cons of Commercial Software, Appendix B.1 from his book *Design of Feedback Control Systems*, HBJ Technology Press, 1989.

Professor Miron of South Dakota State university offers some provocative obervations gleaned from his experience in developing programs for feedback control systems. He weighs in with his own favorite language, one not previously mentioned in this column, APL. Among the more general points he makes are three with which many of us would likely concur. One is the importance of documentation, practice of which is probably honored more in theory than in actual practice for most research codes, at least. Second, he stresses the value represented in a language/interface that provides convenient graphical output. His final point might be more arguable, which is that 'if a program has a good user interface, it isn't necessary to learn the underlying language,' but a claim to which many Macintosh users can certainly relate. Because of its relevance, I include most of Appendix B.1 from his recent book.

'Before the advent of the personal computer, we working engineers used either a mainframe computer or a tabletop system. In the former case, a few general-purpose software packages were available, but most of us just wrote our own programs, usually in FORTRAN. In the latter case, some software was available either free or at nominal cost from the machine's manufacturer. Again, most of us just wrote our own programs, either in a machine language or in BASIC. I've been told recently that there is a catalog listing over 3,500 software packages for engineering use to run on PCs. Documentation has changed too. When I learned PL/1 in 1975, I did it with a manual about half an inch thick. Now, no self-respecting software publisher would sell a package with fewer than 300 pages of documentation, most of which you will never want or need to read. Even so, the amount of learning you will have to do is on the order of learning a new programming language. You should seriously consider the effort involved before committing money and time to a new software package. For a specialist who can foresee very frequent use of a package, an investment is very clearly justified. For a generalist, on the other hand, the investment is seldom reqarded in even the medium term. In my own case, I mainly use two products, a word processor and an APL interpreter.

I am a generalist, and you might conclude from the above that I have a bias against canned software. I have seen some products that produce very nice displays, and tried out some that claimed to be very user-friendly, but I've always been put off by the size of the manual I would have to wade around in if I bought it, and the low use rate I know the package would actually get. Whatever your preferred language, the advantages of writing your own programs are:

1. You control the models. You can make the compromise you want between accuracy and computation time. You determine what features are important, and you can readily make changes to incorporate as the situation warrants, and as they appear in the literature.

2. You have already made the major learning investment in the language. Each application takes a relatively small investment in additional learning, and that is mostly about the problem itself.

3. You will develop a set of functions or subroutines which turn out to be common to many problems, such as complex arithmetic, two-port parameter manipulations, or plotting functions. These will form your own personal set of utilities from which you can draw to make solution of new problems easier.

To achieve these benefits though, you have to maintain sufficient documentation to be able to use a program six months after the last use. The documentation can be on paper or in comments in the source code. It is ABSOLUTELY ESSENTIAL. Another very important point is this; whatever you choose for a language, choose an implementation that allows pixel-level plotting. The most important contribution PCs have made is affordable computer power

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PCs FOR MTT
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to support a large percentage of our daily professional needs. The second most important contribution is the general availability of good screen and printer plots. The graphical presentation of results with 200 or more points per curve is a tremendous aid to our understanding and presents opportunities that would have been missed with line-printer-style character plots or tables or a few performance figures.

I want to make a special case for leaning APL, even though you probably have already learned at least one other programming language. The other languages I have learned or looked at all seem to me to be first or second-level mnemonic covers for the computer's operation. Languages above Assembler are supposed to be architecture-independent, but one is very aware of storage requirements when declaring data types and dimensions. One is also very aware of the fact that operations are done on one datum at a time. Finally, the functions defined in the languages have one or two scalar arguments.

These languages are like the machines themselves, essentially oriented to do arithmetic in either the numerical or logical sense. It's as if these languages never went to college. APL originated with an effort to regularize the use of functional symbols in mathematics. As such, its defined operators not only operate on scalars but also on vectors and arrays. Furthermore, the nature of an operand doesn't have to be predefined by you. The interpreter checks to see what kind of data you assigned to the operand and allocates storage accordingly. No explicit data type or array dimension statements are required from you. Most important, a whole new class of operators is given to you for use on vectors and arrays. I like to impress people by telling them that matrix inverse is only one keystroke in APL. Actually, I use matrix inverse rarely in comparison to the other array functions. An operator you ordinarily wouldn't think of is the compression operator, /. The division symbol is ÷. A←+/B means 'A is assigned the sum of the elements in each row of B.' The plus sign can be replaced by any arithmetic operator and the result is as if the operator were inserted between each element of a row of B and the operation performed sequentially along the row. In addition, A←C/B, where C is a vector of 1 and 0 elements, means 'Pick out the elements in B that line up with the '1's in KC and throw away the rest, and assign the result to.' Thus C is a selection vector. C can be formed as the result of a logical test on the elements of B. For example, C←2≤B 'If an element in B is not less than 2 (the test is true) put a 1 in the corresponding element of C. If the test fails, put a 0 in that element of C.' Thus, not only are there generalized versions of the operators you are familiar with, such as various kinds of transpose and rotation, taking and dropping of rows and columns, inner and outer products, but there are operators for things that you do but don't have symbols for, such as reshaping an array, sorting, and assembling arrays from smaller arrays or vectors or scalars.

The operators have three major effects; they make the interpreted program go much faster than, for example, interpreted BASIC. Execution is not as fast as for a compiled program, but fast enough to give that interactive feeling. The array operators give one new ways of thinking about how to solve problems. Development time is much shorter.

As an example of the short development time, a few months back I wanted to try out some ideas about multichannel filters on some simple filter structures. I didn't have a workspace for general network analysis, so I had to choose between learning to use a PC version of SPICE or writing a new workspace. I ran the sample SPICE program, discovered that I would need an ASCII editor to enter data to it, didn't like the character-plot output, didn't like the somewhat elaborate element description, and decided I'd make my own.

I decided to describe the networks in node equations with unknown voltages and current sources. Then I converted the equations to three matrices; a conductance, a capacitance, and an inverse inductance matrix. For n nodes I define the input currents as a 2n vector—the first n values being the real parts, the last n values being the imaginary parts. I generate a vector of the frequencies for which I want the response, and a selection vector to pick out the node voltages I want. The foregoing are all global variables. I wrote a function which uses them as follows to produce the frequency response of the network. Inside a loop which steps through the frequencies, it forms the imaginary matrix I←(W[K] x C) + IL ÷ W[K], where W[K] is the k'th radian frequency. The function then forms a 2nx2n matrix of the real and imaginary matrices, inverts it as described in the following section, and right-multiplies by the currents to get the node voltages. It's all just what you would do by hand, but much faster to program as a defined function in APL. The coding and debugging took me about an hour. Compare that with the time it would've taken to learn to use the ASCII editor and the SPICE program.

Another important aspect of APL is that it responds like a calculator. You don't have to write a program to find the product of A and B. You simply type AxB, press ENTER, and the interpreter gives the result on the next line. Programs in primitive languages are user-defined functions (user-defined operators) in APL. To produce such as definition, one enters function definition mode, types the routine, and returns to immediate mode. The interpreter responds to the user-defined function just as it does to a built-in (primitive) operator, immediately. The variables and functions defined in a working session are called a workspace and can be saved with a name. One can select variables and functions to copy from one workspace to another, making it easy to move utility routines from one application to the next.

It is so much faster to work in APL than in the primitive languages that I have come around to a new point of view. I believe the only people who should study the primitive languages are computer scientists and systems programmers. All the rest of us who just want to *use* the computer should learn only APL. The argument for FORTRAN has often been, 'There's so much already invested in FORTRAN programs, people have to learn it.' I propose that if a program has a good user interface, it isn't necessary to learn the underlying language. If the program is becoming obsolete, far less effort would be expended in rewriting its function in APL than in going in and modifying the old program. APL is that good. A lot of time and money have been wasted by not using a college-level language in our professional practice.'

Airfare increase self-defense

☐ **Big airfare price hikes** are coming on some international flights. Effective July 1, airlines imposed new rules that penalize travelers who buy one-way tickets *in the US* for travel between two foreign cities — a common practice among business travelers.

New rule: Because fares between two cities can differ by direction — London to Tokyo costs $1,775, yet Tokyo to London is $2,562 — anyone buying a one-way ticket in the US for travel between two foreign cities will pay the higher fare.

Protection: There is no penalty if the ticket is purchased in the country you're flying from. *Added restriction:* Tickets may only be purchased for flights that *originate* in the country you're traveling from.

The Wall Street Journal.

Call for Papers

IEEE Transactions on Microwave Theory and Techniques Special Issue on *Directions in Design and Applications of Microwave Systems*

Evolutionary developments in design and applications of microwave systems are driven both from internal sources due to technological advances and from external sources as a result of new functional requirements. Advances in semiconductor technologies, particularly in integrated circuit materials and manufacturing techniques, are having a major impact on system architecture and operational capabilities. In the more classic areas of radar and communication systems, the availability of higher device densities has shaped system parameters such as size, performance, operating frequency and cost. These advances have resulted in extended and new system applications. The simultaneous evolution of computing techniques has allowed detailed modeling at the device and system levels, resulting in closely controlled designs, and has opened new horizons in system output information processing for military, commercial, industrial and medical applications. The advent of high temperature superconducting materials promises new challenges.

Papers are solicited for a special issue of the IEEE Transactions on Microwave Theory and Techniques on *Directions in Design and Applications of Microwave Systems,* to be published in May, 1991. The purpose of this special issue is to highlight the diverse areas which interact to provide new directions for microwave and millimeter-wave systems. Relevant topics of interest include, but are not restricted to, the following areas:

- Radar Systems
- Phased and Active Array Systems
- Scanning and Imaging Systems
- Terrestrial and Space Communication Systems
- System Applications of Integrated Circuits, including MMIC Technology
- System Applications of High Temperature Superconductors
- System Applications of Other Emerging Technologies
- Application of CAD Techniques to System Design
- Application of Computing Techniques to Array Output Data Processing
- Influence of Packaging Technology on System Design

Authors are requested to submit four (4) copies of their manuscript by July 15, 1990 to:

George L. Heiter
Guest Editor, MTT Special Issue
AT&T Bell Laboratories, Rm 2A-30
1600 Osgood Street
North Andover, Massachusetts, 01845, USA
Telephone: (508) 960-6031; FAX: (508) 960-6272

Manuscript requirements for submitted papers are outlined on the outside back cover of the IEEE Transactions on Microwave Theory and Techniques.

Call For Papers

IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES

SPECIAL ISSUE
on
MULTIFUNCTION MMICs AND THEIR SYSTEM APPLICATIONS

There have recently been rapid advances in the manufacturing technology of GaAs and Silicon based ICs operating at microwave frequencies. Since these technologies are becoming available through various foundries, there has been a surge in the design of complex MMICs with more than one function on a single chip. Monolithic ICs have inherent advantages of light weight, small size, increased reliability and low cost in large volume production. MMICs have long offered the promise of fulfilling the requirements of many military and commercial microwave systems. The development and insertion of MMICs in microwave systems is at the threshold of a new era, with new levels of capabilities in design, manufacturing, testing, and packaging .

Papers are solicited for a special issue of the IEEE Transactions on MTTs on "Multifunction MMICs and Their System Applications" to be published in September, 1990. The purpose of this special issue is to present recent advances in GaAs MESFET/PIN and Silicon bipolar based multifunction ICs including microwave, analog, digital multifunctions and the combination of these, on a single chip. It will address the modeling, design, test and package, process and material issues for such complex and large size MMICs. Topics of particular interest include, but are not limited to, the following areas:

- MMIC designs with several functions on a single chip
- MMIC based systems and their partitioning with MMIC insertion in view
- Techniques & architectures to optimize performance of multifunction MMICs
- Testing and packaging of multifunction MMICs at microwave frequencies
- Integration of microwave and digital functions on a single chip
- Multifunction MMICs based on HBT,HEMT and other advanced structures
- GaAs on Si processing to combine low frequency Si and high frequency GaAs functions
- Material advancements, techniques for process compatibility and yield improvements to support multifunction/large size MMICs

Ravender Goyal of Anadigics Inc. and E. C. Niehenke of Westinghouse will be the guest editors of this special issue. Prospective authors are requested to submit four copies of the manuscript describing original work by Dec. 15th, 1989, to:

Ravender Goyal
Anadigics Inc.
35, Technology Dr.
Warren, NJ 07060
(201) 668- 5000 X 214

Manuscript requirements for submitted papers are outlined on the outside back cover of the IEEE Transactions on Microwave Theory and Techniques.

Why Bother With Communication?

by Cheryl Reimold
PERC Communications
6A Dickel Rd.
Scarsdale, NY 10583
(914) 725-1024

You're a technical manager—a research director—a VP Operations—an engineer. You're not at work to talk to people. Except for the occasional brief memo or technical report, you don't write that much. Why should you spend a moment of your busy life thinking about communicaton of all things? You're there to get the job done well. That's enough of an effort.

Why bother with communication? Very simply, because you can't get the job done well without it.

Here, I will show you a few reasons to take communication seriously—seriously enough to make the terrific effort required to change behaviors of a lifetime. In following columns, I'll show you how to begin to make those changes.

To Be An Effective Professional or Executive, You Must be Able to Communicate

In *The Effective Executive*, Peter Drucker calls executives and other professionals 'knowledge workers'—people who produce not physical objects but rather knowledge, ideas, information. Then he makes the crucial point:

By themselves, these 'products' are useless. Somebody else. . . has to take them as his input and convert them into his output before they have any reality. . . knowledge work is defined by its results.

Knowledge, imagination, and intelligence are not enough. To be effective—that is, to get the job done well—you must be able to communicate your knowledge and ideas to the people who can convert them into the output or product that the department or company needs.

To Create and Effective Product, You Must be Able to Communicate

How do you know what your company or department needs to produce? If you're thinking, 'Give me a break, that's obvious'—think again. This question touches on one of the most widespread problems I've encountered in my communications workshops in companies of different sizes and from different industries. Mill people complain that those in the technical center don't produce the findings they need. Conversely, researchers say the people at the mill don't give them the information they need to do the necessary research. Sales representatives complain that they're not getting products that meet the customers' requests. And customers complain that the companies' product does not live up to its promises.

An effective product is one that works and fills needs. To create an effective product, you must be able to communicate across boundaries. Find out what your staff wants and needs from you—that's your effective product. Find out what the other departments want and need from yours—that's your department's effective product. Find out what customers want and need—that's your company's effective product.

To Run an Effective Group, You Must be Able to Communicate

You must be able to give your staff clear and understandable instructions. If they don't know exactly what you want them to do, you'll have chaos on your hands. Clarity is essential. But it's not enough.

Do you want your people to work as hard as they can, with all the enthusiasm and creativity they possess? Giving them clear, complete information won't do it. You must be able to inspire them to put out their maximum effort—with pleasure.

In a recent interview with *Fortune* (Aug. 9, 1988) Lee Iacocca talked about one of Chrysler's most successful plants: . . . it appears that our plant with the least automation and least investment is turning out the best quality. You ask, 'What's going on?' Well, it has to be the people in the plant, management and labor. It is how the people approach their jobs that does it. . .The answer is to make a guy—any guy—feel that when he comes to work he does something, and contributes something, so that he can't wait to come back tomorrow. . .

This, to me, is the essence of effective communication at work. 'To make a guy—any guy—feel that when he comes to work, he does something, he contributes something, so that he can't wait to come back tomorrow.'

Communication is a central, essential skill for you in your work. Once you realize that you cannot perform effectively without good communication skills, you'll start to pay attention to what you're doing now and what you could do better. That's the first step.

Cheryl Reimold is author of more than 100 articles and several books, including How To Write a Million-Dollar Memo *and* Being a Boss. *Her firm, PERC Communications, offers businesses in-house workshops and courses in communications, writing, negotiation, and creative problem solving. For information, please contact her at the address listed above.*

Education Committee Report

by Reynold S. Kagiwada
TRW Electronic Systems Group
3117 Malcolm Ave.
Los Angeles, CA 90034

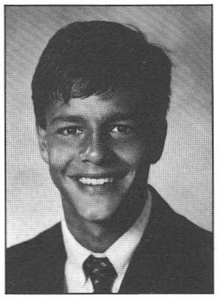
Four recipients were selected by the Citizens' Scholarship Foundation of America, Inc. (CSFA) for the 1989 IEEE-MTT Society Merit Scholarships. They are Sandeep K. Agarwal of Plano, Texas; Karen A. Erlandson of Marion, Iowa; Fredrik L. Rehnnmark of Skaneatelos, New York; and David J. Williams of Bethesda, Maryland. The awards are for one year and renewable for four years.

In making the selection CSFA had to choose from a number of outstanding applicants. The CSFA manages these awards for MTT-S and independently and confidentially collects information about all applicants on forms specially prepared for these awards. In making

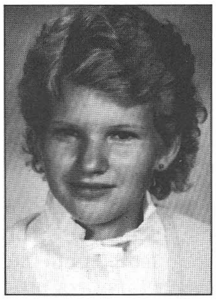
continued on page 51

EDUCATION COMMITTEE REPORT
continued from page 50

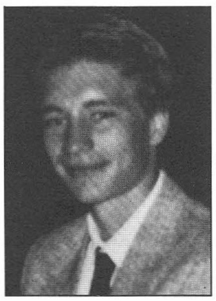
the selections, CSFA utilizes PSAT/SAT scores, class rank, academic record, GPA, leadership, career goals, community and extracurricular activities, and teacher recommendtaions. MTT-S verifies the eligibility of the parent in regard to active membership. For the next school year beginning 1990-91, the announcement for request of information appears in this issue of the MTT-S Newsletter.



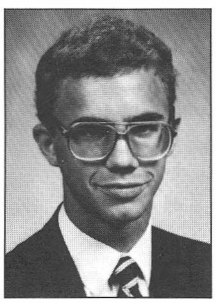
Sandeep K. Agarwal will be attending the University of Texas at Austin, where he will be majoring in biomedical engineering Sandeep says, 'I am honored and pleasantly surprised to have been selected as a recipient of the IEEE MTT Society Scholarship by the Citizens' Scholarship Foundation of America, Inc. This scholarship will motivate me to work hard and to succeed for my future.'



Karen A. Erlandson will attend Iowa State University. Karen commented, 'This scholarship will help me toward my study of food science and technology at Iowa State University. I am glad that the organization encourages its members' children to pursue a higher education through awards like this and hope that it will continue this fine opportunity.'



Fredrik L. Rehnmark was quite pleased to become a recipient. Fredrik remarked, 'I am ecstatic about the award because it was beginning to look like all the scholarships I had applied for were either to specific or too competitive for me to have a crack at. That is one reason why the announcement of my award made me so happy. In addition, and perhaps more importantly, I am also excited because it is an engineering scholarship.' Fredrik will be attending Cornell University where he will major in electrical engineering.



David J.Williams will attend Yale University. At Yale, David will be majoring in history. Dave says, 'I certainly intend to put my award to good use during the next year of my education.'

There were several awards renewed, in addition. For 1988 CSFA there were Lena Gandhi, Harlan Howe III and Akihiro Itoh. Renewals for National Merit Scholarship Corporation were Andrew D. Oliver and Monica Gandhi, 1987, and Monik T. Hinchey, 1986.

The 1989 Graduate Fellowships of $5,000 each were awarded to four recipients: Joel Birkeland of the University of Texas at Austin for his research on quasi-optical planar FET oscillators, Cynthia Furse of the University of Utah for pursuing backscatter RCS, Keary Litvin of Cornell University for working on millimeter-wave monolithic MODFETS, and William McKinzie for research on printed slot-type circuits and antennas employing full wave solutions.

This year's $10,000 Grant-in-Aid was awarded to Robert Strangeway, an Assistant Professor in the Electrical Engineering Department at the Milwaukee School of Engineering The grant contributes towards the purchase of a microwave network analyzer and S-parameter test set. The remainder of the necessary funding was committed by the Milwaukee School of Engineering. The equipment will support the five microwave courses currently offered in electrical engineering and electrical engineering technology as well as microwave oriented senior projects in both programs.

For the 1990-91 Graduate Fellowships and Grants-in-Aid, an announcement is appearing in this issue. Dr. Jorg Raue has done an outstanding job in managing these activities in a very efficient fashion.

The MTT-S Education Committee is soliciting applications for a Student Paper Contest. Professor Ronald L. Carter of the University of Texas at Arlington is coordinating this activity. His phone number is (817) 273-3466. He will be very interested in your ideas and solicits your help.

1990 IEEE Microwave Theory and Techniques Society Undergraduate Scholarships

- For children of MTT-S members
- Not limited to engineering
- $1,000 - $2,500 each
- Renewable for 4 years
- Given to meritorious students based on PSAT/SAT test scores, academic record, GPA, class rank, leadership, career goals, significant extracurricular and community activities.
- Application forms for the IEEE Microwave Theory and Techniques Undergraduate Scholarship can be obtained from the Citizens' Scholarship Foundation of America (CSFA).
- Requests for applications forms should be made in writing before January 1, 1990 and refer to the MTT-S Undergraduate Scholarship.
- Complete applications must be sent to CSFA and post marked before February 1, 1990.

Citizens' Schoarship Foundation of America
1505 Riverview Road
P.O. Box 297
St. Peter, Minnesota 56082
Telephone: (507) 931-1682

For further information on the Scholarship, contact:

Dr. Reynold Kagiwada
3117 Malcolm Avenue
Los Angeles, CA 90034
(213) 814-1970

1990 IEEE Microwave Theory and Techniques Society Fellowships and Grants-In-Aid

GRADUATE FELLOWSHIPS

- Several $5,000 fellowship awards each year
- For graduate research studies in microwave engineering on a full-time basis
- Applicants must have attained high academic achievement in engineering or physics
- Award can be granted *in addition* to any other support received by student
- Award cannot be used for equipment purchase, travel, supplies, etc.
- Award made to institution for support of named student
- Faculty supervisor must be MTT-S member

Application deadline: 20 October 1989

EDUCATIONAL GRANTS-IN-AID

- For individual members of MTT-S
- Number and amount to be based on proposals submitted, proposed activity, financial justification, and Society budget
- Applicant must be MTT-S member of 5 years standing
- Applicant must be a full-time employee of a degree granting institution of higher learning or a not-for-profit research institution
- Emphasis is on supporting junior faculty members
- Award made to institution for support of named individual research activity (i.e., faculty member, etc.)
- Award may be used for equipment, travel, supplies, or individual use, directly related to a clearly defined microwave activity
- Funds cannot be carried over into second year

Application deadline: 13 November 1989

For applications for the Fellowships and Grants-in-Aid contact:

Dr. Jorg E. Raue
Chairman, MTT-S Educational Awards Committee
TRW, Electronics Systems Group, R5/1291
One Space Park
Redondo Beach, CA 90278
(213) 813-8224

Requests for application materials must be received no later than 22 September 1989.

Microwave Education: Present and Future Trends

by George D. Vendelin:, Vendelin Engineering and Fazal Ali:, Pacific Monolithics

The present status of microwave education was recently reviewed by a 12 member panel of USA university professors, with several interesting observations. A complete survey of electromagnetic teaching at 61 US universities will be published in the November issue of the IEEE Transactions on Education which shows, for example, there are 356 faculty in this field teaching 1725 graduate students, which is about 6 faculty at each university. This survey was conducted by Professors Bob McIntosh (University of Massachusetts) and Fred Rosenbaum (Washington University St. Louis). The long range trends show that graduate students are turning toward business educations rather than engineering, a trend which has been increasing over the psat 20 years.

The increasing activities of the MTT-S Education Committee were reported by Professor John Owens of Santa Clara University. This support has grown from 0 to about $10K per year and will continue to grow.

A major concern of this committee is the best way to service the needs of graduate teaching in the industrial environment. When professors are hired to teach courses at the industrial site, the students find it very difficult to complete the course, apparently due to conflicitng priorities. Video courses offer another alternative for on site education. There seems to be a common view that universities do not provide adequate services to industry; on the other hand, when courses are presented, the students are not motivated to finish the work. When students are removed from the industrial site by at least 50 miles, the educational process proceeds very well.

Excellent reviews of microwave education were presented by all panel members, which also included Professors Bob Trew of North Carolina State, Steve Schwarz, U.C. Berkeley, K.C. Gupta, U. Colorado, Tim Healy, Santa Clara University, Vijai Tripathi, Oregon State University, Tatsuo Itoh, University of Texas, Dimitri Pavlidis, University of Michigan, George Matthaei, U.C. Santa Barbara, and several audience participants from Ohio University, University of Florida, etc.

Representing the need for microwave education in industry was Les Besser, who pointed out the long term trend in technical test scores has been reducing for some time. Another perception was the lack of jobs in microwave fields for new college graduates at the present time; no one seemed to disagree with this, which will directly effect the number of graduates in this area. If there is any conclusion which can be found from such a large, diverse panel of experts it could be that universities can provide more microwave engineers than industry can absorb, so new applications for this technology must be developed in order to support future growth.

Intersocietal Relations

by Ferdo Ivanek
Communications Research
P.O. Box 60862
Palo Alto, CA 94306

At the June 11, 1989 MTT-S AdCom meeting in Long Beach I presented a written Intersocietal Relations report and attached the inputs received from our representatives to the various IEEE committees. My verbal report was rather brief due to the extensive AdCom agenda.

In summary, our Intersocietal Relations activities have intensified in most areas. I am particularly pleased with the good start of our newly appointed representatives.

In this issue we present the regular TAB highlights report, the updates on the Committee on Communications and Information Policy and on the Engineering R&D Committee, and the PACE contribution which is a sequel to the changing demographics theme from the Number 124 MTT-S Newsletter.

I would also like to bring to your attention Bob Moore's article published in the June 1989 issue of *The Institute* under the title 'Addressing Technology Transfer Concerns—How Restriction of Technical Data Affects Engineers and the Nation.'

I repeat my invitation to all interested MTT-S members to contribute to our Intersocietal Relations column with letters, comments and proposals for new activities. Please mail to Ferdo Ivanek at the above address or call (415) 329-8716.

IEEE Board	Committee or Council	Representative
Educational Activities Board	Technical Activities Advisory Committee (EAB-TAAC)	R. Kagiwada
Standards Board	Standards Coordinating Committee	E. Belohoubek
	Standards Coordinating Committee on Non-Ionizing Radiation	J. Osepchuk
	Standards Coordinating Committee #26 — Photonics	**D. Paul**
Technical Activities Board		V. Gelnovatch (ex officio)
	Solid-State Circuits Council (SSCC)	P. Greiling V. Gelnovatch
	Steering Committee of the Journal of Lightwave Technology (JLT)	N. Dietrich P. Stabile
United States Activities (USA)	Aerospace R&D Committee	W. Brown S. Okwit
	Committee on Communications and Information Policy (CCIP)	F. Ivanek
	Defense R&D Committee	D.N. McQuiddy, Jr. G. Thoren
	Energy Committee	W. Brown
	Engineering R&D Committee	H. Sobol R. Gutmann
	Health Care Engineering Policy Committee	K. Carr
	Committee on Man and Radiation	R. Petersen
	Professional Activities Council for Engineers (PACE)	L. Medgyesi-Mitschang R. Moore

Committee on Communications and Information Policy (CCIP)

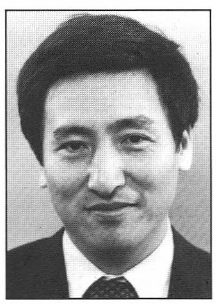
by Ferdo Ivanek
Communications Research
P.O. Box 60862, Palo Alto, CA 94306

In my initial write-up (Number 122, page 41) I pointed out the importance of strengthening the commercial microwave market segment and reported the CCIP activities that promise to help to achieve it. Since then, in the second half of 1988, the CCIP took up the HDTV issue which has become the focal point of the broader issue of declining technological leadership and competitiveness of the U.S. electronics industry. The major results accomplished so far are:

- IEEE Entity Position Statement 'A National Initiative for the Electronics Industries,' Technology Activities Council, January 25, 1989.
- Workshop on Creation of Government/Industry Partnerships through the Formation of American Technology Corporations, sponsored by IEEE-USA, Washington, D.C., February 13-14, 1989. (30-page report including the above Entity Position Statement is available at request from IEEE-USA, Suite 608, 1111 19th Street, N.W., Washington, D.C. 20036-3690.)
- Testimony presented by Alan K. McAdams, Chairman of the CCIP Technological Leadership Subcommittee, before the House Committee on Science, Space and Technology, at the hearing on 'Advanced Television Systems—Regaining the Competitive Edge,' March 22, 1989. (Copies available from IEEE-USA.)
- Workshop on the Role of a U.S. DRAM Consortium in Revitalizing the U.S. Electronics Base, sponsored by IEEE-USA, Washington, D.C., June 26-27, 1989. (Report to be issued.)

Further initiatives are in preparation toward the same general goal of reversing the erosion of U.S. R&D and manufacturing leadership in electronics. These can be expected to facilitate corresponding initiatives in the areas of microwave and lightwave communications.

TAB Highlights



by T. Itoh
Vice President
MTT-S AdCom
University of Texas at Austin
Austin, TX 78712

The spring TAB meeting was held in San Francisco on May 31—June 2, 1989. This series of IEEE meetings started with the Publication Workshop, which is covered in detail by Chester Smith on page 55 of this issue.

An important discussion topic of the Presidents' Workshop was chapter issues and the TAB worldwide speaker bureau. It was my pleasant surprise to learn that due to the extensive effort of the

continued on page 54

TAB HIGHLIGHTS
continued from page 53

MTT Membership Committee, MTT is clearly the leader among many other Societies. Our Distinguished Speaker Program, Speakers Bureau and the new Home Video Tutorial address many of the concerns surfaced in this workshop session.

During the formal TAB meeting on June 2, several motions were executed. I will only include some of the more important to MTT.

- In response to a considerable concern over the staff move from New York to Piscataway, a motion was passed directing the TAB Chairman to appoint an ad hoc committee to work with staff in defining changes in the approach to magazine publications and to monitor the transitions of magazine operations from New York to Piscataway. (Transactions operation continues in New York.) Another related motion was passed requesting that, during the transition period of the above move, Societies be authorized to use outside publishing services for magazines, with the approval of the Vice President for Publication Activities only.
- In an attempt to enhance the relationship with the IEEE Technical Activities Department, a motion was introduced and passed which states support for a transitional budget allocation for 1989-90 not exceed $300,000 to hire up to four associates in the Technical Activities Department. Each interested Society will be assigned to a specific associate, who will support the Society's activities.
- In the memberhsip services area, several motions were passed. In order to enhance interactions between Chapter and Section, a motion was passed to recommend that Societies send Chapter coordinators to the Sections Congress to be held in Toronto, Canada in October 1990. On a related subject, TAB passed a motion directing the RAB/TAB Chapters Committee to prepare a brief document covering the manner in which Chapters interact with Sections and Societies. The document shall include, as a minimum, such topics as finance, chain of command, and reporting requirements.

In line with an increasing global involvement of the IEEE, distinguished lecturers at the IEEE level have been extensively discussed. A motion was passed recommending that the IEEE Foundation Board provide financing to support selected IEEE major medal winners traveling to various Chapters and other IEEE entities in the role of very distinguished lecturers.

Another motion passed endorses the scope of expansion of, and Societies' participation in, the TAB OpCom meeting in Region 10 in October 1989, to include colloquia and other technical activities such as industrial visits. Financial suport for this activity will be provided by Society and Regional sources and by TAB through the Book Broker fund.

Personal Points

☐ **Golde Rule variation:** Do unto others as *they* would have you do unto them. *Rationale:* Very often others don't want what you want. It's important to consider a person's values before you take action that will affect your relationship.

Managing the Equity Factor by Richard C. Huseman, PhD, Houghton Mifflin Co., 52 Vanderbilt Ave., New York 10017. $14.95.

☐ **To beat the crowds** at a theme park, walk toward the left after you enter the main gate. *Reason:* Most people head toward the right.

Leslie Laurence, senior writer for *Conde Nast Traveler,* writing in *Working Mother,* 230 Park Ave., New York 10169. Monthly. $12.95/yr.

Engineering R&D Committee

by Ronald J. Gutmann
ECSE Department
Renssealaer Polytechnic Institute
Troy, NY 12181

At a committee meeting held in Washington, D.C. on July 13, Mr. Lee Rivers gave a presentation about the Federal Laboratory Consortium (FLC) for Technology Transfer. The FLC was chartered by Congress in the Federal Technology Transfer Act of 1986 to strengthen the cooperative transfer of Federally developed technology to industry, State and local governments and universities. The following is quoted from an FLC document:

'America's Federal research and development facilities represent a reservoir of technologies, expertise and facilities which can be applied for the benefit of domestic industry. This reservoir is the raw material of the age of technology, requiring cooperative refinement, application and packaging to become a powerful force for economic growth in America and for strengthening this country's competitive position in the world economy.

Materials, techniques, formulas and methods have been developed within the laboratories for which commercial uses have yet to be devised. Instrumentation, hardware, software and process technologies are all part of these Federal resources. In most cases these technologies result from the pursuit of agency mission requirements and single-purpose projects—tightly-targeted investigations to answer specific questions. But the same results might be used in other applications outside the scope of the original research. For example, a significant share of the computer industry's technology is based on Federal laboratory developments and cooperative efforts with the laboratories.

Federal agencies are dedicted to a continuing program of transferring this technology to those who can make use of it for commercial, humanitarian or cultural purposes. Government laboratories are striving to insure full value return for the Nation's investment in Federal research and development by offering cooperation and assistance to those who can take advantage of it for expanded uses.

America's industry—businesses large and small—is in an enviable position to use this resource of researched ideas and materials to enable competitive pursuit of both domestic and foreign markets. This research can be transformed by market-oriented motivated businessmen into products and services with tremendous profit potential for America's industry.

Congress has passed and the Administration is implementing the Federal Technology Transfer Act of 1986 (PL #99-502), which permits and encourages the delegation of authority to the directors of all government-operated Federal laboratories to enter into cooperative research and development agreements with the private sector, universities and State and local governments. The Act allows these laboratory directors to negotiate licensing agreements and contracts, giving special consideration to small businesses and those companies willing to manufacture in the United States. In all cases security provisions must be observed.

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ENGINEERING R&D COMMITTEE

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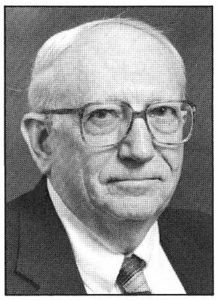
In general, this new law has given Federal research laboratories wide flexibility regarding the use of staff, facilities and equipment to insure increased inter-laboratory cooperation as well as teamwork with private enterprise. For years American companies have found it profitable to work in harmony with Federal research and development facilities for the development and distribution of new products, systems and services, and the improvement of existing ones. The federal Technology Transver Act of 1986 makes it easier for this exciting and rewarding process to occur with greater frequency and regularity.'

There are a growing number of examples of such technology transfer. With the expertise in microwave technology at many government laboratories, this appears to be a fine opportunity for many of our American organizations. Contact Lee Rivers, federal Laboratory Consortium, (201) 331-4220 for more information.

Technical Publications



by Chester L. Smith
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The MITRE Corp.
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Bedford, MA 01730

Tech Pubs Meeting (May 2, 1989):

There has been some movement in IEEE in the technical publications area. For some time we have had two committees with overlapping responsibilities—the Society Publications Committee (SPC) chaired by Friedrick Smits and the Periodicals Committee (PC) chaired by James Tien. These have been merged and will be absorbed into the Technical Publications Board (Tech Pubs or simply PUBs).

During the transition period SPC/PC will meet under that flag one day and reconvene as Tech Pubs the next. The next meeting of this hybrid committee is scheduled for the 18th and 19th of September in New York.

Also, in connection with this reorganization is the revision of the period of appointment of Division Representatives. Division Representatives are to be appointed for two year terms with the starting date the beginning of the second year of the Division Director's term. Division Directors are elected for two years and staggering the Pubs representatives allows time for the new director to get acquainted with the situation rather than having to make appointments essentially in the dark.

Magazine: Approval of the IEEE Magazine on Antennas and Propagation was given to begin with the January 1990 issue. Final approval will be an item on the TAB agenda in June—the ultimate okay will be by the IEEE Executive Committee. Unless something totally unforeseen arises publication of this magazine should come off on shcedule.

The perennial hot potato of conference records being published as Transactions was brought up. This is a long way from final resolution, however, the Committee will make a presentation to the Publications Workshop at the next TAB meeting.

The main points are:

1. The practice of using the Transactions as a vehicle for Conference Records is to be phased out over a period of three years.
2. The IEEE Bylaws at present do not restrict the Transactions and some changes are to be requested.
3. If the practice is to be allowed, then some trivial material—such as photographs of social events—should be eliminated (Newsletter-type material).
4. Assurances are needed that the review process is as thorough as is commonly ascribed to regular Transactions.
5. The formatting should conform to IEEE standards for regular issues of Transactions. This may not be too hard to do with the computers and printers now available.

The whole issue is being referred to the Technical Activities Board for review and recommendation to the IEEE Executive Board for a final disposition.

A new Transactions from the Computer Society to be called *The IEEE Transactions on Parallel and Distributed Computing* was approved. Publication is to start with the March 1990 issue and will appear quarterly.

A draft of a proposed IEEE Manual for Transactions Editors was submitted for PUB's review and comment. This manual is intended primarily for new editors and associates and for the 'Guest Editors' who assemble the special issues. The experienced editors do not need this manual, however, and views or comments from this group would be most welcome.

A running complaint that the Publication Services (PS) report is enigmatic was taken up and a new format suggested. Maybe this will help. Also PS commented that the lead time at Headquarters is about 13 weeks. This should be allowed for in setting up issue schedules. In general, it appears to have been observed and a combination of things have worked to delay some issues even though they were submitted in a timely manner. There is a 'Murphy's Rule' in Publishing as in everything else.

The Changing Demographics— A Further Look

by Betty M. Vetter
Executive Director
Commission on Professionals in Science and Technology, Washington, DC

(Ed. note: The following is the second of two excerpts from an address by Ms. Vetter to the National PACE conference held in Phoenix, September 3, 1989. The first article described the effect of population trends on college enrollment and appeared in the Spring 1989 MTT Newsletter. *The present installment discusses the impact on undergraduate and graduate education in the sciences. The full text of the address is available from Louis Medgyesi-Mitschang, MTT PACE representative.)*

It is easier to understand the problem if we look back for a moment over the decade behind us, and see what has been happening to production of new engineers, particularly EEs.

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THE CHANGING DEMOGRAPHICS

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As we enter 1975, there was a growing demand for engineers that had been building for two years, although the low point in engineering degree production was still a year away because of the four year lag between freshman perceptions of the job market and their graduation. EEs in particular were in great demand in 1975, but the 10,200 EE baccalaureate graduates of that year were to drop to 9,800 in 1976 before starting up again. Meantime, a social movement to bring minorities into the mainstream of American life had resulted in a few programs designed to bring more minority men into engineering. The women's movement had also indicated to a lot of young women that they could go into any career they wanted, and about 15,000 of the bolder ones were enrolled as engineering undergraduates in 1975, up from 9,800 just one year earlier. Certainly nobody at that time saw women as becoming an essential part of the engineering labor force, but a lot of people had come around to thinking that it was allright for them to study engineering if they wanted to. Some 860 of them actually earned a bachelor's degree in engineering that year, including 130 who chose an EE major.

Over the decade from 1975 to 1985, the number of bachelor's graduates in engineering doubled, including a ten-fold increase in the number of women graduates and a tripling of graduates from the underrepresented minority groups. The number of foreign graduates also doubled, at all three degree levels.

The size of the college age population will continue to shrink in most of the years through 1996, for a total drop of about 25 percent. By 1988, about 13% of the decline in 18 year olds has occurred. But we have seen a decline of 17% in freshman enrollment in engineering since fall 1982, including a 22% drop in women. It will be important to understand why this is so if it turns out that we need more graduates than we get. Something is affecting engineering, besides the shrinking age group.

First, it is important to note that although total college and university enrollments have been generally maintained despite the smaller 18-22 year old population, this condition has been brought about principally by large increases in older and part time students. In general, these groups do not earn their degrees in engineering, which relies instead on students of traditional college age.

Second, engineering enrollment rose considerably faster during the 1973-1983 decade than did the college-age population [Fig. 1], both because of an excellent job market and because of a significant infusion of women. But as we have noted, women appear to be losing interest in engineering, and probably will stay at about 15% of the bachelor's graduates unless some kind of encouragement or intervention occurs.

At the graduate level, all are well aware of the shortage of American graduate students in engineering (as well as in physics and in computer science), and thus, of the shortage of American faculty candidates in these fields. A new projection by the National Science Foundation indicates a growing academic demand for natural scientists and engineers, based on replacement needs, through the 1990s. By 2000, replacement needs will continue to increase while at the same time, the need for new faculty will increase as the next wave of growth occurs in the college age population. By 2004, this projection indicates a need for 18,000 PhD hires—compared with a total NS&E PhD production of only 8,632 Americans in 1987, including 1,505 engineers.

American-born graduates make up less than half of new engineering PhDs [Fig. 2]. An increasing problem for American engineering students is the language barrier between them and many of their foreign teaching assistants and faculty. There has been very little change in PhD awards in science and engineering over the past decade, although an upturn in the physical sciences and engineering appears after 1980. Unfortunately, that upturn consists solely of foreign graduates. We have not materially increased PhD awards to Americans in any of the natural science/engineering fields over the past decade. A slight upturn in engineering is evident in 1987.

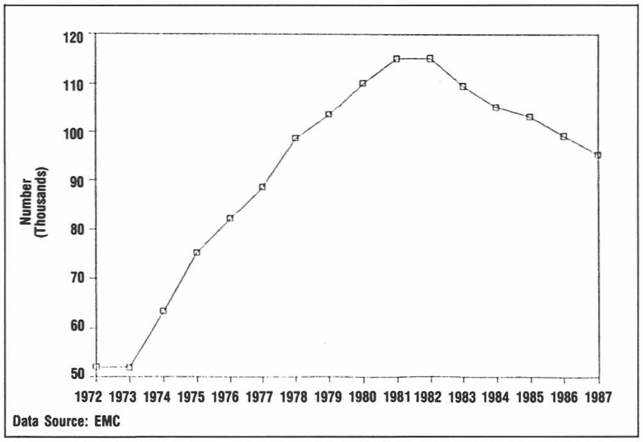

Figure 1. Freshman Enginering Enrollment. The enrollment peaked in 1981-1982.

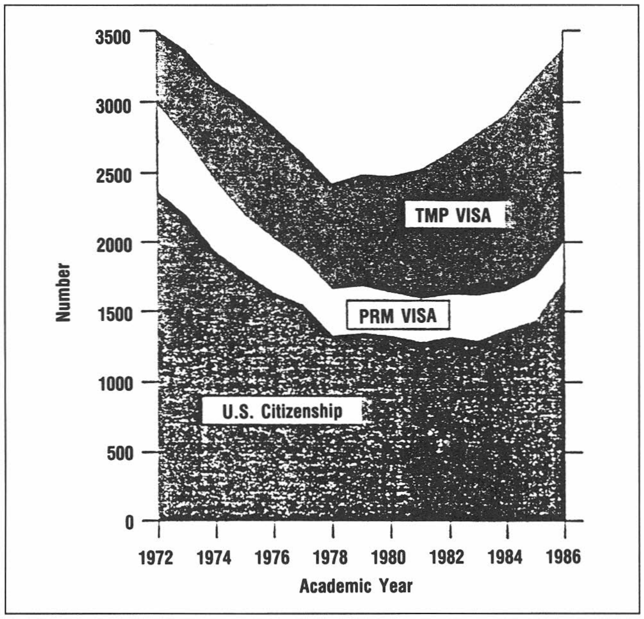

Figure 2. New PhD Recipients in Engineering by Citizenship, 1972-1986. Only half of the degree recipients in engineering are U.S. citizens.

The new PhD class in engineering in 1987 included only twelve American blacks, one of them a woman. That's down from 19 (including 3 women) in 1985 and 14 including 4 women in 1986! The 1987 class included only 132 white American women, 14 American minority women, and almost 2,000 foreign citizens, including about 70 women.

Among the 692 EE PhDs in 1987, only 290 were U.S. citizens. Within this group, none were black, but there were three native Americans, four Hispanics, 37 U.S. Asians, and 233 whites. Among the 323 who were known to be foreign citizens, 60 were permanent U.S. residents. A total of 30 women earned EE doctorates in 1987, but we do not know the proportion who were U.S. citizens.

How do we expect to replace our American science and engineering faculty as they grow older and retire? A third of them were already over 50 three years ago, and a fourth will reach age 65 by 1995 [Fig. 3]. Even by 1985, almost 1 of every 6 engineering faculty members was a foreign citizen, with about one third of them

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THE CHANGING DEMOGRAPHICS

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still on temporary visas. In electrical engineering, 9.6% of faculty were foreign citizens on permanent visas, and an additional 4.7% had only temporary visas in 1985. Already, more than half of young assistant professors in engineering are foreign nationals! [Fig. 4]. Will American universities continue to fill hiring needs with foreign graduates? What choice will they have?

On the whole, I believe that the education of foreign students, and the ultimate utilization of about 60% of them in our own labor force, has greatly benefited the nation. Industry has used many of them in non-defense work. Their contribution to American universities as students, as researchers and as faculty, is immense. But we can't count on keeping our own supply by importing and keeping foreign brains. The real problem has been and probably will continue to be the shortage of American graduate students, including minorities and women.

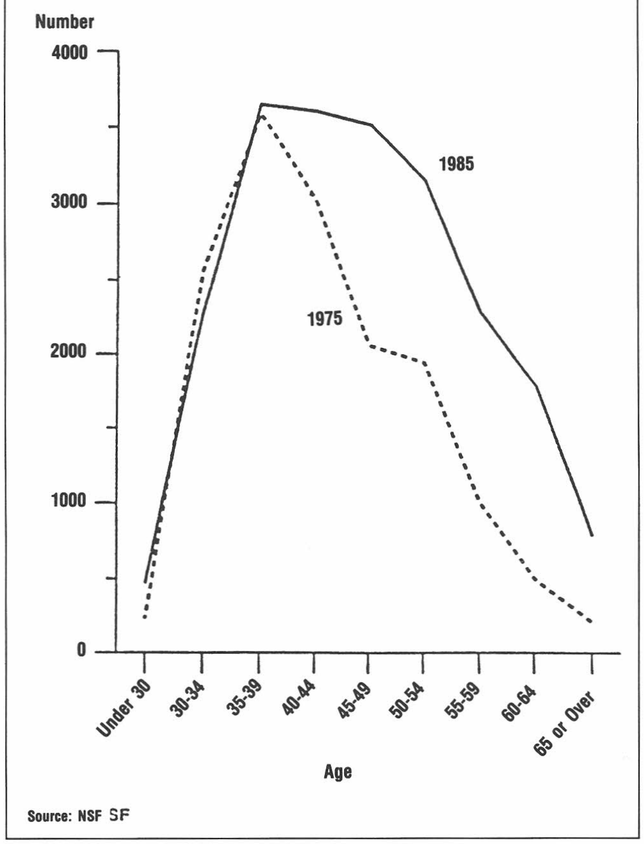

Figure 3. Doctoral Engineers Employed in Universities and Four-Year Colleges by Age, 1975-1985. This graph shows that a significant part of the faculty is past age fifty.

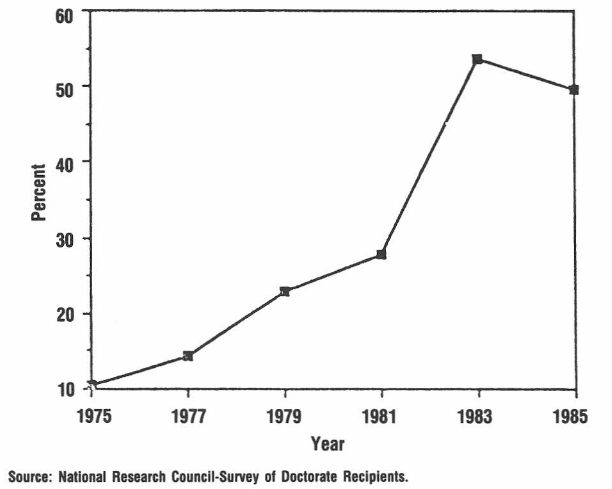

Figure 4. Percentage of Foreign Engineering Assistant Professorships, Age 35 or Less. The replenishment of university faculties will come increasingly from overseas.

☐ **Beware of real estate agents** who show you grossly inadequate houses (*handyman's specials*) followed by one that is only mediocre (you're being set up)...or houses out of your stated price range...or houses only at night (you'll miss imperfections, such as signs of water damage, that you'd notice during the day)...or who try to coerce you to make an immediate offer because someone else is ready to buy...or who brush off valid objections (*Example:* No dining room — one less room to clean)...or who show you only two or three houses and are annoyed if you don't choose one.

Sylvia Porter's A Home of Your Own: A Complete Guide for the First-Time-Home-Buyer by Sylvia Porter, Avon Books, 105 Madison Ave., New York 10016. $7.95.

☐ **To locate a missing person:** The Social Security Administration's letter-forwarding service can help you locate missing persons for *humanitarian* purposes (estranged children, lost heirs, etc.).

How it works: You give them an unsealed letter for the person you want to contact and as much information as you can about him/her (full name, date and place of birth, parent's names, etc.). If they can find the person, they will forward the letter to his employer (Social Security does not track home addresses) to give him. The agency won't tell you the person's location, but they will let you know if a forwarding address is on file. The recipient is not required to respond.

For more information: Contact your nearest Social Security office.

THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

UNITED STATES ACTIVITIES

Announces the 18th Annual Competition for

1990-1991

IEEE-USA Congressional Fellowships

A CONGRESSIONAL INTERNSHIP FOR MEMBERS OF IEEE

PROGRAM: Electrical and Electronics Engineers and Allied Scientists are competitively selected to serve a one-year term on the personal staff of individual Senators or Representatives or on the professional staff of Congressional Committees. The program includes an orientation session with other Science-Engineering Fellows sponsored by the American Association for the Advancement of Science (AAAS).

PURPOSE: To make practical contributions to more effective use of scientific and technical knowledge in government, to educate the scientific communities regarding the public policy process, and to broaden the perspective of both the scientific and governmental communities regarding the value of such science-government interaction.

CRITERIA: Fellows shall be selected based on technical competence, on ability to serve in a public environment and on evidence of service to the Institute and the profession. Specifically *excluded* as selection criteria shall be age, sex, creed, race, ethnic background, and partisan political affiliations. However, the Fellow must be a U.S. citizen at the time of selection and must have been in the IEEE at Member grade or higher for at least four years. Additional criteria may be established by the selection committee.

AWARDS: IEEE-USA plans to award at least two Congressional Fellowships for the 1990-1991 term. Additional funding sources may permit expansion of awards.

APPLICATION: Further information and application forms can be obtained by calling W. Thomas Suttle (202) 785-0017 at the IEEE-USA Office in Washington, D.C. or by writing:

Before October 1:
Secretary, Congressional Fellows Program
The Institute of Electrical and Electronics Engineers, Inc.
United States Activities
1111 Nineteenth St., N.W.
Suite 608
Washington, D.C. 20036

After October 1:
Secretary, Congressional Fellows Program
The Institute of Electrical and Electronics Engineers, Inc.
United States Activities
1828 L Street, N.W.
Suite 1202
Washington, D.C. 20036

Applications must be postmarked no later than March 30, 1990 to be eligible for consideration.

IEEE UNITED STATES ACTIVITIES

IEEE USA HOT LINES

IEEE-USA Hot Lines is designed to provide IEEE Sections and Societies with up-to-date information on United States Activities.
IEEE publication editors who receive IEEE-USA Hot Lines can use entirely or excerpt from the contents.
We invite your comments on format, content, and lead time.

IEEE-USA Office, 1111 19th Street, N.W., Suite 608, Washington, DC 20036, USA, (202) 785-0017

Joseph A. Edminister, Editor—Catherine S. McGowan, Associate Editor

Congressional Fellows—The United States Activities Board recently approved recommendations for two 1989–1990 Congressional Fellowships. Mr. Philip M. Paterno and Dr. Alfred E. Victor will take one-year leaves of absence to work in selected staff assignments on Capitol Hill. They will begin their Fellowships on January 1, 1990.

Mr. Paterno has been a district manager at AT&T since 1978. He is responsible for developing computer models to estimate and verify access expense from local exchange companies and for developing methods, computer tools, training and guidance for Bell System service costs groups.

Dr. Victor is program manager of the Joint Service Airborne Self-Protection Jammer at the Naval Air Systems Command in Washington, D.C. He manages the joint Navy-Air Force service's development, test and production of the Department of Defense's largest electronic warfare jammer for common application on tactical aircraft. He received his bachelor's degree in Naval Science from the U.S. Naval Academy, and his Master's and Ph.D. in Physics from Brown University.

Applications will be accepted until March 30, 1990 for the 1990–1991 IEEE-USA Congressional Fellowships. For more information on the program or for an application kit, contact the IEEE-USA Office in Washington, D.C.

Electronics—Seventy representatives of industry, government, academia and professional societies participated in a workshop in June to discuss the role of a U.S. dynamic random access memory (DRAM) initiative in revitalizing the U.S. electronics base. The attendees focused on the announcement of the formation of U.S. Memories, Inc. (USM). They endorsed the broad outlines of USM's DRAM initiative, endorsed establishment and support of similar ventures, and called on the U.S. government to respond affirmatively.

The workshop, convened by IEEE-USA, was the second held to discuss a national initiative for electronics industries. According to a consensus statement delivered to Capitol Hill after the workshop, the USM initiative is required, "if the United States is to reestablish a strong technology and manufacturing base." USM's and other initiatives can provide significant American-owned, controlled and secure sources of supply of DRAMs; can provide additional markets for the semiconductor manufacturing equipment sector; and can complement the overall efforts and contributions of SEMATECH, the semiconductor manufacturing industry consortium.

The group called on government to support industry-led initiatives for dual-use (civilian and military) technologies by providing an environment and incentives that are economically attractive and reduce risks to U.S. participants.

Careers Conference—"Engineers and Engineering Managers—Career Challenges of the 1990s" is the theme of the sixth biennial IEEE-USA Careers Conference, to be held at the TradeWinds Hotel in St. Petersburg, Florida, from November 1 through November 3. This two-and-a-half-day Conference will be sponsored by IEEE-USA's Career Maintenance and Development Committee.

This year's Conference will address such topics as the competitive environment for engineering in the 1990s; a comparison of U.S. and Japanese engineering careers; the impact of restructuring and new organizational structures on engineering careers; career transitions; and engineering productivity, among others.

The cost of the Conference is $225 for members and $300 for nonmembers. However, if you register before October 2, the cost will be $175 for members and $250 for nonmembers. The registration fee includes admission to all sessions, an opening reception, two lunches, all breaks, and a *Conference Record.* For more information or to register, contact the IEEE-USA Office in Washington, D.C.

Awards—The United States Activities Board recently announced the recipients of 1989 IEEE-USA achievement awards:

- Distinguished Public Service—Erich Bloch, Director of the National Science Foundation, for his efforts to enhance the understanding and status of engineering and technology on a Federal level.
- IEEE-USA Citation of Honor—William W. Middleton, for enhancing the IEEE-USA Awards program; John J. Miller, for originating, developing and documenting leadership in Section organizations, and training initiatives; and Ralph W. Russell, II, for attracting member support for state legislative programs and precollege math and science education programs.
- Regional Professional Leadership Award—Michael R. Andrews (Region 6), for developing precollege math and science education programs for students and teachers in the Phoenix, Arizona, area; Mark H. Arndt (Region 6), for his ongoing efforts in Washington state to increase the public's awareness of nuclear energy; Peter Bergsneider (Region 6), for developing a coalition of city government, local industry, local schools, parents and children to operate a Young Scientists and Engineers program in Fort Huachuca, Arizona; Carl K. Kintzel (Region 4), for his dedication to local and Regional congressional activities in Region 4; and Wallace A. Skelton (Region 2), for planning, publicizing and supporting career development workshops and presentations in Region 2.
- Professional Achievement—Walter Bury, for providing IEEE leadership in the Missouri Science Olympiad and for his efforts to establish an intersociety legislative group in the Kansas City area; Bernard H. Manheimer, for his activities related to environmental quality, energy and man-machine systems; and John E. Spencer, Jr., for promoting engineering awareness at Alabama's local political level.

Nominations are open until March 15 for IEEE-USA Awards for 1990. Other awards presented by IEEE-USA include awards for Distinguished Contributions to Engineering Professionalism and Divisional Professional Leadership, as well as two literary contributions awards. For information, award descriptions and nomination forms, contact the IEEE-USA Office in Washington, D.C.

IEEE-USA telephone hotline recording: (202) 785-2180

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