IEEE SOCIETY ON
MICROWAVE THEORY
AND TECHNIQUES

NEWSLETTER

Number 123
Winter 1989

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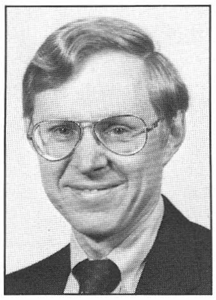
Editor's Notes



by Peter Staecker

A useful measure of service and enthusiasm toward the Society is the sitings of *old elephants* (Past AdCom Presidents) at Administrative Committee meetings, where the real business grunt-work of the Society takes place. At the meeting in Long Beach, I counted 15 of these distinguished gentlemen. Each has better things to do, but every meeting finds ways of guiding the newer members of the Committee in their activities. One of our Past Presidents, Saul Rosenthal, has passed away. On behalf of the MTT community, which benefitted so greatly from Prof. Rosenthal's contributions, we express our sympathy to his family.

There is much attention paid to the service, awards, and achievements of those who serve the Society—the Awards Banquet at the MTT-S Symposium, the printed coverage in the Transactions, the MTT-S Symposium Digest, and in this Newsletter. It is appropriate. In the articles below by Charlie Rucker, our outgoing Awards Chairman, you will read the accomplishments of this year's elected Fellows and award recipients. All richly-deserving. Three new AdCom members were elected at the Fall meeting. Of the retirees, Ralph Levy, after completing his three year term of strenuous activity as *Transactions* Editor, has resigned. The quality and standards of our *Transactions* has never been higher. Paul Greiling has finished out a decade of service to the Society and to the Administrative Committee; his presence will also be missed.

Some words on the Newsletter. The quality and quantity of article submission continues to be gratifying, although the bleatings of the editor for **timely** transmission are probably starting to wear thin on many contributors. Bear with me. As part of the perceived editorial responsibilities, I have polled other newsletter editors on the fiscal mechanics of their publications, and share that with you in the article below. As word processing and desktop publishing become more available, the layout composition mechanics become more uniform and professional. We are beginning to receive the longer articles on floppy media; thank you. E-mail is beginning to take hold, also, and will make the layout and editing tasks less time-consuming. It is a pleasure to work with all the energetic contributors who make this enterprise a success.

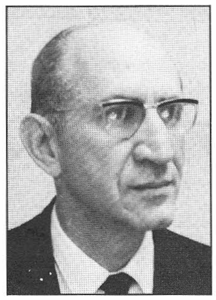
With regard to our life blood, the MTT-S International Microwave Symposium, we have a preview of this year's extravaganza from Chuck Swift and a few of his Committee members. Look for an in-depth report and schedule in our next issue.

The financial health of the Society is steadying, due to the formation of a new Standing Committee on Budget, chaired by Tatsuo Itoh, our Vice-President. Through the actions of his committee, the budgeting process has become well defined and objective.

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.



Saul Rosenthal
Aug. 13, 1918 - Jan. 15, 1989

Saul Rosenthal was taken from his family and friends on Sunday, Jan. 15 by a cerebral hemorrhage, a sudden event which followed a long period of increasingly poor health. His wife Estelle; his two sons Marc and Eric; Polytechnic University colleagues; friends and relatives attended a memorial in Huntington, NY near his home on Thursday, Jan. 19.

The principal focus of Saul's microwave work was in the area of biological effects. His two decades of research, publication and activity in this field earned him international renown. He was instrumental in setting permissible exposure levels to microwaves as chairman of the ANSI C95 committee from 1968-88; he was a founder and influential member of BEMS (the Bioelectromagnetics Society); organized and chaired innumerable panels and technical conferences on biological effects; helped to initiate, and then participated strongly in, URSI activity in this area from 1976-88.

For an even longer time, Saul used his organizational skills to serve the MTT as a long-term National Administrative Committee member; as chairman of the NY chapter (1957-58); of the 1964 International Symposium; of the National MTT (1966-67); of the Long Island chapter (1969-70); as chairman emeritus of the 1988 International Symposium. As a member of URSI/USNC Commission A since 1971, Saul was active on the national level, and also as the US delegate to the General Assembly in 1975, 1981 and 1984.

Saul's liking for people, his kindness, modesty, intelligence and good sense often made it possible for people with conflicting interests and views, and from different nations, to work together constructively when they might otherwise be at odds with each other.

He will be strongly missed by all of us.

Leo Birenbaum
Polytechnic University

To perpetuate Saul Rosenthal's memory, a scholarship fund has been established for Poly students. Persons wishing to contribute to the **Saul Rosenthal Scholarship Fund** should make a check payable to **Polytechnic University** and mail to:

Polytechnic University
333 Jay Street
Brooklyn, NY 11201
Attn: Thomas Daly (Saul Rosenthal Fund)

Letter to Editor

REPLY TO AN 'OPEN QUESTION TO TIME-DOMAIN EXPERTS'

In your Summer 1988 (#122) issue, Professor Fred Gardiol (Open question to time-domain experts) raised a number of interesting and relevant points related to electromagnetic modeling in the time domain which have, I believe, puzzled many readers. They boil down to two fundamental questions: Can one model frequency-dispersive structures in the time domain, and how?

The answer to the first question is simply YES. The answer to the second question takes a little longer.

By the way, one could theorize that this question would never be asked in a fictitious unstable world in which nothing repeats itself. What a horrible thought! The concept of frequency would be unknown there. Nevertheless, Maxwell's equations in their general time-dependent form would still apply.

Returning to Professor Gardiol's question, we must distiguish between two types of frequency-dispersive structures. The first type comprises those that are dispersive due to their geometry and/or the presence of losses, while the intrinsic constitutive parameters (e, μ, σ) of the materials they are made of do not depend on frequency. Examples are lossless waveguides, finlines, microstrip, optical fibres, etc., but also lossy media and materials. The second type contains materials in which the constitutive parameters depend on frequency by virtue of magnetic or electric dipole resonances, such as gyromagnetic and gyroelectric materials.

The first type of structures is the easiest to model because the material parameters in the discretized field equations or in the transmission line matrix (TLM) model are constants. An electromagnetic signal can be imagined as a stream of photons. To each frequency component of the signal correspond photons of a given energy $E = h f$ (h is Planck's constant). Fig. 1(a) shows a group of photons of various energy levels entering simultaneously a dispersive structure, for example a waveguide. Photons of different energy levels interact differently with the structure. This results in a dispersion of their velocity (group velocity) in the guide. Hence, they emerge at different times, and the time history of their arrival in relation to their energy (frequency) clearly contains complete information on the frequency dispersion of the structure.

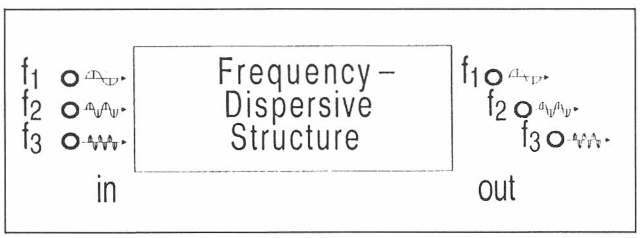


FIGURE 1(a). Photons of various energy levels corresponding to various frequencies travel through a frequency-dispersive structure.

In a similar way, the impulsive excitation of a transmission line matrix (TLM) modeling the waveguide (Fig. 1(b)) results, by virtue of the multiple scattering of impulses at mesh nodes and boundaries, in a stream of impulses at the output point. This impulse response is the characteristic time signature of the dispersive structure and contains complete information on the complex transmission coefficient which is simply the ration of the Fourier transforms of the input and output time functions.

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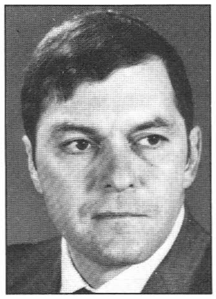
Incoming President's Report

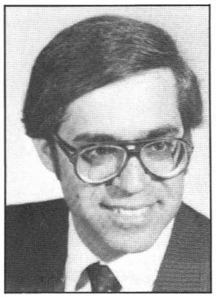


by V.G. Gelnovatch

It is extremely difficult to measure the health of an organization as multifaceted and complex as the MTT-S. If I was asked for an adjective rating my answer would be an unequivocal 'excellent.' This rating is based on a 9 year service history on AdCom and 2 decades of association with MTT-S. By any reasonable barometer the Society is in good shape. There is a large surplus which allows financial stability, a comprehensive scholarship package has been initiated, technical leadership is without challenge (witness the emergence of the highly successful Monolithic Symposium), various interconnections have been made with overseas professional entities as well as an increase in overseas chapters. As I write these words in the Fall of 1988 the membership is 10,300 across 46 chapters. A president could sit back and relax through his one year term. However, as with most everything else the picture, at first glance, is not always what is there. As an example, some potentially serious financial trends have developed that could threaten our financial reserves and hence stability. In 1988 we had projected the beginning of a deficit spending trend which, because of the extraordinary event of having the surplus of two conferences (1987 and 1988) both credited to 1988, will produce a smaller deficit than would have normally accrued. The accounting system is cumbersome and does not allow recognizable identification of fiscal resources. Correction of this problem was begun by Dave McQuiddy, continued by Barry Spielman and must continue until completion. The AdCom meetings have gotten longer and longer, straining the collective attention span. The last AdCom meeting lasted 12 hours with two preparatory meetings of the Standing Budget Committee which lasted 3-1/2 hours. This strains our volunteer cadre.

All of the above probably have a common denominator, specifically, we are treating a million dollar business like a roadside lemonade stand. As an example, a recent call for scholarship candidates produced 6 replies from ten thousand members, low by any standard. Our long range policy for global growth is largely non-existent. We will soon reach a point where our publications will cease paying for themselves: what should our policy be then? For my part, I believe the most serious challenge to our professional development is the downturn of revenues and increase of fixed expenses. During the coming year I will focus my attention on getting back to financial solvency and introducing a number of prudent business changes which will streamline our operation. Additionally, I will focus on the emerging technologies such as superconductivity for useful microwave functions and optical testing and interfacing for MMIC's. With your help and participation, I hope to make a meaningful contribution to the professional needs of our membership.

Outgoing President's Report



by Barry E. Spielman

As the year draws to a close, I reflect on the 1988 calendar year during which I was privileged to serve as the MTT-S AdCom President and make the following observations by way of this report. During the previous year, important advances were made for the MTT Society in areas such as: the processes for establishing the society budget and handling financial expenditures; the addessing of our membership's needs with regard to emerging technologies; and a variety of other items which enhance the services provided to our membership.

Our efforts to improve our processes for establishing the Society budget and handling financial expenditures actually began and continued during the terms of the two previous AdCom Presidents, Reinhard Knerr and David McQuiddy. During this year our budget preparation process has evolved to the point where we first determine the expenditures which are anticipated/desired by our standing committees. We have established a Budget Committee, comprised of experienced present and past AdCom members, which develops a recommended set of core or 'must have' expenditures and a prioritized set of discretionary expenditures. Recommendations on these expenditure sets are brought to the AdCom for consideration consistent with a sensitivity for needed services and budgetary prudence.

On the technical side, during this year AdCom has focused particularly on emerging technologies of interest to the MTT membership. These technologies include: superconductivity; lightwave technology; on-chip optoelectronic device characterization; monolithic integrated circuits; and microwave packaging. New Technical Committees were created for superconductivity and packaging. Erwin Belohoubek has assumed the leadership of the former committee, while the packaging committee is co-chaired by Fred Rosenbaum and Bert Berson. Each of these committees has already been instrumental in fielding Symposium-associated activities for the membership. The AdCom has also begun to address the need to provide appropriate forums for highlighting activity in all of these emerging areas in the face of pressures created by having only limited time slots available during our International Microwave Symposium week to feature activity in these 'hot' areas of interest.

There is not adequate space available within this report to cite the many contributors associated with the AdCom's activity during this year. Particular tribute must be paid to those involved in Symposium planning and operation and to the especially dynamic individuals associated with our memebership services program. Additionally, all of us who worked along with Walter Cox, who chaired our Meetings and Symposium activity, share in the grief at his passing. Walter distinguished himself in outstanding fashion both as an achiever in our field and as a decent human being. In conclusion, I salute both the members of the MTT-S AdCom and those associated with its activities for their dedication and achievements. It has truly been an honor to serve as the President of this dynamic group.

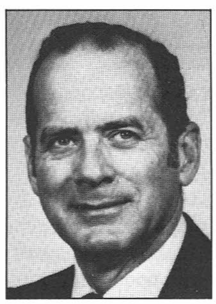
New MTT-S Awards Chairman

Professor Fred J. Rosenbaum has been named Chairman of the MTT-S Awards Committee succeeding Charles T. Rucker, the outgoing Chairman. Charlie Rucker, of the Georgia Institute of Technology, was Chairman for two years and led the Committee ably in its important function of recognizing contributions of members and others to the microwave field, MTT-S, and the IEEE. He also spearheaded the establishment of the new N. Walter Cox Award. People may not realize the extent of the Award Committee's responsibilities and the significant effort put forth by Charlie in carrying out his task. In addition to organizing and presiding over the selection for the Society's major award winners, which include the Microwave Career Award, the Microwave Applications Award, the Distinguished Service Award, and the Microwave Prize, the Committee is also responsible for evaluating IEEE Fellow nominations, and nominating candidates for several IEEE awards. Numerous writing duties also accompany the Chairman's task. These include articles for the MTT-S Symposium Advanced Program and Digest, the Symposium Issue of the Transactions, and the Newsletter. Further tasks include preparations for the Award Ceremony at the Annual Awards Banquet, including preparation of the various awards and certificates represented at that time. Congratulations to Charlie on a job well done!

Fred J. Rosenbaum has served MTT-S in many capacities since he was elected to AdCom in 1971. He was editor of the *IEEE Transaction on Microwave Theory and Techniques,* President of AdCom, and Chairman of the Steering Committee of the 1985 MTT-S International Microwave Symposium. He is a Fellow of the IEEE, a recipient of the IEEE Centennial Medal, and in 1988 was chosen for the Distinguished Service Award. For those wishing to communicate with the Awards Committee, Fred's address is:

Professor Fred J. Rosenbaum
Washington University
Department of Electrical Engineering
Box 1127
St. Louis, MO 63130
(314) 889-6157
FAX (314) 726-4434

MTT-S Awards



by C.T. Rucker
Retiring Awards Chairman

At the October meeting of the Administrative Committee, recipients were chosen for the Microwave Career Award, the Distinguished Service Award and the Microwave Prize. These awards recognize those whose contributions to the profession have been extraordinary. I have truly enjoyed the opportunity to assist the Society with selection of its awards recipients.

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MTT-S AWARDS (continued from page 4)

MICROWAVE CAREER AWARD

The Microwave Career Award is the highest award given by the Microwave Theory and Techniques Society. It is given to an individual for a career of meritorious achievement and outstanding technical contribution in the field of microwave theory and techniques. The eligibility requirements are publication in technical journals, presentations of lectures and a distinguished career of contributions to the microwave field. This award is given only to those individuals who have distinguished themselves over a long period of time.

The award consists of a certificate, a plaque, a cash sum of two thousand dollars and a feature publication in the IEEE Transactions on Microwave Theory and Techniques.

This year, for only the second time in the history of the awards, two Career Awards will be presented. Recipients are: **Professor Alexander L. Cullen,** University College, London University, and **Mr. Harry F. Cooke,** Los Altos Hills, CA.

MICROWAVE APPLICATION AWARD

The Microwave Application Award is presented periodically for an outstanding application of microwave theory and techniques. The eligibility requirements are creation of a new device, component or technique, novel use of components, or both.

The award consists of a certificate, a cash sum of one thousand dollars, and a feature publication in the *IEEE Transactions on Microwave Theory and Techniques.*

This year's recipient is **Mr. Kenneth L. Carr** of M/A-COM, Burlington, Massachusetts. he will be cited **'for the application of microwave technology to the detection and treatment of cancer.'**

DISTINGUISHED SERVICE AWARD

The Distinguished Service Award was initiated in 1983 and is made to an individual who has given outstanding service for the benefit and advancement of the Microwave Theory and Techniques Society. The eligibility requirements are service in one or more of the following areas: the Administrative Committee, publications, meetings and symposia, chapter leadership, committee chairman, committee member, editor, lecturer or other distinguished service. Factors considered are: leadership, innovation, activity, service duration, breadth of participation and cooperation. The individual must be a member of the IEEE and a member of the Microwave theory and Techniques Society.

The award consists of a certificate, a plaque and a feature publication in the *IEEE Transactions on Microwave Theory and Techniques.*

I am pleased to report the Society's selection of Dr. Don Parker to receive this year's Distinguished Service Award. Dr. Parker is one of those rare contributors who gives much and demands little. He richly deserves this special recognition.

MICROWAVE PRIZE

The Microwave Prize is awarded to the author of that paper, published in the *IEEE Transactions on Microwave Theory and Techniques, Proceedings of the IEEE* or other official IEEE publication, which is judged to be the most significant contribution in the field of interest of the Society. The paper must have been published during the period January 1 to December 31 of the year preceding the annual meeting of the administrative Committee at which the award is considered. The award consists of a suitable certificate, a cash sum of one thousand dollars, and a feature publication in the *IEEE Transactions on Microwave Theory and Techniques.* If the paper as published has more than two authors, a certificate is presented to each author and the cash sum of five hundred dollars is provided to each.

The 1989 Microwave Prize will be awarded to **Dr. Stephen A. Maas**, The Aerospace Corporation, Los Angeles, California, for his paper, 'Two-Tone Intermodulation in Diode Mixers', *IEEE Trans. MTT,* Vol. 35, No. 3, March 1987, pp 307-314. You will be interested to know that another paper by Dr. Maas, published the same year, was also nominated to receive the Microwave Prize.

NEW AWARD

Many of you know that N. Walter Cox, a respected member of the MTT-S Administrative Committee, died of leukemia on June 29, 1988. He was 45. At the October meeting, your Administrative Committee initiated a new service award to be called the N. Walter Cox Award in recognition of his extraordinary ability to contribute and accomplish much in a spirit of selfless coopertion. We have also recognized that, almost always, there is someone whose hard work for MTT-S simply falls through the cracks. We either fail to notice or, as is the case with Walter Cox, have no opportunity. The award citation will read: **'for exemplary service given in a spirit of selfless dedication and cooperation'** and will be awarded aperiodically at the Awards Banquet of the International Microwave Symposium.

NEWLY-ELECTED FELLOWS

It is always a great privilege to report the election of IEEE members to the grade of Fellow. This year 12 of those whose nominations were evaluated by the Society were elected to the Fellow grade. It is appropriate that we give special recognition to these 12 by noting their names and citations below:

Professor Mohammed N. Afsar
For contributions to the development of measurement techniques for determination of complex dielectric and optical parameters of solids, liquid, and gaseous materials at millimeter frequencies and above.

Dr. Inder J. Bahl
For contributions to microstrip technology, and to the theory and design of hybrid and monolithic microwave integrated circuits.

Dr. Prakash Bhartia
For contributions to the development of microwave and millimeter-wave transmission lines and microstrip antennas.

Dr. Harold C. Bowers
For leadership in the development of microwave devices, components, and systems, and in the establishment of major businesses in these areas.

Professor Chung-Kwang Chou
For contributions to the understanding of biological effects and medical applications of microwave energy.

Dr. Madhu S. Gupta
For contributions to the characterization and modeling of noise in high-frequency semiconductor devices in microwave integrated circuits.

Mr. Tom M. Hyltin
For contributions to monolithic microwave integrated circuits and solid-state, phased-array radar systems.

Dr. Rolf H. Jansen
For contributions to field-theoretical analysis of microwave IC structures and the development of advanced CAD tools.

Dr. Reynold S. Kagiwada
For contributions to low-temperature ultrasonics and technical leadership in the development and insertion of microwave acoustic devices in space payloads.

Mr. Edward C. Niehenke
For contributions to the development of low-noise microwave oscillators and amplifiers.

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MTT-S AWARDS (continued from page 5)

Dr. Christen Rauscher
For contributions to linear and nonlinear circuit applications of microwave field-effect transistors.

Dr. Herbert L. Thal, Jr.
For contributions to the application of computer-aided procedures in the development of microwave components.

Newly elected Fellows will be given the opportunity to be recognized further at this year's Symposium Awards Banquet. I look forward to that time.

In addition, seventeen MTT-S members, whose Fellow nominations were evaluated by a Society other than MTT-S, were also elected to Fellow grade. They are:

Dr. Yasuo Akao	Dr. Benedikt A. Munk
Professor Jerome K. Butler	Professor Edward H. Newman
Professor Charles A. Cain	Dr. Krishna P. Pande
Mr. Richard F. Clark	Dr. Daniel H. Schaubert
Dr. Kazuo Fujisawa	Mr. Luther G. Schimpf
Dr. Herbert Goronkin	Dr. Kishore Singhal
Professor Tor Hagfors	Dr. Armand Staprans
Dr. Charles F. Krumm	Professor Tadasi Sueta
Mr. Bruce R. McAvoy	

ATTENTION IEEE FELLOW NOMINATORS

Election to the grade of Fellow of the IEEE is one of the highest honors that can be paid to IEEE members. For those of you interested in nominating worthy candidates for this grade, here is a list of present MTT—S members who are Fellows for your convenience. Note that at least six recommendations of present Fellows are needed for each new nomination.

IEEE Fellow nomination kits can be obtained by writing:

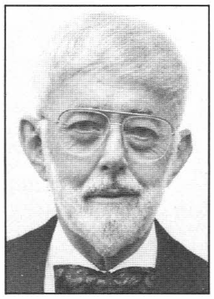
Staff Secretary
IEEE Fellow Committee
345 East 47th Street
New York, New York 10017
(212) 705-7750

1989 MICROWAVE CAREER AWARD

PROFESSOR A.L. CULLEN was born in Wood Green, London, in 1920. He was educated at Lincoln School and Imperial College London. Imperial College had at that time an excellent option in Communications Engineering. One of the lecturers on that course, David Tomba, gave a special lecture one day on the Klystron; this was hot-off-the-press stuff since the classical Varians and Webster papers had only just been published, so it was tremendously exciting, and was the start of an enduring love of microwave engineering in all its varied aspects. In July 1940, Cullen joined the staff of the Royal Aircraft Establishment in Farnborough, where he worked on radar. After a brief period touring the original 'CH' chain of ground radar stations with a small team responsible for phasing the 'aerials', as they were always known in the UK at that time, he returned to base at Farnborough to work on the newer 1.5 m wavelength 'GCI' (ground control interception) radars which he found more to his taste than the 5 to 10 m wavelengths used in the 'CH' stations. Microwaves were coming nearer! At last he was put onto real microwave work in an antenna group working on shaping radiation patterns. The need to measure the result of theoretical design work held an interest for him as strong as the design work itself and his subsequent research work has been largely in the two fields of microwave antenna and microwave measurements. In 1946 he joined the staff of the Electrical Engineering Department at University College London at the invitation of Professor Harold Barlow, who had been Head of Radio Department at RAE, Farnborough and had taken an interest in Cullen's work during that period. Cullen helped Professor Barlow to establish a research school in microwaves at UCL and collaborated with him in writing a book *'Microwave Measurements.'* In 1955 he ws appointed to the first Chair in Electrical Engineering at Sheffield University, building up another microwave research group there. In 1967 he was invited to return to UCL as Pender Professor of Electrical Engineering on the retirement of Professor Barlow, who, however, remained inthe Department as an Honorary Research Associate.

In 1980 Cullen was awarded a Senior Fellowhship, tenable at UCL, which enabled him to concentrate wholly on research. He is currently an Honorary Research Associate in the Department of Electronic and Electrical Engineering at UCL, where he continues his research in antennas and measurements at microwave and millimeter wave frequencies.

1989 MICROWAVE CAREER AWARD



HARRY F. COOKE was born in Little Rock, Arkansas in 1921. After serving with the R.A.F. and the U.S.A.A.F. (1941-1945) he graduated from the University of Arkansas in 1948 with the B.S.E.E. degree. his postgraduate work at Southern Methodist University was in the field of microwaves and non-linear circuits. While at the U. of A. his senior paper on locked oscillators won the Southwestern IEEE student prize. Between 1948 and 1957 he worked in the area of instrumentation (U.S.D.A.), proximity fuzes, and low noise vacuum tube amplifiers. In 1957 he joined the Semiconductor Research and Development Laboratory at Texas Instruments. While at TI he initially managed the applications group. Following this he worked with Roger Webster on the first solid state TV receiver, FM receiver, and hand-held transceiver. He was a member of the team which developed the first bipolar microwave transistor and the first solid state radar. He, in conujction with two other team members, holds the basic solid state radar patent. From 1970 to 1979 he was manager of device design and analysis at Avantek. While at Avantek he published a number of tutorial papers including one in the *Proceedings of the IEEE* on bipolar microwave transistors. In 1979 he joined Varian Associates as a senior scientist working on GaAs FET design and testing. He retired from Varian in 1987 and now works as an independent consultant in the design of microwave devices and test systems for amplifiers and devices. He also writes software for device design and automated test.

He is the author of over 50 papers in the fields of VHF to mm devices and circuits. He has 14 patents covering devices, circuits, and systems.

Mr. Cooke is a member of Tau Beta Pi.

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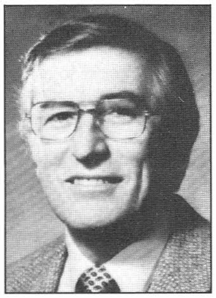
MTT-S AWARDS (continued from page 6)

APPLICATION AWARD



KENNETH L. CARR was born in Cambridge, Massachusetts on 15 February 1932. He received his B.S. in Electrical Engineering from Tufts University in 1953.

During the past thirty-five years, he has worked at Philco, Sylvania, and Airtron.

In 1958 Mr. Carr co-founded Ferrotec, Inc., serving initially as Technical Director and later as President. Following the acquisition of Ferrotec in 1970 by M/A-COM, Inc., Mr. Carr became Senior Vice President and Technical Director.

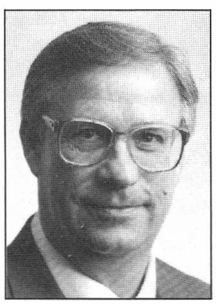
In January 1985, while maintaining his position at M/A-COM, Inc., he co-founded Microwave Medical Systems, Inc., serving as its Chairman and Technical Director.

Mr. Carr is currently a Trustee of Wentworth Institute of Technology, Boston, Massachusetts; a Director of the East Coast Aeronautical Technical School, Bedford, Massachusetts; a Member of the staff of the Eastern Virginia Medical School, Norfolk, Virginia; and a member of the Engineering Advisory Council for Southeastern Massachusetts University, North Dartmouth, Massachusetts. He is also serving as Technical Advisor to both the University of Pennsylvania and the Medical Physics Department at Tufts New England Medical Center. In conjunction with his duties at the University of Pennsylvania, Mr. Carr is now serving as Chairman of their Bioengineering Advisory Council.

He also maintains membership in the AAPM, NAHG, BEMS, IMPI, RRS and the Association of Old Crows. In December 1985, Mr. Carr was elected Fellow of the IEEE. He was also appointed the 1985-1986 MTT Distinguished Microwave Lecturer. Most recently he has accepted a position on the newly formed Health Care Engineering Policy Committee of the IEEE.

Mr. Carr presently holds 14 patents with 3 patents pending, and is widely published in peer related journals. He was the recipient of the 1978 IR-100 Award for the TERRASCAN Underground Utility Locator. Much of his recent work has been in the development and application of microwave techniques to medicine and, in particular, to the detection and treatment of cancer for which he received NASA's Certificate of Recognition in 1980 and again in 1983 for his technical innovations and scientific contributions.

DISTINGUISHED SERVICE AWARD



DON PARKER was born in Ogden, Utah in 1933 and received his undergraduate education in electrical engineering at Brigham Young University. He received an M.S. degree from Harvard University in Applied Physics in 1957, and a Doctorate of Science (D.Sc.) in Electrical Engineering from the Massachusetts Institute of Technology in 1964.

Dr. Parker was a member of the Technical Staff of MIT Lincoln Laboratories from 1956 to 1961 and from 1964 to 1969. He designed and developed solid-state microwave pwoer sources including frequency multipliers and IMPATT diode oscillators.

From 1961 to 1964, Dr. Parker served as a Lieutenant in the U.S. Air Force and assisted in the development of an R&D program in the Electronic Systems Division at Hanscom Field, Bedford, Massachusetts.

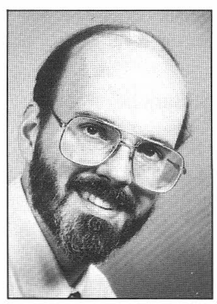
Dr. Parker joined Stanford Research Institute in October 1969 and became manager of the Electromagnetic Techniques Laboratory in 1970. The Laboratory developed state-of-the-art microwave components, antennas, and subsystems for radar and communication systems. He helped develop the use of automatic network analyzers for making rapid broadband radar cross-section measurements.

Dr. Parker joined Hughes Aircraft Company in 1976 as manager of the Microwave Department in the Missile Systems Group. Later he became manager of the Radar Laboratory where he directed a staff of 150 scientists, engineers, and technicians in the design and development of RF subassemblies for tactical missile radars. He managed the design teams that developed the solid-state transmitter for the Phoenix Missile, the solid-state transmitter, guidance antenna, fuze antenna, data link, and RF processors for the AMRAAM validation missile. The millimeter-wave sensor for the WASP missile was developed by design teams under his direction. Dr. Parker transferred to Hughes Radar Systems Group in 1986 as an Assistant Manager, Radar Microwave Laboratories, and is responsible for all active array programs in the Engineering Division.

Dr. Parker served as Secretary to the Administrative Committee of the MTT Society in 1972. He was elected to AdCom in 1973 and served as a member through 1982. He was Vice President of the Society in 1978 and President in 1979. Dr. Parker was editor of the *IEEE Transactions on Microwave Theory and Techniques* 1975 through 1977 and has been a member of the Editorial Board from 1970 to present. He was Chairman of the Awards Committee from 1983 through 1986. Dr. Parker was Chairman of the Technical Program Committee for the 1981 Symposium and has been a member of the Technical Program Committee for many MTT-S Symposia. He is Vice-Chairman of the 1989 International Microwave Symposium and is Chairman of the 1994 Symposium. As a member of AdCom, Dr. Parker has served in several other capacities including: MTT-S Representative to the Solid State Circuits Council 1973-1975; Meetings & Symposia Committee, 1973-1974; Chairman, Publications Evaluation Committee, 1982; Long Range Planning Committee, 1982; and as a Member of the IEEE Technical Advisory Board (TAB) Awards Review Committee, 1985. Dr. Parker is presently Chairman of the Past Presidents Council for MTT-S.

Dr. Parker is a Fellow of the IEEE, and was awarded the Centennial Medal by the MTT-Society in 1985.

1989 MICROWAVE PRIZE



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LETTER TO EDITOR (continued from page 3)

The complex frequency-dispersive surface impedance of a lossy conductor is another phenomenon due to the way in which electromagnetic fields penetrate into the material. As long as the conductivity and permeability of the conductor are independent of time and frequency, it can be modeled, for example, by a regular TLM network with loss stubs at the nodes. Of course, the mesh parameter in the conductor must be much smaller than the wavelength in it. An impulse entering the lossy TLM mesh is scattered at the successive layers of nodes, resulting in a stream of reflected impulses. Again, this impulse response represents the time signature of the lossy conductor. Its Fourier transform yields complete amplitude and phase information on its complex reflection coefficient at all frequencies. Naturally, such a complicated impulse response cannot be represented by a single impulse reflection coefficient at the boundary, as in time-harmonic analysis. However, very good conductors have surface reflection coefficients which are almost real; their magnitude is slightly smaller than unity and has a $\sqrt{\omega}$ dependence. If we replace the lossy metal surface with a real impulse reflection coefficient (the value of which is only accurate for one frequency, say f_1, the resulting time response is not accurate. Only its spectral component with the frequency f_1 is properly represented.

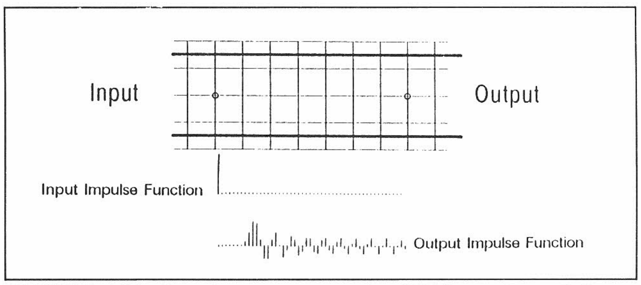

FIGURE 1(b). Impulse response of a TLM mesh modeling a dispersive waveguide.

From the computational point of view, the above-mentioned time signatures of structures and media interfaces represent numberical Green's functions in the time domain. Once they have been computed for given geometries and materials, they can be stored and convolved with arbitrary excitation functions. This numerical preprocessing can lead to considerable savings in CPU time.

The frequency dispersion in many materials is due to dipole resonances. In such materials, the permeability or permittivity is governed by a differential equation of the following type:

$$dM/dt = \gamma\ (M \times H)$$

This equation, for example, governs the relation between magnetic polarization and magnetic field in a ferrite material. The resulting permeability tensor can be modeled in the 3-D TLM method by introducing permeability stubs with characteristic impedances which depend on the instantaneous magnitude of the local magnetic field components and their first derivative with respect to time. Such a feature is easy to implement since all six field components are computed at every iteration for each node. Time derivatives are obtained by computing the diffference between successive field values and dividing it by the time step Δt. The value of the stub impedances and the resulting node impulse scattering matrix are updated at each iteration as the fields evolve.

Incidentally, nonlinear structures and devices can be modeled in a similar way through iterative updating of the pertinent TLM network parameters. We are presently preparing a number of publications which describe this procedure and show that it leads indeed to realistic results confirmed by measurements.

I should mention that the three-dimensional space and time discretization of complicated structures requires considerable computer memory. However, all nodal computations for a given iteration step can be executed simultaneously. Hence, vector computers and array processors are well suited for solving such problems in a rather short time. In fact, many routine computations in other areas such as image processing, chemistry, medicine, metereology, aerodynamics, etc. are based on similar algorithms and require comparable computer resources.

I believe that with the increasing availability of large computer memory at low cost, time domain methods will become attractive modeling options for microwave structures of high complexity. The groundwork is now being prepared, and results obtained so far are encouraging.

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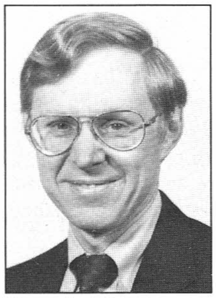
MTT-S AWARDS (continued from page 7)

Aircraft Co. and later at TRW. The components he developed include FET and HEMT amplifiers, millimeter-wave diode mixers, active FET and HEMT mixers (including a 45-GHz HEMT mixer), and integrated millimeter-wave downconverters using HEMT low-noise amplifiers. In 1985 he joined the Aerospace Corporation as a Research Scientist, working on the analysis of nonlinear microwave circuits and systems. At Aerospace his primary interests are in the application of Volterra-series techniques to nonlinear microwave CAD, and in practical means for improving the dynamic range of microwave systems and components. He also teaches electronics and microwave courses at UCLA and consults for companies in the Los Angeles area.

Dr. Maas is the author of two books on microwave subjects, *Microwave Mixers* and *Nonlinear Microwave Circuits,* published by Artech House Books (Norwood, MA) in 1986 and 1988, respectively.

Newsletter Production Costs, Statistics and Strategies



by Peter Staecker

There are almost as many styles and approaches to producing Society/Council Newsletters within IEEE as there are newsletter editors. As a member of this group, your author is part of the "complementary" mailing list included on all IEEE newsletter mailings. The MTT Newsletter costs roughly $60K/year to produce (the total MTT operating budget is $1.2M). Just where did MTT Newsletter production costs stand with respect to all others? Late in 1987, I sent an informal questionnaire to the others on the list to solicit their inputs on various aspects of producing their newsletters. The purpose of this article is to share those responses with you. In the following, some of the basic concepts of production costs are defined and compared among Societies, with notes to explain the differences.

Elements of Production Costs:

1. Editing and Layout

E&L includes the costs of typing the inputs of authors, typesetting and laying out the copy with any line drawings or half-tones, proofing the galleys and paginating the final photo- ready copy. There are almost as many approaches to this task as there are editors. At MTT, there are no stringent requirements on author-prepared copy. Upon receipt, the inputs are entered and formatted into ASCII files for transfer to a computerized phototypesetting machine in the M/A-COM advertising department (MTT pays for the operator). A number of us proof the galleys. Not an inexpensive process, as you can see from looking at the figures below. Even when normalized to a per member per page basis, MTT has an extremely high E&L cost. An example of a less expensive alternative is provided by AP, which requires camera-ready copy from authors. Robotics and CHMT editors do E&L themselves, for free. You can't beat that! (By the way, CHMT has been lobbying at the AdCom level for electronic collection and distribution of its Society news items.)

2. Printing

Printing includes, binding (not cheap - for our printer, inserting our Society's Committee Directory in our Winter Issue costs about $1000), and boxing for shipment. Whereas the normalized cost of Editing and Layout varied by 14 to 1 over the survey respondents, printing costs showed a tighter distribution (2 to 1). The variables here are paper quality, ink, and, of course, print run.

3. Distribution

This is the tricky one. Distribution includes the cost of mailing labels, drop shipment to the distribution center (Marie Hogan at IEEE, Piscataway, for most of us), labor and **postage**. Domestic mailing can use second class rates, but foreign must go first class! Normalized distribution costs account for more than 1/3 of the total production cost, and are going up. The foreign mailing at MTT accounts for 54% of our total distribution budget, while servicing only 22% of our membership. Similar statistics ***should*** apply for other Societies, unless their membership demographics are skewed from those in MTT and AP. (These numbers are very difficult to extract from IEEE-supplied data—a direct call is much more effective.) The Central New England Council (CNEC) puts out a monthly bulletin to over 15000 members and shows the cost benfits of a domestic-only mailing list (13 cents/member-issue vs. ~50 cents/member-issue for AP and MTT).

How to Save Money

There are some ways to cut production costs. As mentioned above, you could volunteer your editing services. Another method is to accept paid advertising. For AP and CNEC, advertising revenues amount to about $15000 annually, and have been included

NEWSLETTER STATISTICS (1987-1988)

S/C	Issues	Pages	Copies (K)	Mmbrs (K)	E&L Cost ($)	Prt Cost ($)	Dist Cost ($)	Ads Income ($)	Total Cost ($)	E&L Cost ($/p)	Prt Cost ($/p-Kc)	E&L+P Cost ($/p-Kc)	Dist Cost ($/mi)	Total Cost ($/m)
CNEC	9	272	144	15.0	11130	40320	17638	14430	54658	40.92	1.03	1.31	0.13	3.64
EMC	4	120	10	2.5	1305	2750	1328		5383	10.88	2.29	3.38	0.13	2.15
AP	6	356	45	7.1	10847	30618	24159	15000	50624	30.47	1.91	2.59	0.57	7.11
MTT	3	214	30	10.0	18829	27841	16585		63255	87.99	4.34	7.27	0.55	6.33
Robotics	2	40	16	8.0	570	3890	5698		10158	14.25	6.08	6.97	0.36	1.27
CHMT	4	80	16	3.2	500	7000	3500		11000	2.50	5.47	5.63	0.27	3.44
IM	4	188	20	5.0	7400	14800	8195		30395	39.36	3.98	5.96	0.41	6.14
OE	4	100	9	2.2	3000	6000	2400		11400	30.00	6.82	10.23	0.27	5.18
EM	4	32	36	9.0	4667	9333	2200		16200	145.84	8.10	12.15	0.06	1.80
ITG	4	48	20	5.0	1250	IEEE	IEEE			26.04				
NPS	3	108	9	3.0	3000	9000	IEEE			27.78	9.26	12.35		
PC	4	75	8	2.0	8000	IEEE	IEEE			123.08	9.62	25.00		

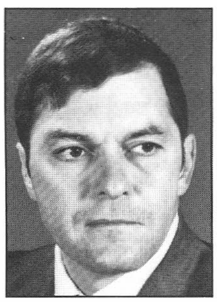
NEWSLETTER PRODUCTION COSTS
(continued from previous page)

in the *total* cost figures shown in table on the previous page. NB: Make sure your production cost per page is less than your ad rate. Finally, you could consider becoming a part of the IEEE All-Transactions package, which has certain editorial requirements (restrictions), but because it is distributed as part of a selection of IEEE periodicals, is supported by subscription fees. A fairly significant fraction of your production costs could be underwritten by this technique. Finally, one thing we are doing this time at MTT (starting with our last issue), is going to a reduced font size, to get more information on fewer pages, while preserving the overall high quality format. How are we doing?

Interpreting the Tabular Data

The table on the previous page shows complete information for 8 Society/Council Newsletters. Information on the left-hand side of the chart shows yearly statistics, including the total issues and pages per year, as well as copies/year and membership (the latter two in thousands). The costs for E&L, Printing, and Distribution are shown, as well as advertising income, and total cost. Proceeding to the right, E&L cost is shown on a per page basis, followed by printing and the sum of E&L plus printing on a per page per 1000 copies (p-Kc)basis. Looking at the E&L column, it is obvious that CHMT does their own editing and layout. Distribution is normalized to number of member issues (mi), and this number should be uniform from group to group. I think there is some confusion about the reporting of this information.

AdCom Highlights



by Vladimir G. Gelnovatch

The Fall 1988 MTT-S AdCom meeting was held in Albuquerque, NM on 9-10 October at the Marriott Hotel which will be the site for the 1992 International Microwave Symposium. The Fall meeting is usually the annual AdCom election event and eight vacancies on AdCom were filled. In addition, a president and vice-president were elected. These terms begin in January 1989 and a full report will be found elsewhere in this Newsletter by Ed Niehenke, Nominations Chairman.

The Standing Budget committee met before the AdCom meeting to close the books on the 1987 and 1988 International Symposia. The 1988 NYC Symposium showed a much reduced surplus, the causes of which are currently under analysis. A robust financial goal was given to the organizers of the 1989 Symposium in Long Beach, California. Bob Moore, Finance Chairman, reported that the original reforms began by Dave McQuiddy to overhaul and simplify the accounting procedures interfacing with IEEE Headquarters will not be fully in effect until next year. A new format for 'un-anticipated' new expenditure requests was formulated. This method requires that the standing budget committee examine off-line all requests and make recommendations to the full AdCom membership as to the disposition of the request. In its first implementation the method seemed to work well.

A discussion on superconductivity was held focusing specifically on searching for future potential applications. It ended essentially with the recommendation that superconductivity is of critical interest to the MTT-S.

Chuck Swift gave a report of the hotel situation in Long Beach for next year's Symposium which gave a glowing account of the 1989 Symposium site.

A sum of $5,000 will be donated by the MTT-S to the Georgia Institute of Technology Scholarship fund to establish a graduate scholarship at that institution in the name of Dr. Walter Cox. As reported previously, Dr. Cox, an active member of MTT-S-AdCom, passed away last June. Additionally, a service award in his name was also authorized to honor AdCom members for distinguished service.

As of this meeting, six of the previous national lecturers have been videotaped. These tapes will be available soon and most probably will be distributed to active chapters.

Niehenke and Maury ascend.

AdCom Elections

by Edward C. Niehenke

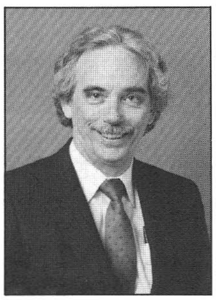
The annual Fall election meeting of the MTT-S was held in Albuquerque, NM on October 9, 1988. Eight qualified members were elected to membership on the AdCom of MTT-S. Six were elected to three-year terms and two were elected to a one-year term. For three-year terms, the re-elected members were Ferdo Ivanek, Reynold Kagiwada, Mario Maury, Jr., and Vladimir G. Gelnovatch. Rolf Jansen and Rodney Tucker were newly elected to three-year terms. The two one-year in-term vacancies left behind by out-going President, Barry Spielman, and Walter Cox, deceased, were filled by Alton Estes and Louis Medgyesi-Mitschang. The voting for both the three- and one-year terms was close and required three and four ballots respectively. The nominees were taken from a slate of 18 proposed by the Nominations Committee and one proposed from the floor by direct nomination. There were three petition candidates this year.

After the October AdCom meeting, a two-year in-term vacancy due to the resignation of Ralph Levy for job-related reasons, was filled by a mail ballot of MTT-S AdCom eligible voting members. The nominees considered were interested nominees (three) who were on the second ballot of in-term vacancies at this Fall AdCom meeting. Gary Lerude received a majority of votes on the first ballot and was re-elected to AdCom for a two-year term.

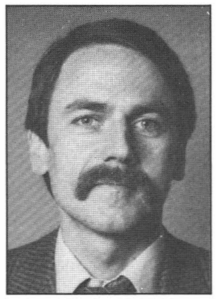
The five re-elected memberts have demonstrated an excellent history of contributions to the MTT-S and will go on to become senior statesmen while the four new members will bring new ideas and initiatives.

In order that you may meet the four new members of MTT-S AdCom, their bio-sketches appear below. The bio-sketches of re-elected members have been published in previous Newsletters.

In additional elections at the Fall AdCom meeting, a president and Vice-President for 1989 were elected. Vladimir G. Gelnovatch was elected to the position of President, while Tatsuo Itoh was elected Vice-President.



Alton L. Estes (M '82), B.S.E.E., 1971, Wichita State University; M.S.E.E., 1977, Southern Methodist University. employed by Texas Instruments, 1982-present. Current responsibilility is to establish a GaAs MMIC Reliability data base for products manufactured in TI's DS&EG GaAs prototype facility. Previous assignments included providing the engineering and managerial direction to complete development and assembly of GaAs MMIC Power Amplifier Modules used to fill the antenna array of the X-Band Satellite Aperture Development program. Employed by Scientific Communications, Inc., 1978-1982. Assignments included designing low noise parametric or GaAs FET amplifiers, and multi-octave microwave or millimeterwave Surviellance Tuners. Employed by Texas Instruments, 1972-1978. Assignments included developing radar IF, L-band and Ku-band assemblies. Dallas IEEE MTT-S Chapter Chairman, 1986/1987; preceded by other Chapter Offices, 1982-1986. MTT-S Membership Development Officer, 1987-1988. MIDCON/88 Technical Conference Chairman, 1987-1988. Member other Professional Organizations: Association of Old Crows, ISHM, and Toastmasters International.

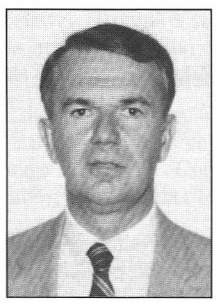


Rolf H. Jansen received his MS (1972) and Ph.D. (1975) degrees, both in electrical engineering, from the University of Aachen (RWTH). He continued his research work at the RWTH Aachen microwave laboratory as a Senior Research Engineer 1976-1979 where he was mainly engaged in the characterization of MIC components and the CAD of microwave circuits. He was also in charge of the thin-film technology of the microwave lab and, since 1977, worked as a research associate for the radio communication of Standard Elektrik Lorenz AG (SEL) in Pforzheim, West Germany.

In 1979, he became Professor of Electrical Engineering at the University of Duisburg near Dusseldorf/Cologne and started teaching and research on electromagnetic theory, microwave techniques and CAD, measurements techniques and modelling. His university career was supplemented by a one year's leave 1981/1982 as a full-time scientist with SEL Pforzheim, and the conduction of a variety of software and hardware projects for the communication industry since 1976. He developed, introduced and tested the first layout-oriented general purpose microwave CAD package in a West Germany production oriented industry environment. He is author of 65 technical papers in the field of microwaves and recipient of the outstanding publications award in 1979 of the German Society of Radio Engineers.

Presently, with a preparatory phase since the end of 1984, he is engaged in the development of a novel engineering CAD workstation for GaAs MMICs with Plessey Research Caswell, Great Britain. This research effort uses completely new design components. He is founder and owner of a small company engaged in microwave design software and hardware developments.

He is a member of the IEEE and of the MTT-Society since 1975 and a Senior Member since 1984. In the time 1982-1987 he served and contributed in the IEEE Standard Committee P1004 on Planar Transmission Lines as the only European member. Also, since 1984 he served as a member of the IEEE committees MTT-15 (microwave field theory) and MTT-1 (CAD) with workshop contributions and since then joined the editorial board of the IEEE Transactions on Microwave Theory and Techniques. He was a cofounder of the West German MTT Chapter and served as a Chapter Chairman during the period 5/85-5/87. Under Jansen's leaderhip the chapter received two consecutive membership increase awards. Presesntly, he is still active as chapter officer for the term 5/87-5/89 and works to promote European chapter cooperation. In 1987/88 he served as a Distinguished Microwave Lecturer, lecturing worldwide on the topic of CAD of hybrid and monolithic microwave and millimeter wave MICs.



Louis N. Medgyesi-Mitschang (S'60 – M'63) received the B.S.E.E. and M.S.E.E. degrees from Washington University, St. Louis, MO, in 1961 and 1963, respectively. He received the D.Sc. degree in 1967 in electrical engineering from the same institution, minoring in mathematics and physics. His graduate work was done at the Bio-Medical Computer Laboratory of the Washington University School of Medicine. His work dealt with the application of statistical communication theory for analysis and reconstruction of bio-physical phenomena. In 1967

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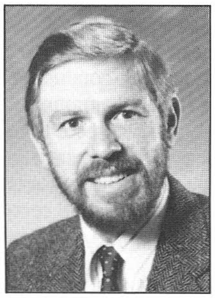
AdCom ELECTIONS (continued from page 17)

he joined the McDonnell Douglas Research Laboratories (MDRL). Currently, he is Staff Manager of the EM and Optical Signatures Group responsible for applied electromagnetics research in MDRL. In 1986 he was nominated McDonnell Douglas Research and Engineering Fellow. Previously he was principal investigator on a series of reseearch programs for the U.S. Army, Air Force, navy, and MIT Lincoln Laboratory dealing with airborne antenna systems and scattering problems. His special interest is the mathematical modeling of non-specular effects in absorbers and the development of hybrid methods for radar cross section analysis and reduction.

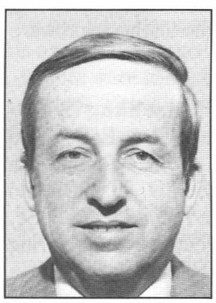
Dr. Medgyesi-Mitschang is a member of the Aerospace and Electronic Systems Society, AIAA, Eta Kappa Nu, Tau Beta Pi, and Sigma Xi. He is former PAC Chairman of the St. Louis IEEE Section, a member of its executive committee and past chairman of the combined group of AP, ED, and MTT of the St. Louis Section.



Rodney S. Tucker (S '72–M '75–SM '85) received the B.E. and Ph.D. degrees from the University of Melbourne, Australia, in 1969 and 1975, respectively.

From 1973 to 1975 he was a lecturer in Electrical Engineering at the University of Melbourne. he was a Harkness postdoctoral research fellow with the Department of Electrical Engineering and Computer Sciences, University of California, Berkeley from 1975 to 1976, and during 1976-1977 he was with the School of Electrical Engineering, Cornell University, Ithaca, NY. From 1977 to 1978 he was with Plessey Research (Caswell), Ltd., Allen Clark Research Center, England. In 1978 he joined the Department of Electrical Engineering at the University of Queensland, Brisbane, Australia, where he was a Lecturer and later a Senior Lecturer. Since 1984 he has been with AT&T Bell Laboratories, Crawford Hill Laboratory, Holmdel, NJ. His current research interests are in high-speed semiconductor optoelectronic devices for lightwave communications systems.

Reflections from an Outgoing Division IV Director



by Gary A. Thiele

After two years of serving as your Divisional Director, I would like to share with you some observations from the perspective of an outgoing Director.

Volunteerism is both a strength and weakness of the IEEE. Aside from the IEEE staff in New York and New Jersey, essentially all other positions are volunteer. Elected positions are either for one or two years while appointed positions vary somewhat more in their duration. Thus, people come and go rather quickly and the organization as a whole tends to suffer from short 'corporate memory.' On the flip side of the coin, the steady stream of volunteers does insure a constant supply of willing workers with fresh ideas and invigorating enthusiasm.

Most volunteer positions require a reasonably modest commitment of time on the part of the volunteer. Exceptions to this are positions at the Board of Directors level which require considerable amounts of time. For example, a Divisional Director is: 1) a member of the Institute Board of Directors (BOD); 2) a member of TAB OPCOM, the executive committee of TAB, the Technical Activities Board; 3) a member of another board as a liaison between that board and the Board of Directors or a member of a major committee as a BOD representative. Memberships (1) and (2) require at least five trips per year, three of which last for six days. If TAB OPCOM meets outside of North America as it is committed to doing annually and which it did this past autumn, add two weeks to the travel schedule. Membership (3) typically can require three more trips of the one to three day kind depending on the assignment. In addition to this, there are five Societies in Division IV which are AP, EMC, MAG, MTT, and NPS. Thus, there are five AdCom(s) that look forward to having the Divisional Director at AdCom meetings. For obvious reasons, I found it impossible to meet this AdCom expectation and was grateful for the understanding and cooperation of the Society Presidents on this matter.

In my opinion, as well as that of others, the best interests of the Institute are not served by over burdening its volunteer workers. What can be done about it? I made a preliminary proposal at the June special meeting of TAB OPCOM that there be established the position of Division Director-Elect. This would be the elected position and would automatically lead to the Division Director position after a one year tour as Director-Elect. During this year the Director-Elect would serve without vote, but would liaison with the division AdCom(s). If managed properly, this arrangement could take some of the load off the Division Director, and it would also provide a period of time during which the Director-Elect could get up to speed on the various issues. The way things are done now, the in-coming Director hits his new duties pretty cold and spends the better part of the first year learning the issues and politics involved. After two years he is gone. Unfortunately, unless one of the continuing directors takes up an interest in this Director-Elect proposal, it will die for lack of sponsorship.

Next, there is the issue of size. The size of TAB (over 50 members) and the BOD (33 voting members) are both too large. It is widely recognized by those of us on TAB OPCOM that TAB is too large, so much so that much of its effectiveness is lost. I look for proposals to downsize it. This will be about as easy to do as closing a military base, but it should be done. Furthermore, in my own opinion, the BOD is too large as well, but not to the same degree as TAB. Changes in the Board of Directors are not likely, however.

Then there is the revenue issue. In spite of the recent five dollar dues increase, when inflation is taken into account your IEEE dues now are about 60% of the 1967 dues! Maybe, just maybe, the quality of service you've been receiving has decreased a little over those same 22 years. This is not the way to build a stronger professional organization for the future. More revenue is needed. One way to raise this, which was proposed in 1987, was to place a fee on all non-IEEE attendees at IEEE conferences with that fee coming to the general fund. Not a bad idea, but some on the BOD felt it infringed on the Societies' turf, and the proposal was defeated. An idea I had during our agonizing sessions over a dues increase this past summer, was to place a surcharge on all Society memberships. I saw two defenses for this. First, 40% of all IEEE members are not Society members. The other 60% are

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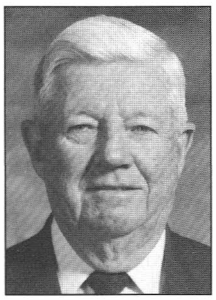
REFLECTIONS (continued from page 18)

getting more out of the IEEE, Society memberships are marvelously cheap, so why shouldn't beneficiaries pay a bit more ($2-$5 per membership) for what they are getting? Second, those who have multiple Society memberships are likely to be older, more established, and therefore more able to pay a little extra for their IEEE memberships.

Raising taxes never got anyone elected, but than I'm not running! By and large one gets what one pays for. If we want more then ways must be found to pay for it. It is as simple as that. The IEEE is doing a darned good job with the resources it has. But I'd like to think it could be better if it had revenues that approximately kept pace with inflation.

Finally, some have asked why I'm not seeking higher office. The sole reason is that I need to direct my energies at my career. I have, hopefully, 15 to 20 more productive years ahead of me and now is the time to seek out some fresh challenges. I have enjoyed many aspects of my tenure as your Division IV Director and thank you for the opportunity to serve. I turn over the reins to the capable hands of Len Carlson. Give him your support and cooperation as you have done for me. Best wishes to all!

1989 MTT-S Symposium



by Chuck Swift

In my last article, I asked your help in providing support for my 'One Penny Opera.' Surprisingly, the Steering Committee approved my going ahead with this madness, and if things work out (if I finish the lyrics) the world premier of the 'One Penny Opera' will be presented at the Awards Banquet. We are auditioning professional singers to play the roles shown below. I want you to be familiar with the plot, so a capsule appears as well, with some of the possible characters. We have a small budget, so some of them may not make the final line-up. One problem I'm having is I only know 'old' songs, and some of you will have trouble relating to the tunes I have chosen to desecrate. I have been listening to Michael Jackson's 'Bad,' figuring if I just change the 'B' to an 'M' I've completed the lyrics, which could be sung by Dr. Doolittle.

One of the first lyrics I completed was 'Oh QC,' written around 'Answer Me, My Love,' a song made popular by Nat 'King' Cole years ago; I'll make it unpopular in just one night. I refer to this as the 'Paralax Song,' and here's how it goes:

Answer me, oh Que Cee
As to why these parts came back to me
With a tag that says discrepancy
Please answer me, Que Cee

I have heard you're a nerd
And to you Accept's *a dirty word*
Your degree displayed for all to view
Came from 'Nit Pick' U.

Can it be so catastrophic
Viz wars somewhat hight?
If you lean a little this way
You'll see we do comply.

Don't you know, sales are slow
When we do not ship, we get no dough
Next they hang a lock upon the door
It's up to you, Que Cee.

THE ONE PENNY OPERA
Music by Berlin, Wilson, Fain, Kern, Ross, Rodgers, et al
Lyrics by Swift

The One Penny Opera was originally titled 'The Three Penny Opera.' However, because we were an alternate source and to be competitive, we changed to the 'Two Penny Opera.' After the contract award and a DCAS audit, where profit and overhead were eliminated, the opera assumed its present title.

The setting: The 'Zee Best Connector Co.,' a struggling young company, under-financed. Most of the capital came from the V.P. of Engineering, who mortgaged 50% of his $30,000, 1963 ERA home in Palos Verdes for 500K to provide the initial financing. The company has not settled on a motto; they are torn between 'Mating is Our Business,' 'A Place Where Males and Females Mate,' and 'We Try to Make Ends Meet.' The latter is prophetic; they are currently experiencing cash flow problems, and are negotiating with Drexel, Burnham and Lambert to go public.

CAST OF CHARACTERS:

Thomas Norman See — President. An old timer, once a brilliant design engineer, now relegated to a role he was never trained for. spends most of his time in meetings concerning equal opportunity, strategic planning, IRS audits, and union unrest. Uses his slide rule for a paper weight, and doesn't own a calculator.

Dianne Pohl — Personnel. Dianne prefers to be called Di, is a member of NOW, supports ERA amendment, gets belligerent when referred to as 'girl,' as in 'the girl in the office.' Is receptive to male advances. Not related to 'Load' Pohl. Pohl is spelled with a 'P,' as in 'Pneumonia.'

Millie Meter — Recent hire, still on probation, shows a lot of promise, but leaves a lot unfilled. Spends a lot of time in the hallway near the water cooler, which has led to the saying 'Millie Meter's right around the corner.' Has job security because she is young and attractive, and is niece of Di Pohl.

Chart Smith — V.P., Engineering. Father, John Q. Smith, IV, was engineer at Gilfillan Brothers during World War II. John never liked being one of the 99 John Smith's in the telephone directory, so chose a unique name for his only son. Smith enjoys his notoriety as Smith, Chart.

Norm 'Al' Ohm — Q.C. Looking forward to turning 50, as he believes 50 ohms is perfect. Batchelor, referred to behind his back as 'matchless.' Son of a Prussian general. Seen with a smile on his face just once, at the funeral of the former production manager.

Ernest A. Fortune — Sales Representative. His friends call him 'Earn,' think he's very wealthy because he has a cellular phone and leased BMW. Only his banker knows the truth. Divorced three times, fears another termination. Has a wallet with 32 credit cards.

Anne Knode — Secretary. Silent 'K,' as in knew. Not as in Knerr, former President of AdCom. Liked by management for her positive attitude. All-American image, but seems attracted to unsavory opposite type males.

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1989 MTT-S SYMPOSIUM (continued from page 19)

Bui Lo — Purchasing Agent. Listed in Guiness Book of Records for requesting 'last and final' bid four times on same procurement, prior to cancelling requirement. Left Viet Nam with the shirt on his back, and a million in gold hidden in the keel of the boat. Owns five 7-11 stores.

Cutler Price — Buyer. 'Cut' Price is vet of WWII, smokes cigars, has butch hair cut, tatoo on arm, refers to everyone as 'Pal,' known to consume a 6 pack for lunch. Never met a vendor he didn't hate. Junior High drop-out.

Henry Fonda — Production Manager. No relation to the actor, but still is referred to as the 'late' Henry Fonda. Wears patch over one eye at work, which explains why he and Q.C. don't see eye to eye. Has been observed driving vehicle without glasses or sight aids.

Dewey Feelgood, Jr. — Consultant. Named after his father, a Doctor in Sherman Oaks (you can look it up in the Valley directory). Chose not to follow in his father's footsteps. Former AF Colonel. Retired Hughes employee. Has two pensions.

Dr. No — Design engineer who will not accept any new challenges, once bid $50,000 NRE on what turned out to be a Heath kit.

Dr. Doolittle — Ph.D. who writes great papers, but never turns any of his ideas into hardware. He's presently working on a 'no go/no go' gauge, a project suggested to him by Norm Ohm of Qualtity Conrol.

The 'One Penny Opera' will deal with the every day problems and ordeals of the 'Zee Best Microwave Connector Company.'

THE SONGS:

1. The Paralax Song (Answer Me, My Love), *Chart Smith*
2. I'll Be Sueing You (I'll Be Seeing You), *Millie Meter*
3. Please Pay the Bill (He's Just My Bill), *Earn A Fortune*
4. Pink Slip time is Coming Around, *Di Pohl* (Santa Claus is Coming to Town)
5. Gallium Arsenide (My Funny Valentine), *Chart Smith*
6. Ol Don Parker (Old Man River), *Di Pohl/Smith/See*
7. No Theory Like Microwave Theory, *Ensemble* (No Business Like Show Business)
8. Hey There (Hey There), *T.N. See*
9. Oh P.A. (Answer Me, Oh My Love), *Henry Fonda*
10. Oh V.P. (Answer Me, Oh My Love), *Bui Lo and Cut Price*
11. Pay a Little, Talk a Lot (Music Man), *Dewey Feelgood, Jr.*

TRAVELLING TO THE SYMPOSIUM

You are planning on coming to Long Beach next June, aren't you? I mean, how can you pass up such a bargain? Three days of your peers presenting topical papers for only $140? And if you are an IEEE member, and register prior to May 19, you get in for 95 greenies. Compare those prices to the RF Technology Expo. They're asking $235 for on-site registration, and $175 for preregistration! I attended the European Microwave Conference in 1987, where registration ran $500 in dollars, and millions in lira. In addition, we throw in a three volume, hard bound digest, so in case you sneak off to Disneyland and miss some papers, you can fake out your supervisor when you return to work. Consumer's Union would definitely rate the MTT as a 'best buy,'

So now you've made the decision to come, how do you get here? We'll save you some money there, too, if you'll make your reservation through our official carrier, United Airlines. Call (800) 521-4041, 8AM to 11PM EST, identify yourself as 'IEEE Account Number 9006L,' and for travel between June 10 and June 25 United offers:

1. Five percent discount off any applicable fare; this includes advance purchase fares, and is the least costly. These fares have a cancellation penalty, however.
2. 40% off full coach. If you come down to the last minute, you can still save money using this fare. There is no penalty for cancelling.
3. United will accept reservations from you, your travel department or your travel agent, and ticket can be mailed directly to you.

When you utilize the official carrier, you make it possible for the Symposium to furnish complimentary tickets to students. It's one of those rare win/win situations, and we hope you take advantage of this opportunity.

Now, I know all of you want to know the best way to get here. Motorcycle, of course, but I doubt if many of you will accept my heart-felt advice. Sso here's my preferred route, one my son and I traversed on our return to California after the 1988 symposium. The start is Denver. Follow Rt. 285 West until it intersects Highway 50 at Poncha Springs. West on 50, up through Monarch Pass (elev. 11,312 ft., and, because this is an international symposium, 3480 meters), continue thru Gunnison to Montrose, where you head south to Telluride. That's day one. Next morning, leave this old mining town turned ski resort, and head SW toward Cortez. Pick up Rt. 160, which takes you past 'Four Corners,' where you can have a hand in Utah, one in Colorado, with your feet in Arizona and New Mexico. That is, if you don't feel too silly doing it. We chose to head North toward Page and Drive through Zion, a scenic wonder. An option is to head South, and go to the Grand Canyon. We spent night two in St. George, and were home in Los Angeles the next evening. If you have never made this trip, you won't find many better for sheer beauty. Las Vegas is on this route, too. So rent a car or motorhome ('Cruise America' offers one-way rentals; 800-327-7778), allow yourself a few extra days and you'll have a memorable trip.....guaranteed.

ACTIVITIES PREVIEW

What kind of things are we planning for '89? A delightful setting, a conscious effort to limit the technical program to three parallel sessions, and a new time for the plenary session.

You're going to like Long Beach. This 100 year old city has done a remarkable job of renovation in the last few years. Three of the major hotels are less than five years old, and the convention center is about ten. The Queen Mary and Spruce Goose are but minutes away, and Disneyland is but 30. There are facilities for your motor home or yacht within walking distance of the Symposium, and inexpensive rooms for those on a tight budget.

In keeping with our theme, 'Microwaves Among the Stars' we've lined up two top industry leaders for our plenary session; Dr. Harold Rosen of Hughes Space and Communications Group, known for his work on the synchronous satellite, and Dr. Simon Ramo, noted author and founder of TRW. Because we know you'll be out looking at the stars the night before and we don't want you to miss the plenary, it's scheduled for 10:00 AM.

Dr. Bob Eisenhart of Hughes is planning a special space exhibit, to compliment the standing 'Historical Exhibit,' which gets more complete and comprehensive every year.

What else do we have in store for you? There's a rumor that each registration package will contain a packet of pistachios, but at this time it has not been confirmed. Guess you'll have to attend to find out if it's merely a nutty rumor.

Guest Program

by Loretta Oltman

This years's schedule for the Guest Program will include daytime programs of exciting tours with a visit to Universal Studios to travel the streets and backlot sets where Abbott and Costello chased the Frankenstein monster, where Newman and Redford planned 'The Sting' and Lon Chaney terrorized audiences as the 'Phantom of the Opera.' See how illusions are created through special effects. Be shocked by Jaws, awed by the parting of the Red Sea and amazed by the Battlestar Galactica and terrified of King Kong. Other locations that our guests will have the opportunity to visit will be the Getty Museum situated in the wooded hillside overlooking the Pacific Ocean at Malibu. The building itself is a reconstruction of the Villa dei Papiri, a 1st century Roman seaside villa that was destroyed when Mt. Vesuvius erupted in Ad 79. and covered Pompeii. See glamourous Beverly Hills, home of the rich and famous. Stroll down Rodeo Drive lined with elegant shops and boutiques catering to the stars and the international jet set. See Gumps, an internationally known specialty store where Mr. Shelton Ellis will give you a private tour. Travel to San Juan Capistrano where you will visit the beautiful mission where the buildings and gardens reflect the joint accomplishments of two cultures, Indian and Spanish working together to create a new way of life in a young land. The oldest building in California, the only remaining chapel used by Father Serra preserves the original Indian decorations and displays a beautiful 300 year old Spanish alter built in Barcelona and given to the mission in 1924. Drive along the scenic coastal route through Dana Point to the art colony of Laguna Beach and browse in the galleries and shops featuring the unusual wares for which Laguna is famous.

A Guest hospitality suite will be located in the Hyatt Regency Hotel. The suite will be open from 8:30 a.m. to 5:00 p.m. from Monday through Friday and will be serving conplimentary continental breakfasts in the morning and snacks and liquid refreshments in the afternoon. Hostesses will be on duty to assist you and your guests with your arrangements and needs during your stay in Long Beach. Information will be available in making independent arrangements to visit other California attractions such as Disneyland, Knott's Berry Farm, San Diego Zoo, Sea World, Catalina, etc.

DID YOU KNOW THAT. . .

. . .**the average age** of first-time homeowners is now 37? That's up from 32.4 in 1977.

Sylvia Porter's Personal Finance, 380 Lexington Ave., New York 10017. Six issues. $11.97/yr.

. . .**the average liability** for a failed business in 1986 was about $600,000? *In 1976:* $313,000.

Avoiding the Pitfalls of Starting Your Own Business, by Jeffrey P. Davidson, CMC, MBA Walker & Co., 720 Fifth Ave., New York 10019. $19.95.

1989 MTT-S Symposium: Technical Program

by Reynold Kagiwada

The MTT-S International Microwave Symposium's Technical Program Committee is now awaiting (December 2, 1988) the arrival of the many contributed papers with great interest. Several papers have already been received well ahead of our December 12, 1988 deadline. Several hundred papers are normally submitted to the Symposium and they are always of the highest quality. This makes it extremely challenging for the paper selection. The Technical Program Committee meets on January 10, 1989 at the Long Beach Hyatt Regency to finalize the program. We are all quite excited about the Symposium and expect many microwave technological breakthroughs to be presented at the Symposium.

The various events will be held at the Long Beach Hyatt Regency Hotel, Long Beach Sheraton Hotel, and the Long Beach Convention Center. The Microwave and Millimeter Wave Monolithic Circuits Symposium will be held early in the week on June 12 and 13, while ARFTG will be held late in the week on June 15 and 16. In addition, several workshops will be held on June 12 and June 16.

The Technical Program which is a cornerstone of the Symposium will have focused sessions, special sessions, a European Microwave session, open forums and contributed and invited papers. The Technical Program will focus on recent advances in the microwave field.

John Horton and Ken Conklin are coordinating the activities for focussed sessions, special sessions, panels and workshops. Michael Kim is coordinating the activies of the open forum.

The Long Beach Symposium promises to be the most exciting event of the year! We hope to see you there.

. . .**too-tight neckties** can affect vision? Many men cinch their ties tight, squeezing the carotid artery, which carries blood to the eyes, and causing blurred vision. *Good news:* Vision is restored after a tie is loosened.

Study led by Richard Leavitt, MD, at Cornell University, Ithaca, NY, reported in *Self,* 350 Madison Ave., New York 10017. Monthly. $15/yr.

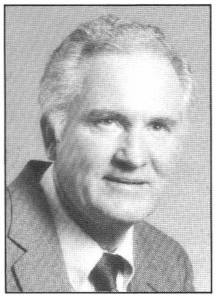
. . .**70% of students** in grades seven through 12 currently use drugs? *Aslo:* 87% of high school seniors drink alcoholic beverages. . .and 30% get drunk at least once a week.

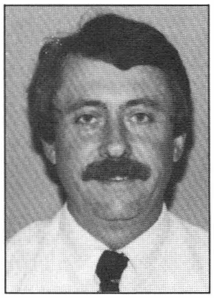
Statistics from a Department of Health and Human Services national survey, cited in *Physician's Management,* 7500 Oak Rd., Cleveland 44130. Monthly. $30/yr.

. . .**smokers like alchohol** and caffeine more than nonsmokers do? And they are less apt to like fruits and vegetables. *Upshot:* Their reserves of vitamins A and C suffer. *Good news:* The aversion to vegetables decrease as smoking decreases.

Study of 9,689 nonsmokers and 5,622 smokers by the Medical College of Wisconsin, Milwaukee, cited in *The Medical Post,* Maclean Hunter Bldg., 777 Bay St., Toronto, Ontario M5W1A7. 44 issues. $35/yr.

Special Sessions Focus on Emerging Technologies





by J. Horton and K. Conklin

Special sessions for the 1989 International Microwave Symposium include four focused sessions which will be integrated into the regular technical program, six panels and six workshops. In addition to these features, a special session honoring Seymour Cohn will be held on Wednesday afternoon, June 14. All of these activities are to be held at the Hyatt Regency Hotel throughout the week of June 12 through June 16. Workshops will be held on Monday, June 12 and Friday, June 16, with a mini workshop on superconductivity scheduled for Tuesday evening, June 13. Panels will be held during lunch on Tuesday, Wednesday and Thursday, and on Tuesday evening. Listed below are the topics, organizers and sponsoring MTT committees for the special sessions. More information on each session will be included in the Advance Program. In the meantime, early information can be obtained from the organizers.

FOCUSED SESSIONS

Optical Interactions with Microwave Circuits (C. Lee, MTT-3)

Microwave Superconductors (E. Belohoubek, MTT-18)

High Power Technology (J. Goel, MTT-5)

Future Trends in SAW Products (B. McAvoy, MTT-2)

Session Honoring S. Cohn (P. LaTourette, MTT-8, AdCom)

WORKSHOPS

Lightwave Technology (Tutorial) (H. Yen, A. Rosen, MTT-3,-11, -15,-16, Monday)

Advances in High Power Equipment for Space Application (C. Kudsia, MTT-8, Monday)

Microwave Characterization of Superconductors (R. Ralston, M. Nisenoff, MTT-18, Tuesday evening)

Microwave & Millimeter Wave Synthesizers (D. Hornbuckle, H. Ogawa, MTT-6, Friday)

High Frequency Interconnections (M. Steer, J. Mink, MTT-15, Friday)

PANELS

Microwave Superconductor Applications (A. Silver, J. Fiedziuszko, MTT-18, Tuesday lunch)

Microwave Education: Present Status & Future Trends (F. Ali, G. Vendelin, AdCom Education Committee, Tuesday evening)

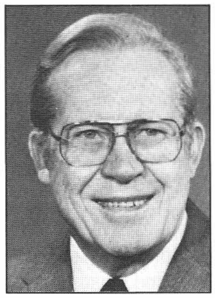
Heterojunction Devices, Circuits and Reliability (F. Sullivan, MTT-6, -7, Tuesday evening)

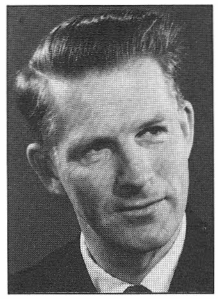
Microwave Hardware Descriptive Language (MHDL) (A. Sharma, MTT-1, Wednesday lunch)

Entrepreneurship in Engineering (L. N. Medgyesi-Mitschang, AdCom PACE, Wednesday lunch)

MMIC Designs for Low Cost, High Volume Applications (G. Brehm, F. Ali, MTT-6, Thursday lunch)

Centennial Celebrations of the Work of Hertz in Electromagnetics





by John H. Bryant and Thomas B.A. Senior

The historic experiments carried out by Heinrich R. Hertz during the period 1886 to 1891 validated the Faraday-Maxwell theory of electromagnetics and opened up the entire RF portion of the spectrum for scientific and practical uses. He published his results in a series of papers in the *Annalen der Physik*. The sixth paper of the series, 1888, with 'waves in air' in the title attracted the attention of the scientific community. The centennial of this work has been celebrated in Great Britain, the Federal Republic of Germany (FRG), and the United States.

CENTENNIAL CELEBRATIONS SUMMARY

The first such celebration was at the IEE/URSI Fifth International Conference on Antennas and Propagation (ICAP 87) held in March 1987 in Edinburgh, where a session of six papers was devoted to Hertz's contributions and influence.

Most of Hertz's work in electromagnetics was carried out at the Technical Institute (now University) of Karlsruhe, FRG after he took up his professorship there in March 1885. The University and City of Karlsruhe celebrated this with an exhibition entitled '100 Years of Radio Waves, Heinrich Hertz—His Work and Influence' from 27 January to 31 March 1988. Hertz's investigations and discoveries were depicted in posters and a display of several items of his original apparatus borrowed from the Deutsches Museum in Munich. Subsequent applications ranging from radio and television to radar, remote sensing and microwave ovens were also illustrated.

A two-day Symposium 'Heinrich Hertz, 100 Years of Electromagnetic Waves,' co-sponsored by the Verband Deutscher Elektrotechniker (VDE) Informationstechnische Gesellschaft (ITG), the University of Karlsruhe, and the Deutsche Physikalische Gesellschaft (DPG), in cooperation with IEEE and URSI, was held in Karlsruhe on 14 and 15 March 1988. Thirteen papers presented are included in the Conference Digest (published by VDE Verlag, Berlin) along with facsimiles of some of Hertz's notes and correspondence. The two journals *Fridierciana Zeitschrift der Universitat Karlsruhe,* volume 41, and *Baden-Wurttemberg,* January 88, contain a total of 18 articles discussing Hertz's life and work, all written by the University of Karlsruhe faculty, including an article in the first journal, 'Heinrich Hertz: a personal and historical background to his discoveries: (In German), by Gerhard Hertz, a grand nephew of Heinrich Hertz.

There have been several celebrations in the United States. At the 1988 IEEE MTT-S International Microwave Symposium in New York, 25-27 May 1988, two special sessions included the papers 'The History of Electromagnetics as Hertz Would Have

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Known It' by Robert S. Elliott, 'Heinrich Hertz: a Short Life' by Charles Susskind, 'Heinrich Hertz—Theorist and Experimenter' by John D. Kraus, 'Heinrich Hertz at Work in Karlsruhe in 1888' by Helmut Friedburg, and 'The Legacy of Hertz: Some Highlights in Microwave History from 1889 to 1945' by James E. Brittain. The first three of these have been published in *IEEE Transactions on Microwave Theory and Techniques,* vol. 36, no. 5, May 1988, along with an article by John H. Bryant entitled 'The First Century of Microwaves—1886 to 1986.' A commemorative book, *Heinrich Hertz: The Beginning of Microwaves; Discovery of Electromagnetic Waves and Opening of the Electromagnetic Spectrum in the Years 1886-1892,* by John H. Bryant contains many photographs and drawings of Hertz's apparatus and experiments and is available from the IEEE Service Center, 445 Hoes Lane, Piscataway, New Jersey 08854 USA (IEEE Catalog No. 88TH0221-2; $10.00 for members, $15.00 for non-members of the IEEE).

The MTT-S Symposium also included a Hertz exhibit. A key part of this was a set of 20 replicas of Hertz's apparatus owned by the Science Museum in London, and refurbished prior to their loan to the MTT Society. Thirty-five posters were prepared for the exhibit. Following the Symposium, the exhibit was moved to the MIT Museum in Cambridge, Massachusetts, for display through December 1988. In addition, at the 1988 IEEE Antennas and Propagation Society (AP-S) International Symposium in Syracuse, New York, 6-10 June 1988, there was an exhibit of posters, and photographs in lieu of the replicas. This easily portable exhibit is now in the MTT-S Historical Collection and is available on loan.

Preparation of the book and the posters presented the opportunity to illustrate Hertz's experiments in detail using photographs. One photo shows many pieces of the original apparatus designed by Hertz and built by an assistant in Karlsruhe, along with items of laboratory equipment, at the time of their receipt in Munich in 1913. A total of 33 separate items are identified and described in modern terminology.

HERTZ: A BRIEF TECHNICAL BIOGRAPHY

Although Hertz made photographs, none appeared in his published papers (presumably because the technology for reproducing them in journals was not available). Two photos that were taken in Hertz's laboratory were only found in Karlsruhe in 1988. These, along with the individual photos of the replicas and the excellent drawings from his papers, highlight this centennial presentation of Hertz's investigations.

The pieces of apparatus designed by Hertz and built by an assistant are elegant in their simplicity and functional capability. For the most part they are made of inexpensive materials: metal sheet and wire, wood, glass, string, and sealing wax. Their size is impressive. Hertz's resonant circuits are distributed circuits, so that the size is related to the wavelength, and include the balanced half-wavelength dipole and the half-wavelength loop which he invented.

Hertz worked at the threshold of the microwave region, first at a wavelength of about 6m (frequency 50 MHz), and later at 3m and 60cm wavelengths. His first signal source/transmitter used a capacitively loaded dipole 2m long, and a loop receive/detector 70 cm in diameter. With this equipment he demonstrated the coupling of circuits through space, resonance (by tuning either the transmitter or receiver), wave interference, and the measurement of wavelength. Properties predicted by Maxwell, such as dielectric polarization in insulators, skin effect, and the finite velocity of propagation corresponding to the velocity of light—both on transmission lines and through space—were also demonstrated. Hertz experimented with wire-over-ground-plane and coaxial transmission lines, and his coaxial line section is 5m long. In the midst of these experiments he stopped to investigate a strange phenomenon and discovered the photoelectric effect. His study was so thoroughly done and well presented that it set off a new line of investigation in physics, and was the start of quantum physics.

To conduct focused-beam experiments, Hertz scaled his transmitter and receiver down in wavelength by a factor of ten, to 60 cm. He used cylindrical parabolic reflectors which stand 2m high. With these and a metal reflector, a wedge-shaped box for holding dielectric material, and a polarizing screen, Hertz demonstrated the optics-like properties of electric waves: rectilinear propagation, reflection, refraction and polarization. This was strong evidence that light and electricity are the same phenomena, differing only in wavelength.

It is indeed remarkable that the original apparatus of these experiments has been preserved, and that excellent replicas also exist. Around 1913 the Hertz apparatus was transferred to the Deutches Museum in Munich. In the late 1920s, a model maker in Munich, Julius Orth, built three sets of replicas, working from the originals, for: (1) the Science Museum, London, (2) the National Radio Society in Berlin (status of the items is unknown at present), and (3) the 1933 World's Fair in Chicago. After the Fair this last set was given to the Museum of Science and Industry in Chicago, and about half of the items have survived.

A key to Hertz's success was his skill at analytical work—equal to his skill as an experimenter. Independently, in 1884, he worked his way through Maxwell's publications, and concluded that Maxwell's theory was to be preferred over competing theories. In the course of his experiments, Hertz interspersed analytical work to guide the experiments and assess the results.

Although Hertz is best known for his work in electromagnetics, analytical and especially experimental, this work accounts for less than one-half of his career output. His interests were broad, with work in mechanics, instrumentation, friction, magnetics, meteorology, electricity, cathode rays, and electrical discharge in gases.

Hertz died on 1 January 1894 of blood poisoning of the jaw from infected teeth. He was only 36. It was an illness that would be treated routinely with drugs today, and it is intriguing to think what he might have achieved had he been granted a normal life span.

John H. Bryant (M'50-SM'52-F'67) is an Adjunct Research Scientist in the Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor. He holds the B.S.E.E. degree from Texas A&M University and the M.S. and Ph.D. degrees from the University of Illinois.

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He spent six years each at IT&T Laboratories, concerned with microwave electron tubes, and the Bendix Research Laboratories, with interests in passive microwave components and radar systems. In 1962 he was a founder of Omni Spectra, Inc., and served as its President and Chief Executive Officer. In 1980 Omni Spectra becam a part of M/A-COM, Inc.

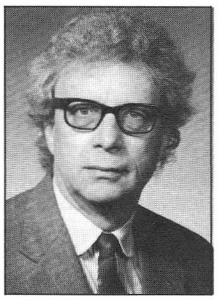
Dr. Bryant is a Past President of the IEEE Microwave Theory and Techniques Society (MTT-S), and served as Chairman of the IEEE MTT-S Hertz Centennial Committee.

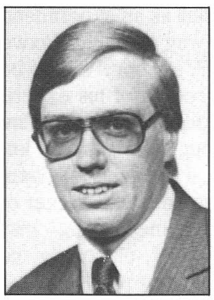
Thomas B.A. Senior (SM'66-F'72) received the M.Sc. degree in applied mathematics from the University of Manchester, England, in 1950 and the Ph.D. degree in research from Cambridge University in 1954.

In 1952 he was appointed as an Established Scientific Officer and accepted a position with the Ministry of Supply at the Radar Research and Development Establishment (now the Royal Radar Establishment) at Malvern, England. In 1955 he was promoted to Senior Scientific Officer. He joined the Radiation Laboratory, University of Michigan, Ann Arbor, in June 1957. He was appointed Professor of Electrical Engineering and computer Science in 1969. He served as Director of the Radiation Laboratory from 1975 to 1986, acting Department Chairman in 1987, and has been Associate Chairman of the Department since 1985. His primary interests are in the study of diffraction and propagation of electromagnetic waves, with applications to physical problems.

Dr. Senior has been an Associate Editor for *Radio Science* and served as Editor from 1973 through 1978, and is now an Associate Editor for *Electromagnetics*. He is Chairman of Commission B of the International Union of Radio Science, the past Chairman of the U.S. National Committee for URSI and served as Chairman of the U.S. Commission B. He is a member of Sigma Xi, Tau Beta Pi, and Eta Kappa Nu, and is listed in American Men and Women of Science.

Membership Services





by Martin V. Schneider, Chairman
and Steven J. Temple, Co-Chairman

NEW IEEE/MTT MEMBERSHIP SERVICES OFFICERS

Starting on January 1, 1989 the membership services committee will be chaired by Alton L. Estes and April S. Brown, both dedicated MTT members with previous distinguished service on our committee. We are convinced that the new team will succeed in solving the persistent problem of reaching out to the sixty-four chapters and generating some echo and responses which will be useful in improving the services. As a first step in improving communications among MTT members, chapters and committees, we have begun to exchange messages by eletronic mail. some e-mail addresses (arpanet and bitnet) will appear in the 1989 MTT committee directory. We encourage you to get in touch with your new membership services chairpersons by phone, mail or computer and let them know about your specific needs and inform them on your activities.

1989 IEEE/MTT VIDEOTAPE LECTURES

Six videotapes of Distinguished Lectures and talks from members of the Speakers' Bureau have been created and can be loaned to chapters and individual MTT members for use at chapter meetings or for studying a specific topic at home. A table including the details of both the Speakers' Bureau and Videotape lectures is shown on page 25. Please note that the videotape service is free of charge for MTT chapters and members. The cost to other organization is $50 - per tape. In order to receive a videotape on loan please contact:

Beth A. Babeu, Coordinator Home Video Tutorials
IEEE Educational Activities Department
445 Hoes Lane
Piscataway, NJ 08855-1331
Phone (201) 562-5499

The length of each tape is approximately one hour. The cost of creating the tapes was shared among the MTT Society, the IEEE Educational Activities Board, AT&T Bell Laboratories and the employers of the speakers. The program is intended to offer you a no-cost continuing education service with emphasis on emerging technologies of interest to the microwave engineering community.

KEY ACCOMPLISHMENTS IN 1988

- The membership team continued to provide regular services to 11,000 members and 64 chapters worldwide.
- MTT-S achieved high visibility at the European Microwave Conference in Stockholm, Sweden through the membership booth.
- Steps were taken to attract more attendees from overseas to future International IEEE MTT-S Symposia.
- A proposal for creating videotapes of the Distinguished Lectures was implemented and six tapes for use by chapters and MTT members were completed.
- A pamphlet entitled 'Student Membership Information and Application' was completed. It is being mailed to 28 universities and colleges offering significant microwave educational programs.

1989 IEEE/MTT MEMBERSHIP DIRECTORY

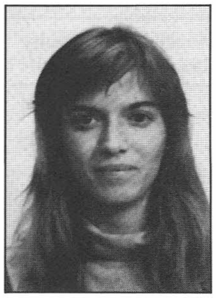
A directory containing the names and addresses of all MTT members will be printed in 1989. It will be distributed free of charge to all Senior Members of MTT and to members with a higher grade. since a majority of our members are eligible to become Senior Members, we suggest that all potential candidates for this overdue recognition of their professional accomplishments submit an application form to the IEEE Service Center as soon as possible. The form entitled 'Application Form for Senior Member Grade' can be obtained from your chapter chairperson or by contacting:

Peggy J. Kovacs, Member Services Supervisor
IEEE Service Center
445 Hoes Lane
Piscataway, NJ 08855-1331
Phone: (201) 981-5530

We hope that with your cooperation MTT-S will have the highest growth rate in elevations to the Senior Member grade in 1989.

MTT SPEAKERS' 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
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

MTT-S Speakers' Bureau



By April S. Brown

The MTT-S Speakers' Bureau was established in 1988 by the MTT-S to provide continuing education to Members on a large number of technical topics. The topics were chosen to inform our Members about advanced or emerging microwave devices, circuits, circuit analysis, and systems. The members of the Bureau are nationally recognized leaders in their field of interest. They have agreed to give up to six lectures during 1989 to MTT-S Chapters. **Because of the limited number of lectures given by each of the Bureau Speakers, the Chapters are encouraged to act soon, invite speakers, and plan meetings.**

We are happy to report that members of the Speakers' Bureau are already busy. The Sweden MTT-S Chapter has received lectures from both Fred Gardiol and Bernard Yurke. Umesh Mishra and April Brown gave their lecture to the Ithaca MTT-S Chapter. All of these meetings were well attended with approximately twenty to thirty people at each.

In order to best utilize this service, Chapters should understand the Speakers' rationale in scheduling. The speakers will accept invitations from Chapters which can provide a lively and sizable audience in order to reach as many people as possible. Therefore, it is suggested that Chapters try to arrange joint meetings with their Section and with other Society Chapters within their Section having an interest in the topic to be presented. Chapter Members are encouraged to interact with the Bureau Speakers (locally arranged dinners, or industry visits) to maximize the information exchange between the visiting Bureau Speaker and the Chapter Members. Videotapes of some of the Bureau's lectures are available at no cost for Chapters which cannot schedule a visit by a member of the Bureau. Consult the Membership Services Newsletter article about the videotape information.

TRAVEL EXPENSES

There has been some confusion by Chapters about sharing the Speakers' travel expenses. The funds to support the 1989 MTT-S Speakers' Bureau come from the Distinguished Lecture budget of the MTT-S AdCom's Membership Services Committee and from the speakers' companies. For travel outside some IEEE Regions, some support will be required of IEEE Regions, Sections, and MTT-S Chapters. This will be explained in detail by this article. The Membership Services budget will support expenditures of at least $1,500 per topic in 1989. Any Bureau Speaker needing any more funds in 1989 from MTT-S greater than $1,500 will need to request these extra funds from April Brown by May 1, 1989. All Speakers' 1989 budgets and lecture schedules must also be submitted by May 1, 1989 to April Brown. This will enable commitment by May 15, 1989 of any surplus funds to those Speakers who have made extra funds requests. This procedure should enable firm lecture scheduling for those lectures starting in September, 1989 which are to be given by lecturers requesting extra funding. Also, this procedure should enable firm lecture scheduling at least through August, 1989 and perhaps through December, 1989 for all Speakers whose budgets only require up through $1,500 support from the MTT-S.

The following is meant to explicitly clarify how to determine the Society's, the Speakers' employers', and the IEEE Regions', Sections', and Chapters' share of the Speakers' travel expenses:

The speakers' travel expenses are determined by which IEEE Region the Speakers are Members of, and by which of two geographical segments of IEEE, IEEE Regions 1-6, and 7-10, the Speakers are traveling to or within. Notice that the travel has been divided into two geographical segments of IEEE: Regions 1-6, and 7-10. For Speakers who are Members of any one of IEEE Regions 7-10, the speakers' travel expenses are co- financed by our Society and the Speakers' employers for travel within the IEEE Region of which the lecturer is a Member. For Speakers who are Members of any one of IEEE Regions 1-6, the speakers' travel expenses are co-financed by our Society and the Speakers' employers for travel to and within any of IEEE Regions 1-6.

Some Bureau Speakers may schedule travel to Chapters in IEEE Regions outside those specified above. These IEEE Regions will be termed 'other' Regions. An example of this is travel for a Bureau Speaker who is a member of IEEE Region 8 from IEEE Region 8 to Chapters within Regions 1, 5 and 6. In this example, Regions 1, 5 and 6 are 'other' Regions. Travel expenses for travel to the first of 'other' IEEE Regions not specified in the above paragraphs (there may be more than one 'other' IEEE Region during any trip), will be co-financed by the Society and the Speaker's company, including the first but no other night's lodging. All other travel expenses within or to 'other' IEEE Regions which occur for the same lecture trip, will not be the responsibility of the MTT-S. Direct return travel expenses from the last 'other' IEEE Region visited during the lecture trip to the Bureau Speakers' home will be co-financed by the Society and the Speaker's company. In no instance will the MTT-S be responsible in 1989 for more than $1,500 travel expenses per topic or for travel expenses in excess of the approved budget mailed May 15, 1989. All Speakers travel expenses not supported by the Society and the Speakers' companies must be supported by the IEEE Regions, or Sections, or MTT-S Chapters visited by the lecturers. This support will require coordination, so all Chapters who must provide this support would do advance planning with their IEEE Regions, Sections, and the other Society Chapters within their Section.

ABSTRACTS AND BIOGRAPHIES

A table that summarizes the 1989 MTT-S Videotape Lectures and Speakers' Bureau information including Speakers' abstracts, biographies, addresses and telephone numbers is shown on page 25.

High TC Superconductivity: Facts and Fancy

By Richard E. Howard
AT&T Bell Laboratories
Crawford Corner Road, Holmdel, NJ 07733

ABSTRACT

With the recent discovery of the high transition temperature superconductors, this formerly obscure field has developed a front page importance. Dramatic and wide-ranging claims have been made for the opening of a new era of technology. Almost every application of electricity or magnetism could benefit from the use of superconducting technology. Examples that capture the imagina-

continued on page 27

SPEAKERS' BUREAU continued from page 26

tion include high speed electronics, levitated trains, power transmission, and high-field magnets for everything from controlled nuclear fusion to pollution control. There is no doubt that an inexpensive, room temperature superconducting technology could revolutionize much of our technological base.

As is often the case, though, reality is more complex. After decades of steady work, the 'old' superconductors are beginning to have an impact in several selected niches, mainly high field magnets, low-noise instrumentation, and medical diagnostics. There is also a good chance that there will be some limited application of a digital electronics technology in the near future based on recent demonstrations of high speed VLSI circuits. Wide-spread application of any of these technologies will be limited by the cost and complexity of systems needed to cool the superconductors to liquid helium temperatures. The new superconductors make the technology more accessible (experiments can now be done on a kitchen table), but the need for cryogenic cooling still limits the applications. A more serious limitation is found in the difficult array of materials problems that must be overcome before any of the high temperature superconductors can be fabricated with good properties in a form (e.g., wire or film) that is suitable for engineering applications.

This talk will present a brief background of the phenomena of superconductivity and attempt to give a balanced account of its potential applications and the problems yet to be overcome.

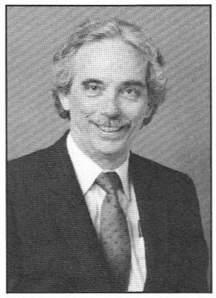
BIOGRAPHY

Richard E. Howard has a BSc degree in Physics from Cal Tech and a PhD in Applied Physics from Stanford University where he studied the transport of refractory superconducting films and layered composites made using e-beam evaporation. He also developed microfabrication techniques for making superconducting electronic devices using these films.

He joined AT&T Bell Laboratories in 1978 where he is now head of the Microelectronics Research Department. His research has been concentrated in the areas of microfabrication, microscience, and thin film technology. The microfabrication work has been centered around high resolution (0.1 micron) electron beam lithography and related technologies including multilevel resists and plasma etching. Device studies have included quantum properties of small-area (0.1 x 0.1 micron) Josephson junctions, silicon MOSFET's with minimum gate dimensions (length or width) as small as 0.02 micron, electron waveguides in GaAs microstructures. He has also applied microfabrication techniques to other fields including optical storage and fiber optics. Currently, he is studying techniques to other fields including optical storage and fiber optics. He is also studying techniques for making thin films of the new high temperature superconductors and exploring the feasibilities of implementing electronic neural network in silicon VLSI.

He is a member of the American Physical Society, the American Vacuum Society, the Materials Research Society, and the IEEE, the AAAS, the Steering Committee of the Electron, Ion and Photon Beam Technology Symposium and member of the Organizing Committee for the Workshop on Neural Networks for Computing.

Membership Development



by Al Estes

NEW MEMBERSHIP OFFICER

Starting on January 1, 1989, Fazal Ali, of Pacific Monolithics, Inc. will be our Society's Membership Development Officer. Fazal accepted this responsibility in order to be able to interact with our Society Members and Chapter Officers to encourage educational programs and continued membership growth. Fazal's primary goal for 1989 is to develop and put substance in a Student Membership Program that will ensure the future of our Society's Student Members, their Chapters, and our Society. The principle objectives of this Program will be to stimulate the growth and technical activities of our Society's Student Members. This Program is planned because the long term well-being of our Institute and Society depends on today's Students who will be next decade's technical leaders and innovators.

1989 MEMBERSHIP DEVELOPMENT OBJECTIVES

- Develop Student Membership Program
- 15 percent Student Membership Growth
- Develop IEEE Senior Membership Elevation Program
- Continue Membership Growth

1988 PROGRESS REPORT

Growth Rate Continues Above 10 Percent Goal

The current Membership growth rate, 10.6 percent, and our Society's growth momentum positions the MTT-S Membership to achieve our Society's growth goal of 10 percent for 1988. The MTT-S membership growth rate (compared to the other 33 IEEE Societies) has been as high as first place, and at the end of November was third place. At the end of November, the MTT-S Membership grew 10.6% when compared to the November, 1987 Membership results. This growth compares favorably to the Institute Membership growth rate of 3.8% and to the Institute Society Memberhsip growth rate of 7.0% for the same period. In addition, at the end of November the MTT-S continued to be the 6th largest IEEE Society with 11,409 active Members. MTT-S was the 6th largest IEEE Society at the end of 1987.

If this large growth rate continues annually, MTT-S will continue to be the 6th largest IEEE Society for many years to come. Furthermore, with a 10 percent growth rate continued for seven more years, the MTT-S will double its Membership and will become the 5th largest IEEE Society.

MTT-S EuMC Membership Booth a Success

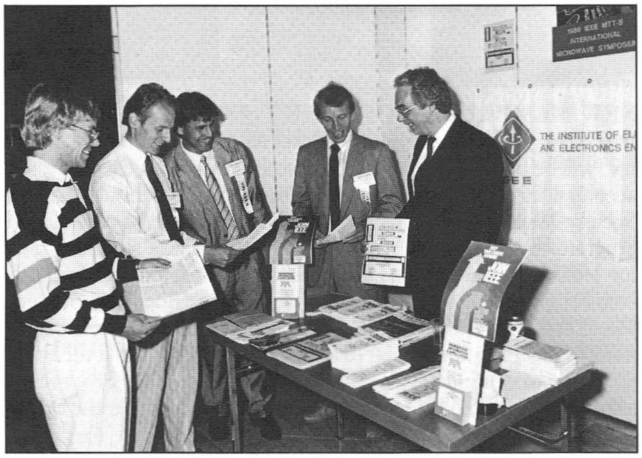
A record 30 new Members enrolled with the Society at the 18th European Microwave Conference. Of this total, 16 Members joined the IEEE in addition to the MTT-S, 8 current IEEE Members took advantage of the free Membership offer by the MTT-S, and 6 delegates enrolled as IEEE Student Members and added a MTT-S Membership for free. The picture shows the enthusiasm these IEEE Student Members had for enrolling with the MTT Society.

continued on page 28

MEMBERSHIP DEVELOPMENT continued from page 27

Also, adding to the booth success was the receiving and servicing of many inquiries concerning current IEEE or MTT-S Members.

The booth was a success because of the enthusiastic involvement of the Officers and Members of IEEE Region 8, the Swedish IEEE Section, and the Swedish MTT-S/AP-S Chapter; and Roger Marriot and Microwave Exhibitions and Publishers, Ltd. who provided the booth space and furniture. Thanks to all who participated in making this year's booth such a tremendous success.



Professor Antti Raisanen, Finland Chapter Chairman, shows West German and Swedish student EuMC delegates and speakers what a pleasure it is to enroll with the MTT Society.

Future EuMC Booths Ensured Success

The long-term objective behind MTT-S sending me to the EuMC in Stockholm was to assist Region 8 MTT-S Chapters to develop the capability to manage and hold future successful Membership booths at other Region 8 conferences such as the EuMC. This objective was accomplished in the following manner:

First, the Swedish IEEE Section and MTT-S/AP-S Chapter showed their excellent management and leadership skills while organizing and supporting this very successful IEEE/MTT-S membership booth.

Second, before I made the trip to Stockholm, Ian Williamson, Chairman of the U.K./Ireland MTT-S Chapter, telephoned me in response to a letter I had sent him. He called to tell me that he will be organizing the booth in London at the 19th EuMC. He met me at the EuMC in Stockholm and confirmed his interests in managing a successful booth at the next EuMC.

Also, Dr. Tibor Berceli, 20th EuMC Chairman, discussed organizing the booth with me and the other Region 8 MTT-S Chapter Chairmen. He decided to organize the booth in Budapest, Hungary in September, 1990. With Dr. Berceli's decision came the wonderful result that two colleagues from IEEE Region 8 have enthusiastically accepted responsibility for managing the IEEE/MTT-S Membership booths at the next two EuMCs. It apepars (partially because of the MTT-S support in sending me to the 18th EuMC in Stockholm, and partially because of the wonderful leadership from the top of IEEE Region 8 through the Region's Sections and MTT-S chapters) we have started to develop an excellent future regarding IEEE/MTT-S membership booths in Europe. It was my pleasure to serve the IEEE and MTT-S in this regard.

Student Membership Drive Underway

The Society's Student Membership goals for 1988 and 1989 were given quite a boost recently. First, MTT-S AdCom voted to continue the FREE MTT-S Membership promotion through February 28, 1990. This promotion enables colleagues to join MTT-S for FREE if they were not a MTT-S Member in the year preceding the enrollment year. Also, our new Membership Development Officer, Fazal Ali, is primarily concerned with creating an MTT-S Student Membership Program.

In addition, 1989/1990 Student Information & Information pamphlets were printed and mailed in December to the IEEE Student Section coordinators of 28 target colleges and universities. The targets are those colleges and universities that have Significant Microwave Programs as designated in John Owens' 1987 survey on Microwave Education. Enrolling Students is challenging since the USA student population is declining. With fewer students graduating, there is less upgrading to higher IEEE Grades by students. Hence a reduction in experienced (Senior) Members could occur in future years if this trend continues. The pamphlets were designed and printed to assist in alleviating this trend in the short term. The future (ten to twenty years from now) health of our Society depends on the leadership derived from today's students who are next decade's experienced technical leaders.

Part of Being a Professional

IEEE & MTT-S Membership

by Alton L. Estes

IEEE Enrollment Fee Reduced By One Half on March 1

Starting March 1, 1989 encourage your colleagues to join IEEE at half the annual rate. This special enrollment fee is for all enrollments received by IEEE prior to September 1, 1989. Those colleagues who enroll using a special MTT-S application pamphlet will receive a **free** 1989 MTT-S membership. Many application pamphlets were mailed to your Chapter Chairman this winter. Ask your Chapter Chairman for the special IEEE/MTT-S applications you can hand to colleagues who will benefit from membership with the IEEE and our Society.

Free MTT-S Membership for Current IEEE Members

Current IEEE Members who do not currently belong to the MTT-S may enroll—**free of charge**. This free membership offer should stimulate your IEEE colleagues and friends to join MTT-S and benefit from the educational opportunities that the Society has to offer. Let your colleagues know about this promotion.

Why Add Members to IEEE and the MTT Society?

The purpose for adding members is to expand a skilled and enthusiastic membership so as to enhance the value, the technical scope, and the effectiveness of the Institute and the Society in achieving the Constitutional Object of the Institute and the Society. One of the most important objectives of MTT-S is to serve the professional interests and needs of those engaged in the use of microwave theory or are using techniques that employ microwave field theory.

continued on page 29

MEMBERSHIP continued from page 28

A major objective of the MTT-S as outlined in the MTT-S Bylaws (Section III, 9.(b)[2] Membership Drive Subcommittee...) is...'promoting the increased membership for the purpose of improved well-being of the Society and the IEEE.' 'Well-being' is the key word and reason for adding members.

The MTT-S Constitution, Section 2, has something to state concerning the Society objectives that relate to 'well-being': 'Its object shall be scientific, literary, and educational in character. The Society shall strive for the advancement of the theory and practice of electronics ... with special attention to such aims within the field of interest of the Society ....'Adding Members to our Society also adds to the numbers of potential papers, articles, or tutorials that will be written that assists in meeting the Object of the Society. Actively pursuing a worthy task, such as increasing membership, that assists the Society in achieving its Object should be taken as improving the 'well-being' of the Society.

Why Should Colleagues Join IEEE and the MTT-S?

Here are some good reasons for joining IEEE:

- To change local, state, and national issues by combining colleagues' voices with other engineers.
- To make contacts outside a colleague's job environment for personal and professional growth.
- To equip colleagues to deal with today's job challenges, non-job oriented experiences are needed.

Here are some good reasons for joining the MTT-S:

Enrolling with the MTT Society will give colleagues the practical, timely, and comprehensive information they need to keep pace in our rapidly changing profession. An MTT Society membership brings with it publications and an awareness of technical conferences, tutorials, and workshops targeted toward the new member's primary technical interests. Adding an MTT Society membership provides an opportunity to interact with professionals of similar interests and to participate in some of the most meaningful and rewarding activiteis of the IEEE and the Society.

Need Membership Applications?

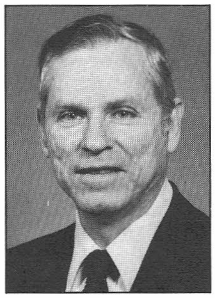
Membership applications were mailed this winter by Bill Hunter to all Chapter Chairmen. These applications reflect the current IEEE membership fees for 1989 and the free MTT-S membership. Please use these applications since they have a tracking code that will allow the IEEE to give the Society a five dollar rebate for each new IEEE member added. If you need more applications, you may photocopy the mailed applications.

Who to Contact

For assistance in adding members, use your 1989 COMMITTEE DIRECTORY of the IEEE MTT-S to find the address and phone number of your Chapter Chairman, the AdCom Liaison assigned to your Chapter, or the Membership Development person, Fazal Ali. In addition, contact Bill Hunter, IEEE Membership Development Support Coordinator, for membership development supplies, brochures, Information Centers, and suggestions that will be a valuable aid in promoting membership. Bill Hunter's address and phone number follow:

Mr. William Hunter, Coordinator
IEEE Membership Development
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331 USA
Telephone: (201) 562-5522

International Liaison



by R.A. Sparks

EUROPEAN MICROWAVE CONFERENCE

The 18th European Microwave Conference was held in Stockholm, Sweden, 12-16 September. The Special Session of U.S. invited speakers included:

A.H. Silver, Microwave and Gigabit Super-Conductive Electronics

C.A. Liechti, The Impact of Advanced Microwave Transistors on High Speed Electronics

R.J. Temkin, Recent Advances in the U.S. Gyrotron Program

At the request of Professor VanderVorst, a Chapter Chairman's Meeting was held between sessions at the EUMC. Al Estes co-chaired the meeting as Membership Services representative and has prepared a separate report on the discussion items.

1989 SBMO MICROWAVE SYMPOSIUM, 24-27 JULY SAO PAULO, BRAZIL

The Call for Papers for the third SBMO International Microwave Symposium/Brazil has been distributed. MTT-S Technical Committees have been requested to assist in the review of submitted papers. Invitations have been sent out to key speakers with the final technical program to be organzied by February 1989.

BEIJING CHAPTER, PRC

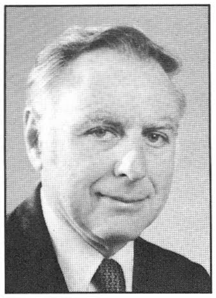
Mr. Xu Yansheng, National Guide for the MTT-S Study Group visit to Peoples Republic of China in 1983, arrived in the United States on 26 September and will be a Visiting Scholar at Colorado State University for the next 4 months. His area of specialty is ferrite devices and would appreciate hearing from anyone interested in arranging technical visits for him. His address and phone numbers are:

Xu Yansheng
500 W. Prospect -5G
Fort Collins, CO 80526
(303) 491-1035 (Office)
(303) 491-0737 (Home)

☐ **The art market** is alive and well. In the last year, the value of old master paintings has climbed 13.4%, 19th century European paintings 14.5%, impressionist and post-impressionist art 109.4%, modern paintings (1900-1950) 100.4%, contemporary art (1945 onward) 21.9%, American paintings (1800-pre-WWII) 37.2%, continental ceramics 27.2%, Chinese ceramics 24.4%, English silver 13.1%, continental silver 29.4%, American furniture 4.0%, French and continental furniture 181.7% and English furniture 21.2%.

Sotheby's Art Market Trends, reported in *Forbes*, 60 Fifth Ave., New York 10011. 26 issues. $42/yr.

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.

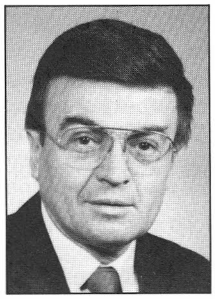
Biography

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.

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 multimode 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.

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.

continued on page 31

LIGHTWAVE COMMUNICATIONS continued from page 30

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.

Technical Committees

by Krishna K. Agarwal

This is the third of a series of reports by the Technical Committees of MTT-S. The purpose is to give the membership a better understanding of the role of the various committees and their activities.

Articles which have appeared so far include:

Committee	Author	Issue
MTT-3	Lee	119
MTT-6	Niehenke	119
MTT-15	Itoh	119
MTT-8	Williams	120
MTT-13	Hord	120
MTT-1	Perlman	121
MTT-12	Berson	121
MTT-17	Temple	122

This issue will feature a description of Microwave Superconductor Applications, MTT-18.

☐ **The best antidote for stress** isn't putting your feet up—it's exercise. *Findings:* Reduced stress levels last only 20 minutes after 40 minutes of rest. . . but last *three hours* after 40 minutes of aerobic exercise.

Study led by John Ragland, PhD, sports psychology laboratory, University of Wisconsin, Madison, reported in *Good Housekeeping*, 959 Eighth Ave., New York 10019. Monthly. $15.97/yr.

☐ **To combat depression,** take two minutes to learn something new—look up the definition of four new words. . . learn to perform a magic trick. . . select a new recipe to try. . . read a few pages of a book. . . speak to a friend (if nothing is new with that friend, call someone else). *Benefit:* Learning energizes and uplifts.

Why Love Is Not Enough by Sol Gordon, PhD, Bob Adams, Inc., 840 Summer St., Boston 02127. $6.95.

1990-1991 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, Society budget and AdCom approval
- 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
- Award made to institution for support of named individual research activity (faculty member, student, 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:

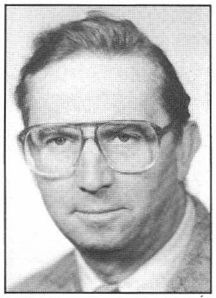
Dr. Jorg E. Raue
Chairman, MTT-S Educational Awards Committee
TRW, Electronics Systems Group, R5/1291
One Space Park
Redondo Beach, CA 90278
(213) 813-8224

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

☐ **Corporations can be as addictive** as drugs. Through various bribes—including benefits, bonuses and promises of power and a better life—a company establishes its importance in employees' lives. *Problem:* Workers rely so much on these bribes that they feel unable to function without the company. . . to move on and try something new. *Treatment:* Similar to any addiction therapy, starting with admitting the problem.

Anne Wilson Schaef, author of *The Addictive Organization,* writing in *New Age Journal,* Box 853, Farmingdale, NY 11737. Six issues. $24/yr.

MTT-18: Microwave Superconductor Applications



by E. Belohoubek

High T_C superconductivity is a new explosive growth area that will lead to applications in many technical fields. Whereas low-T_C microwave superconductor applications have been known and worked on for many years in the past, the necessary low operating temperatures (below 15 K) hindered the widespread use of these materials. The discovery of high-T_C superconductors changed all this drastically and a number of old and new microwave applications may become feasible in the near future.

In recognition of the importance of this new growth area, a Technical Committee on Microwave Superconductor Applications was formed as part of the MTT-Society. The major objectives of the new committee are:

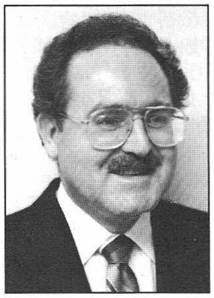
- Provide a focus point for the exchange of ideas relating to the application of superconductivity to microwave components and systems
- Sponsor workshops, panel sessions, focus sessions and special issues related to the microwave characteristics and uses of superconductors
- Both high-T_C and low-T_C superconductor applications will be covered
- Emphasis will be on microwave aspects rather than material chemistry and fabrication processes

Stimulated by the successful workshop at last year's MTT-Symposium in New York, the new committee plans to have a number of superconductor-based activities at the upcoming MTT Symposium at Long Beach. A lunch panel discussion will address the latest state of the art of superconductor materials and their possible application to microwave components. An evening workshop will deal with the microwave characterization of the new materials, their present limitations, and what improvements can be expected in the near future. In addition, two Focussed Sessions dealing with superconductor topics are being planned.

The current membership of MTT-18 is composed of: Erwin Belohoubek (Chairman), David Sarnoff Research Center; Paul Carr, RADC Hanscom AFB; Jerry Fiedziuszko, Ford Aerospace; Moises Levy, University of Wisconsin; Bruce McAvoy, Westinghouse; Martin Nisenoff, NRL; Richard Ralston, MIT Lincoln Laboratory; Arnold Silver, TRW; S. Sridhar, Northeastern University; George Gruner, UCLA.

Suggestions for topics and activities related to this rapidly expanding area that are of interest to the MTT membership should be forwarded to any of the above committee members.

Meetings & Symposium



by Mario A. Maury, Jr.

It is with sincere regret that I have taken over the chair of the Meetings and Symposium Committee from the late Walt Cox who's passing is a great loss to MTT-S. Walt did an excellent job in this capacity and I will do my best to carry on in that tradition.

COMMITTEE MEMBERS

The Meetings and Symposium Committee has been expanded to include more experience and a professional advisory staff so that we can provide better guidance and assistance to present and future Symposium Steering Committees. The following is current membership.

Members	Advisors
Dave McQuiddy	Howard Ellowitz[3]
George Oltman[1]	Larry Whicker[4]
Peter Staecker	
Dick Sparks[2]	

(1) Chairman of the Site negotiating Committee
(2) International Liaison
(3) Exhibition Management
(4) Conference Management

1995 MTT-S SYMPOSIUM SITE SELECTION

At the October 1988 AdCom meeting, Orlando, Florida was approved as the 1995 MTT-S International Microwave Symposium site. Keith Huddleston of Martin Marietta Aerospace, Orlando, Florida will be the conference chairman. The projected dates for the Symposium are May 16-18, 1995.

George Oltman and his Site Negotiation Committee had previously surveyed this site and had given their report indicating that Orlando was an outstanding location for our Symposium. A request had also been received from Denver, Colorado as a prospective 1995 site — however, since it was received late, there was insufficient time for evaluation. The committee has been requested to resubmit for a future year.

FUTURE MTT-S SYMPOSIA

The following is a listing of approved MTT-S International Microwave Symposium sites and their chairmen:

Year	Location	Chairman
1989	Long Beach	C.W. Swift
1990	Dallas	J.W. Wassell
1991	Boston	P.W. Staecker
1992	Albuquerque	J. Hausner
1993	Atlanta	G.P. Rodrigue
1994	San Diego	D. Parker
1995	Orlando	K. Huddleston

continued on page 33

MEETINGS & SYMPOSIUM continued from page 32

Site Selection for the 1996 MTT-S Symposium will be held at the June 1989 AdCom meeting in Long Beach, California. Proposals have been received from San Francisco and Portland. Both sites will be surveyed by the Site Negotiations Committee.

Chapters wishing to host either the 1997 (East or Central) or 1998 (West or Central) are requested to submit their proposals to:

Mario A. Maury, Jr., Chairman
MTT-S Meetings & Symposium Committee
Maury Microwave Corporation
8610 Helms Avenue
Cucamonga, CA 91730
Phone: (714) 987-4715, Extension 200

The Computer Invades Microwave Education

by Tim Healy
Santa Clara University

The digital computer is making ever-increasing inroads into the microwave classroom and laboratory. In a stand-alone form, the computer provides the base for simple as well as powerful circuit analysis software. At the same time the microcomputer is making measurement systems more and more powerful and easy to use. These technologies offer tremendous new resources for teaching, which are only beginning to see application, and which will in time have a profound impact on the way we teach microwaves. Such was the theme of the second annual workshop on 'Modern Technology in Microwave and Communication Education,' held at Santa Clara University, July 18-22, 1988.

The workshop, organized by Tim Healy (Microwave and Communications Laboratory, Santa Clara University) was attended by 19 microwave educators, including one from Canada, and one from Denmark. Participants heard lectures on applications of computers to teaching, and then worked in the laboratory on the appropriate software and hardware.

The workshop led off with a keynote presentation by David White of Hewlett-Packard, foreseeing increasingly powerful instrumentation in the decade ahead, providing even more application challenges to the imagination of the instructor.

Tim Healy then presented a survey of a number of ways to use technology in both classroom and laboratory. This included the introduction of MICROTEMP, a collection of RF and microwave-specific files or templates which can be used within the package MathCAD. This provides the user with the functionality of a hand-calculator, but with much simpler input and output. Used within MathCAD, MICROTEMP provides a very simple approach to complex calculations, and also to graphical demonstrations of concepts, such as impedance traces, coupler directivity errors, effects of parasitics, and many more. Healy believes that this type of application is the next logical tool in the family which starts with log tables, then the slide rule, and the hand calculator.

Les Besser then reviewed the history of microwave CAD, and speculated on future developments. This led to the discussion of a number of EEsof packages.

Martin Grace and Bill Oldfield, from Wiltron, discussed the principles of scalar and vector network analysis, and demonstrated the use of the Wiltron 360 Vector Network Analyzer.

Roger Heintz, from the Rochester Institute of Technology, discussed a network analyzer-based automatic measurement system, and Charles Nelson, from California State University at Sacramento, introduced a novel acoustic approach to the study of waves.

At mid-week, the group journeyed to Santa Rosa, CA to visit Hewlett-Packard's Network Measurements Division. The visit, hosted by Jim Fitzpatrick and Joe Barnhart, included presentations on time and frequency domain reflectometry, de-embedding and calibration, and HP's new microwave software.

Lynn Carpenter, from Pennsylvania State University, and Fazal Ali, from Pacific Monolithics, introduced the subject of microwave monolithic integrated circuits (MMIC), from an educational and an industrial viewpoint.

The workshop concluded with a panel discussion on the appropriate uses of modern technology in education. Panelists included: John Owens (Santa Clara University), Tapan Sarkar (Syracuse University), John Page (Hewlett-Packard), and Michael Anderson (student, Santa Clara University). Everyone agreed on one point. It is essential to understand the basics, the fundamentals, of any field, and certainly microwaves. Less clear is the correct path to that understanding. Some argue that the computer and computer-based instruments can play a powerful role in enhancing understanding. Others believe that the computer can get in the way of 'reality,' hiding it from the learner. At the end of the workshop one thing was clear. There is no obvious answer as to how we should use technology in microwave education, but there are lots of good questions, and they need our attention in the years ahead.

The workshop was supported by the Microwave and Communications Laboratory at Santa Clara University, and by the Santa Clara Valley section of MTT.

Tentative plans are under wway for a third workshop on this emerging topic, for July 17-21, 1989. Organizers are hoping to expand the breadth of planning for this event, and welcome discusions with others interested in this issue. Contact: Tim Healy, EECS, Santa Clara University, Santa Clara, CA 95953. (408) 554-5309.

Second Asia-Pacific Microwave Conference (APMC '88)

By Tatsuo Itoh

The second Asia-Pacific Microwave Conference was held at the Jade Palace Hotel in Beijing, China, on October 26-28, 1988. This is the second in an emerging regional microwave conference series taking place in the burgeoning Asia-Pacific region. The first one was held in New Delhi, India in 1986. The conference was sponsored by the Institute of Electronics, Chinese Academy of Sciences, in cooperation with the Chinese Institute of Communication, IEEE Beijing Section, Southeast University in Nanjing, Beijing University of Post and Telecommunications, University of Electronics Sciences and Technology in Chengdu, and Beijing Institute of Technology. The conference received extensive financial support from the China Natural Science Foundation. The Steering Committee Chairman was Prof. Baowei Lu of the Institute of Electronics. Dr. O.P.N. Calla of the Space Communication Center, India and Prof. E. Yamashita of the University of Electro-Communications, Tokyo, Japan served as Co-Chairmen. Other members of the Steering Committee included representatives from India, U.S.A., Kuwait, and Belgium, in addition to China. The Technical Program

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APMC '88 continued from page 33

Committee consisted of representatives from China, Japan, Hong Kong, India and the United States.

Approximately 230 papers and 29 poster session papers were printed in the proceedings. Foreign participants were aproximately 35. The morning of Wednesday, October 26 was the Opening Session followed by the General Session chaired by Prof. Yamashita. Four invited keynote papers were presented by Dr. Calla (substituted by Dr. Srivastava), Prof. Lu, Prof. T. Yoneyama of Tohoku University, Japan and Prof. Ye Peida of Beijing University of Post and Telecommunications. The conference generally consisted of five parallel sessions for 2 1/2 days. A banquet was held on the evening of October 26. In addition, there were exhibits by Chinese microwave industries and universities.

There was a Steering Committee meeting on the evening of October 27. It was decided that the next conference in 1990 will be held in Japan and Professor Yamashita was asked to initiate the effort. It was pointed out that the publicity of this conference series in the international scene had not been strong and needed rectification. A greater participation from other Asian and Pacific rim countries as well as other parts of the world was strongly desired. The committee has exhibited a very strong determination to nurture this conference series to be accepted as the one with the equivalent status of the European Microwave Conference. The setup of an international committee for continuity and liaison was discussed.

European Superconducting Workshop at the Technical University Braunschweig

October 18-19, 1988

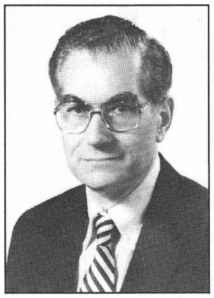
by Nigel Keen
Max-Planck-Institut fur Radioastronomie
Auf dem Hugel 69
D-5300 Bonn 1

The sixth workshop of the West German MTT-Chapter was also the third workshop organised by the Millimeter- and Submillimeter Working Group, and was entitled 'Superconductors at Microwave and Millimeter-Wavelengths.' The six invited talks were:

'SIS-Device Development and Technology' (K.H. Gundlach; IRAM, France)
'SIS-Mixer Technology at Millimeter- and Submillimeter-Wavelengths' (L.R. d'Addario; NRAO, U.S.A.)
'Josephson Voltage Standards' (J. Niemeyer; P.T.B., F.R.G.)
'Frequency Selectrive Detector and Josephson Spectrometer' (J.H. Hinken, T.U. Braunschweig, F.R.G.)
'Present Status and Perspectives for High-T_C Materials' (H. Rogalla, Uni. Twente, Netherlands)
'Passive Superconducting Components and Systems' (H. Chaloupka, U.G.H. Wuppertal, F.R.G.)

Some 50 participants enjoyed excellent talks, extremely lively discussions and the culinary and architectural delights of Braunschweig. The technology and problems of manufacture of SIS, Josephson and high-T_c devices received much attention in discussions, as did experimental results. The presentation of a new quantum theory of SIS-mixing resulted in lively exchanges, whilst disagreement still exists on the subject of terminating impedances for superconducting mixing-elements. The performance of new voltage standards, passive superconducting components and a very broad-band superconducting spectrometer also created lively discussion.

Should anyone wish to obtain the printed version of the talks, please write to Professor P. Russer, Chairman of the West German MTT-Chapter (Institut fur Hochfrequenztechnik, Technische Universitat Munchen, Arcisstrase 21, 8000 Munchen 2): the price is DM 30,-.



Special Session In Honor of Professor Arthur A. Oliner

A special retrospective session in honor of Prof. Arthur A. Oliner of Polytechnic University was held at the 1988 IEEE MTT-S International Microwave Symposium on May 25, 1988, at which many of Prof. Oliner's basic contributions to microwave theory and techniques were summarized in the context of their relevance to present-day needs. This was the first time a session of this type was held at a Microwave symposium.

A summary of Prof. Oliner's major technical contributions, as described by invited speakers at this special session, appears in the December 1988 Symposium Issue of the MTT-S Transactions; for this reason, only some highlights regarding his technical contributions are given below. In addition, some comments relating to personal features of Prof. Oliner's career, made by the various speakers at the special session but not included in the Transactions article, are presented here.

ORGANIZATION OF THE SPECIAL SESSION

The special sesion was organized by Session Chairman Prof. Song-Tsuen Peng (New York Institute of Technology), with the enthusiastic support of the Symposium Steering Committee, the Symposium Technical Program Committee, and the Technical Committee on Field Theory. The session was introduced by Jesse Taub (AIL Division of Eaton Corp.), Co-Chairman of the Symposium Technical Program Committee, who also described his personal experience in successfully applying theoretical results published by Prof. Oliner to a complicated multiplexer problem in strip line, in order to stress that those theoretical results were of great practical value.

Following these introductory remarks, three formal technical talks were presented, by acknowledged experts in the respective areas, that constituted critiques of Prof. Oliner's contributions throughout his long and productive career. They summarized many of the accomplishments themselves, and indicated why they were valuable at the time and in what ways they influence present-day activities. These talks were:

1. 'Perspectives on Guided Wave Phenomena,' by Prof. Tatsuo Itoh (University of Texas at Austin),
2. 'Radiation from Open Waveguides and Leaky Wave Phenomena,' by Dr. Felix K. Schwering (U.S. Army CECOM, Ft. Monmouth, NJ),

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SPECIAL SESSION — OLINER continued from page 34

3. 'Microwave Integrated Circuit Discontinuities and Radiation,' by Prof. Nicolaos G. Alexopoulos (University of California at Los Angeles).

Summaries of the three talks appeared in the Digest of the 1988 IEEE International Microwave Symposium, on pp. 131-143.

After the technical talks, Dr. Kiyo Tomiyasu (General Electric Company, PA) paid a warm tribute to Prof. Oliner, a colleague and friend for over 35 years, and a fellow Microwave Career Award recipient and Honorary Life Member of MTT. Prof. Peng then offered several light-hearted anecdotes about Prof. Oliner's hobbies and life-style, introduced Prof. Oliner's wife, Frieda, to the audience, and then solicited comments from the audience. Kind remarks were made by Prof. Anthony B. Giordano (Polytechnic University), who has known Prof. Oliner well for over 40 years, and by Prof. Paolo Lampariello (University of Rome, Italy), with whom Prof. Oliner has been collaborating closely in research since 1980. the session ended after Prof. Oliver expressed his deep gratitude for the 'many very kind remarks and the warmth behind them,' and stated that the session had been 'an immense privilege and honor' for him.

SOME HIGHLIGHTS OF PROF. OLINER'S TECHNICAL CONTRIBUTIONS

During his long and productive career, Prof. Oliner published about 180 papers and was co-author or editor of 3 books. He made basic contributions in a number of areas, and received many honors and awards for these accomplishments. A few highlights are presented below.

Early in his career, when the printed-circuit waveguide field was also just beginning, Dr. Oliner derived simple closed-form expressions for the equivalent circuits 'for all the practical discontinuities on the center strip, as well as slots in the outer wall, of strip line,' in Prof. Alexopoulos' words. These expressions were widely used in industry, compared very well with measurements, were quoted in handbooks, etc.

His original paper on those strip line discontinuities won the Microwave Prize for him in 1967, twelve years after the paper was published; Dr. Tomiyasu pointed out that this was a unique case—the only time the prize was awarded retroactively. Dr. Tomiyasu also remarked that the paper had been highly praised by several colleagues; he quoted two of them, both famous in their own right: Dr. Seymour B. Cohn, who called the work 'a brilliant application of Babinet's principle,' and Dr. Harold A. Wheeler, who further stated that Prof. Oliner 'has made monumental contributions.'

Another early, significant contribution was the analysis of radiating slots in the top wall of rectangular waveguide. At the special session, Prof. Alexopoulos read the following important tribute from Prof. Robert S. Elliott, the most prominent authority on slot array theory and design: 'Prof. Oliner's work on this subject was a landmark accomplishment. His IRE paper in the AP Transactions in 1957 has been one of the truly seminal contributions to the theory of waveguide-fed slot antennas. Twenty years would pass before any significant improvement in his theory would be achieved. He has been one of our major creative pioneers in this field.'

A third important topic relates to pioneering work on wave types guided by interfaces and layers. Motivated by the various physical effects, such as blackout, caused by plasma layers on reentry vehicles, he examined in depth the wave types that could be guided by plasma layers, and in the process discovered several hitherto unrecognized solutions. These included backward waves (found for the first time on isotropic media), complex spectral waves, and leaky waves, which are complex but nonspectral. These studies were generalized and led to a pair of comprehensive papers coauthored with Prof. Tamir that were published in 1963 in the Proc. IEE (Great Britain). Those papers, which today are considered classics, were then awarded the Institution Premium, the highest award of the IEE, given to Americans for the first time.

Prof. Oliner also engaged in many basic studies involving *periodic structures*. Working together with Prof. A. Hessel, he first showed that a surface wave guided by an open periodic structure would turn into a leaky wave when the frequency was raised sufficiently; that solution was in fact the first *rigorous* solution (1959) for leakage from any periodic structure. They also developed a completely new theory (1965) of Wood's anomalies on optical gratings, which introduced a *guided-wave* aproach, and led for the first time to a correct and physically satisfying explanation for *all scattering resonances*. More recently (1980s) he studied, together with Prof. S.T. Peng, the behavior of waves guided by open periodic dielectric structures; they found that these dielectric grooves, in contrast to metallic grooves, couple TE and TM modes and lead to physical consequences that are different and very interesting.

Several major contributions to antenna theory have been made by Prof. Oliner as a result of his ability to examine certain classes of antennas by viewing them as waveguides in some basic sense. The two most important classes are phased-array antennas and leaky-wave antennas.

As a very important example, he introduced a totally new (waveguide) approach in 1960 to the analysis of *phased-array antennas*, which, in addition to furnishing new insight, presented the first analysis that correctly took into account all mutual coupling effects and showed what happened as a function of scan angle in both scan planes. The approach employed a unit cell with phase-shift walls that change with scan angle; the whole array was thereby reduced to a *single waveguide* with appropriate properties. This same approach was later applied to the explanation of blindness, whereby the array cannot radiate or receive at some angle.

With respect to leaky-wave antennas, Prof. Oliner has probably made more contributions here than anyone else, beginning with systematic transverse resonance analyses during the late 1950s that viewed the antennas as perturbed waveguides, and continuing during the past decade on new leaky-wave structures for the millimeter-wave range. To overcome the higher guide losses and also the greater fabrication difficulties due to the smaller wavelengths, he selected low-loss waveguides as the structures to perturb, devised new methods to control the leakage rate, and proposed and analyzed antennas of simple configuration. As a result, as Dr. Schwering pointed out, these new structures are 'truly novel, with no microwave counterparts.'

Most of these investigations were conducted together with Prof. Paolo Lampariello (University of Rome, Italy) and Prof. Hiroshi Shigesawa (Doshisha University, Kyoto, Japan). Many of these new antennas have been described in two chapters on millimeter-wave antennas, intended for inclusion in two handbooks, on which Dr. Schwering and Prof. Oliner have recently collaborated.

The subject of Prof. Oliner's most recent work, as stressed by Prof. Itoh, is the vitally important one of *undesired leakage effects* in microwave and millimeter-wave integrated circuits, in MMIC configurations, and in high-speed circuits. The (unexpected) cross talk and coupling that result can ruin the performance of a complex, high-density circuit unless the leakage effects are understood and controlled.

The first analysis along these lines (1986) was his detailed investigation, made togetehr with Dr. K.S. Lee, of the properties of higher modes of microstrip line, which were shown to be strongly leaky over a small frequency range just above cutoff. The most recent results (1988), conducted together with Prof. Shigesawa and Dr. M. Tsuji of Japan, concern dominant mode leakage effects in conventional and conductor-backed slot line and coplanar waveguide, for lines of both finite and infinite width. It should be understood that all these leakage effects are in addition to the leakage produced by conversion into surface waves (and space waves if relevant) at various geometric discontinuities.

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SPECIAL SESSION — OLINER continued from page 35

PERSONAL CAREER FEATURES

(1) Prof. Oliner has been at Polytechnic University (formerly Polytechnic Institute of Brooklyn) throughout his professional career, becoming Professor in 1957, at the age of 36, then serving as Department head from 1966 through 1973, and as Director of the Microwave Research Institute for 15 years, from 1967 through 1982. He was also a Visiting Professor at various universities around the world: in Brazil, Japan, China and Italy, as well as the USA. he has also interacted with industry, as a consultant since 1952 to many different companies, and as a member of the Board of Directors of Merrimac Industries since 1962.

His activities with the MTT Society include National Chairman (before the position was called President) in 1959-60, Chairman of IEEE Committee on Antennas and Waveguides from 1959-61, and the first National Lecturer (now Distinguished Lecturer) in 1967-68. His most important MTT-S recognitions are the Microwave Career Award, in 1982, and his election in 1977 as an Honorary Life Member of the MTT Society, where he is now one of only six persons so honored.

(2) Prof. Oliner thinks physically, as all three of the speakers stressed. His approach to new problems is to first try to understand the basic physical phenomena as well as possible before attempting to obtain analytical or numerical results. He looks for possible 'hidden factors,' in Prof. Itoh's phrasing, and then, if he finds any, he makes sure that the analytical approach he selects will take them into account. His strengths also include a mastery of equivalent circuits and the ability to derive simple closed-form analytical solutions.

(3) Dr. Tomiyasu, in his tribute to Prof. Oliner, called him a 'true professional,' a term that he then defined by building upon a submission some years ago to the MTT Newsletter by Robert Rivers, a former MTT Adcom President. 'A true professional,' stated Dr. Tomiyasu, 'generates information, shares it with others, disseminates it, presents papers at conferences, and publishes papers in journals. His work must also have the qualitites of integrity and technical trust. Prof. Oliner exemplifies the role model of a true microwave professional.'

(4) Prof. Peng commented that 'Prof. Oliner is not only a distinguished researcher but also an excellent teacher, a great teacher. I am proud to say that I am a former student of his. he excelled in the theory of guided waves, but his most successful application of his theory is in the guidance of human beings, as a teacher.' Professor Giordano remarked that 'Prof. Oliner has set a standard in terms of teaching integrity.' Prof. Alexopoulos stated that Prof. Oliner had been a 'great teacher to me and my students,' and Prof. Itoh called him a 'role model as a professor as well as a microwave engineer.'

(5) Throughout Prof. Oliner's career he has interacted with colleagues on an international level. he still does so today, collaborating in research with Prof. Lampariello of Italy and Prof. Shigesawa of Japan. Prof. Itoh remarked that 'Prof. Oliner has educated many microwave engineers from Japan. Almost all the leading microwave engineers in Japan have some association with Prof. Oliner.' Prof. Alexopoulos observed that 'Prof. Oliner's impact is international, since he collaborates not only across this country but around the world.'

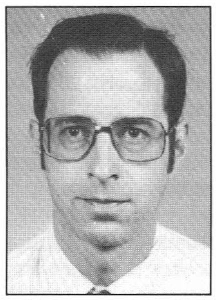
(6) Prof. Lampariello spoke from the floor, saying that he would like to make a point not sufficiently stressed by the preceding speakers. He said he was 'referring to the attitude of Prof. Oliner to be very helpful to people, all people, but particularly toward young researchers who begin to work with him.'

(7) Prof. S.T. Peng, mixing humorous anecdotes with more serious comments, said that 'Prof. Oliner works hard, but also knows how to enjoy life. He is a lover of music, and can be considered an expert on Chinese and Japanese art. Between science and art, it is hard to tell what he enjoys more. As a professor, he has visited many universities, but it is fair to say that he probably visited more museums than universities. Art and science are ordinarily separate subjects, but Prof. Oliner looks at an antique with scientific precision, and does scientific work with the critical eye of a painter; this approach has allowed him to do so much more in a simple and clear way.'

Prof. Peng then paid tribute to Prof. Oliner's wife, Frieda, who 'covered home base while Art was making the hits and runs.' Finally, Prof. Peng thanked the speakers for 'their extensive preparation for this session,' and then expressed his appreciation to Dr. C. Buntschuh, Chairman of the Symposium Steering Committee, Mr. J. Taub and Mr. J. Whelehan, co-chairmen of the symposium Technical Program Committee, and Drs. T. Itoh and J. Mink, previous and present chairmen of the Field Theory Technical Committee, 'for their enthusiastic support in the organization of this special session.'

S.T. Peng
New York Institute of Technology
Old Westbury, NY 11568

Automatic RF Techniques Group News



Raymond W. Tucker, Jr.

The Automatic RF Techniques Group (ARFTG) is an independent professional society that is affiliated with MTT-S as a conference committee. ARFTG's primary interest 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.

33RD ARFTG CONFERENCE ANNOUNCEMENT & CALL FOR PAPERS

The Automatic RF Techniques Group will hold its 33rd technical conference on Thursday, June 15 and Friday, June 16, 1989 in conjunction with the International Microwave Symposium in Long Beach, California. Technical sessions will begin at noon on Thursday. The Awards Banquet will be held on Thursday evening. The ARFTG manufacturers exhibits wil open on Friday morning and the technical session will continue.

The focus topic for this conference is *Microwave Automated Test Equipment as a Productivity Multiplier.* Appropriate papers will describe techniques, both hardware and software, which minimize RF automated test equipment design, development or measurement time. Use of modular hardware and/or software, specialized software development tools, or other techniques to improve productivity could be discussed.

First consideration will be given to papers on the conference topic; papers on other automated measurement and design techniques will be considered if time permits. A post-conference digest will

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ARFTG continued from page 36

be published. The deadline for submission of abstracts is March 15, 1989. Authors wishing to have their paper considered are requested to obtain an 'ARFTG Instructions-to-Authors Kit' by contacting the Conference Chairman:

Mr. Mark Roos
EIP Microwave, Inc.
2731 N. First Street
San Jose, CA 95134
(408) 433-5900

Manufacturers are encouraged to present technical papers and exhibit new products applicable to automated RF techniques. Submit technical papers to the above address. Manufacturers interested in exhibiting their products, contact the Exhibits Chairman:

Mr. William Pastori
EATON Corporation
5340 Alla Road
Los Angeles, CA 90066

Registration material will be contained in the International Microwave Symposium Advance Program available in April.

The Conference fee includes a continental breakfast, lunch and the ARFTG Awards Banquet. Spouses of preregistered ARFTG attendees are invited to the ARFTG Banquet at no additional cost. A post conference digest is also included in the fee. The digest is mailed approximately 90 days after the Conference.

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

32ND ARFTG CONFERENCE HIGHLIGHTS

The Fall 1988 ARFTG Conference was held at Westcourt in the Buttes, Tempe (Phoenix), Arizona on December 1 and 2, 1988. The ARFTG Awards Banquet was held on Thursday evening December 1st.

The Conference was opened with a welcome by Henry Burger from LORAL Defense Systems, who served as the Local Arrangements Chairman. John T. Barr, IV of the Network Measurements Division of Hewlett-Packard and the President of ARFTG welcomed the attendees and introduced the ARFTG Executive Committee. John then introduced the Conference Chairman, Gary Simpson of Maury Microwave who in turn asked the attendees to introduce themselves. Gary then thanked the Technical Program Chairman, Jonathan Schepps from the David Sarnoff Research Center, and the authors for the excellent technical program.

The focus topic selected for this Conference was *Nonlinear Measurement and Modeling Techniques*. Thirteen technical papers were presented at this Conference. The following is a list of the papers presented:

'Principals of Nonlinear Active Device Modeling for Circuit Simulation,' David E. Root, Hewlett-Packard.

'Design Methodologies for Nonlinear Circuit Simulation and Optimization,' Rowan Gilmore, Compact Software.

'New Measurement Techniques for Testing Both Linear and Nonlinear Devices with the HP5753B RF Network Analyzer,' Barry Brown, Hewlett-Packard.

'Nonlinear Measurements Using the Six-port Network Analyzer,' C. Gingras, SPAR Aerospace and R.G. Bosisio, Ecole Polytechnique of Montreal, Canada.

'Developing a Pulsed Vector Network Analyzer - Observations and Experiences,' Mark Roos, EIP Microwave.

'Millimeter-Wave Noise Figure Measurement Techniques and Results,' J.M. Cadwallader, Hughes.

'Automated Millimeter-Wave Systems to Support a WR-22 Band Testing Program,' P.E. Nolan, Lockheed.

'In-Fixture Calibration of an S-Parameter Measuring System by Means of Time Domain Reflectometry,' C. Beccari, A. Ferrero, and U. Pisani, Politecnico Di Torino - Italy.

'Determination of Some Nonlinear Transistor Model Parameters by Using Periodic Time Domain Measurements,' Markku Sipila, Kari Lehtinen, Veikko Porra and Martti Valtonen, Helsinki University of Technology - Finland.

'A Methodology for the Measurement and Nonlinear Parameter Extraction of GaAs FETs,' Larry Lerner and Chuck McGuire, EESOF.

'Large Signal MESFET Parameter Extraction Techniques,' Benjamin Epstein, David Sarnoff Research Center and Zhi-Yuan Shen and Spencer C. Chen, Hypres.

'Nonlinear Measurements of a Microwave Time-Varying Load,' Chia-Lun J Hu, Southern Illinois University - Carbondale.

'Moving the Reference Planes for On-Wafer Measurements Using the TRL Calibration Technique,' Paul Jeroma, Boeing.

On Friday afternoon the group toured the WL Gore facility, and learned the answer to the question - which came first, wire or sports wear?

The ARFTG Exhibits Chairman, William Pastori, Eaton Corporation, assembled 7 vendors for the ARFTG Exhibition.

John T. Barr, IV, the ARFTG President, presided over the Awards Banquet. ARFTG presented its Automated Measurement Technology Award to William Pastori, Eaton Corporation, for his numerous contributions to noise figure measurements. A Mexican-American dance group entertained a the conclusion of the Banquet.

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 automatic 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.

. . . and your diet

☐ **Fattening snack:** Prepackaged microwave popcorn is loaded with fat. *Lowest-fat brand:* Orville Redenbacher's, at seven grams per four-cup serving. *Better:* Pop regular popcorn in the microwave. It's cheaper, too.

Survey by *Medical SelfCare*, Box 1000, Pt. Reyes, CA 94956. Six issues. $17/yr.

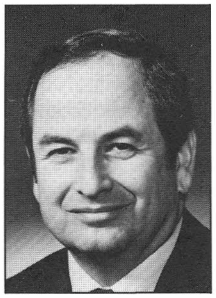
☐ **Eating beef as a side dish** rather than a main dish will allow you to take advantage of its benefits (protein, iron, Vitamin B12 and zinc) and minimize its main drawback (high level of fat).

John LaRosa, chairman of the American Heart Association's Nutrition Committee, quoted in *Longevity*, 1965 Broadway, New York 10023. Monthly. $48/yr.

☐ **To minimize stomach trouble,** avoid caffeine and late-night snacks. . .eat six small meals daily instead of three large ones. . .eat slowly. . .don't take antacids for longer than recommended.

Stephen Stowe, MD, writing in *Mademoiselle*, 350 Madison Ave., New York 10017. Monthly. $15/yr.

Special Articles for the MTT Newsletter



by Zvi Galani

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:

Zvi Galani
Raytheon Company
Mail Stop M1-41
Hartwell Road
Bedford, MA 01730
(617)274-4184

OR

Peter Staecker
M/A-COM, Inc.
52 South Avenue, Bldg. 7
Burlington, MA 01803
(617)272-3000, X1602

This issue features the first part of the article "Monolithic Microwave Integrated Circuits" by Raymond S. Pengelly. The article presents advantages and disadvantages of MMICs, describes active and passive MMIC components, and provides a historical perspective.

Several feature articles are in the process of preparation for future issues of the Newsletter, dealing with the following topics:

- Frequency synthesizers
- Beamed power
- Transmission line transformers

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.

☐ **Dressing for cold weather.** Layer clothing to hold body heat in and keep cold air out. When you are outdoors, wear dark outer colors, which absorb heat from the sun and keep you warmer. When you are indoors, reds, yellows and oranges give a psychological feeling of warmth.

Mississippi Cooperative Extension Service, Mississippi State University and United States Department of Agriculture.

Short Course Announcement

Course Title: Planar Near-Field Antenna Measurements: Theory and Practice

Location: National Institute of Standards and Technology
(formerly National Bureau of Standards)
Boulder, Colorado

Dates: March 6 through March 10, 1989

Contact: Dr. Lorant A. Muth
Antenna Metrology, 723.05
Electromagnetic Fields Division
National Institute of Standards and Technology
Boulder, Colorado 80303
(303) 497-3603

This course is designed for engineers and scientists concerned with the accurate measurement of microwave antenna parameters. The course will cover mathematical foundations of near field to far field transformations, antenna measurement and near field range alignment techniques, as well as near field data analysis and error analysis procedures. Special topics of current importance will also be discussed, and an introcution to the fundamentals of spherical and cylindrical scanning will be presented. Throughout the course both the theoretical and the practical aspects of each topic will be emphasized appropriately. Two visits to the on-site near field range are scheduled to provide a well rounded experience for participants.

Personal Points

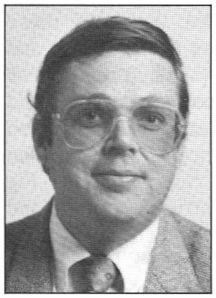
☐ **One more reason to exercise.** Clinically healthy men who have no conventional coronary risk factors but who are not physically fit have a higher risk of heart disease than their physically fit counterparts.

Study by Lars-Goran Ekelund, MD, PhD, and colleagues, Department of Medicine, University of North Carolina, Chapel Hill, published in *The New England Journal of Medicine*, 1440 Main St., Waltham, MA 02254. Weekly. $69/yr.

☐ **Talk yourself to sleep** when you are unable to doze off. *Tell yourself:* It's time for me to sleep. . . I'm ready to relax. . . I feel at peace with myself. . . I am relaxing physically and mentally. . . I visualize a quiet, peaceful place. . . I feel each muscle losing tension and stress. . . My life is good and I deserve to rest. . . Sleep makes me feel good. . . I consciously remove all unnecessary thoughts from my mind. . . I am going to sleep.

The Self-Talk Solution by Shad Helmstetter, Pocket Books, Simon & Schuster, 1230 Ave. of the Americas, New York 10020. $4.50.

Monolithic Microwave Integrated Circuits-Part 1



by Raymond S. Pengelly
Executive Director of Design, RF and Microwave Products
Tachonics Corporation
107 Morgan Lane
Plainsboro, NJ 08536
(609) 275-2550

1. INTRODUCTION

There have been few topics that have captured the sustained attention of the microwave industry so effectively as the development of monolithic microwave integrated circuits. The major microwave communities in Europe, Japan and the U.S. have invested heavily, over the last 15 years, in major research programs in both IC process technologies and circuit design techniques. Monolithic microwave circuits, usually incorporating either field effect transistors or diodes on gallium arsenide, now operate to frequencies as high as 94 GHz at very simple levels of integration while, at lower frequencies, complete subsystems, such as downconverters, are now being manufactured as single chips.

A monolithic circuit is one where all components, both passive and active, are incorporated into a single semi-conductor die allowing complete operation by the application of d.c. and or microwave signals. The main differences from conventional hybrid microwave circuits are:

- Very little wire-bonding and assembly is required;
- All circuit functions can be integrated although in practice simple d.c. biasing, for example, may be achieved with discrete components to reduce the use of semiconductor area for passive elements only;
- The reliability of the circuit/s can be improved owing to the much reduced number of interconnections;
- The size and weight of the circuits are usually much smaller allowing either subsystem size reductions or more complicated functions within the same volume as occupied by a hybrid circuit;
- Simpler packaging schemes can be employed partly due to the reduced circuit sizes;
- Highly reproducible performance provided by batch processing is possible; and
- Circuit techniques can be employed which would either be impossible or very difficult to implement using hybrid technologies.

Although some experimental IC results have been achieved with semiconductors other than GaAs and Si these two materials are the ones towards which most effort has been devoted. Because of its superior mobility and electron velocity properties as a semiconductor and its superior microwave properties as a (semi) insulator gallium arsenide (GaAs) has received the most attention as a substrate for MMICs.

This focus on GaAs follows on from over 10 years of R & D during the 1960's and early 1970's on the semiconductor as a material for discrete field-effect transistors.

Although MMICs have a number of distinct advantages over hybrid circuits there are also a number of potential disadvantages that should be clarified at this point. As with any IC technology, considerable investment is required in manufacturing facilities and staff in order for a company to produce its own circuits. The minimum required investment can be estimated at approximately ten million dollars so it is an option that is only reasonably open to the large system houses. In comparison hybrid microwave circuits can be produced for much less (by, at least, a factor of 10). During the last five years, in particular, therefore many GaAs MMIC (and digital IC) companies have offered their wafer processing services to the industry (so-called 'Foundries') allowing smaller companies to design and have manufactured custom GaAs circuits. A second disadvantage of MMICs is that very little adjustment can be made to the circuits after they have been designed and processed. The design of the circuits themselves, particularly the more complex multi-function ones, requires considerably more sophisticated computer aided design (CAD) hardware and software than 'equivalent' hybrid circuits. This is mainly due to two reasons:

- Much more attention has to be paid to the circuit design to optimize performance and yield; and
- More attention has to be paid to 'parasitic' effects in the circuits due to the much higher levels of integration and closer proximity of circuit elements.

Because of these requirements the development of a MMIC can also be considered more expensive than a hybrid counterpart. Such non-recurring costs are offset adequately, however, where the MMICs are being used in high numbers such as in phased-array radars, expendable munitions, decoys, and 'cellular' and fiber-optic communication equipments.

So much effort has been put into MMIC research, development and, now, production because of the potential huge advantages to be gained in their employment in advanced military and commercial equipments. Even at relatively low frequencies (in the 1GHz (L-Band) frequency range) GaAs is favored over Si for certain applications even though integrated Si devices can achieve the required performance. The most notable advantage is that of superior radiation hardness, both nuclear and space - the reason also that there was considerable activity in the late 1970's in the development of Si FETs on sapphire substrates at L-Band for space-based radar applications.

At higher (millimetric) frequencies integrating Schottky diodes (in the 1970's) and 0.25 micron gate length FETs and HEMTs, (more recently) with passive components is very often, the only viable method of producing the circuits at sufficiently low cost to warrant their use in military systems.

The main areas for the application of MMICs are shown in Table 1. One obvious conclusion from the data displayed is that the larger

TABLE 1
MAIN APPLICATION AREAS FOR MMICs

Frequency Range	Circuit	Application
Up to 100's MHz	Switches Amplifiers Upconverters	Data, radar IFs, Communications, fiber optic comms. TV. Computers
1 to 2 GHz	Switches Amplifiers Downconverters Phase shifters Logarithmic amps.	Data, IFs, Communications Cellular Telephone Positioning satellites Radars
2 to 6 GHz 6 to 12 GHz 12 to 20 GHz 20 to 40 GHz 40 to 100 GHz	Downconverters Switches Phase Shifters Amplifiers Discriminators	TV satellites, Weather radars, Surveillance and tracking radars, Electronic countermeasures, smart munitions, active decoys and jammers. Satellite to satellite links.

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users of such devices are military although there are some commercial applications requiring relatively large volumes particularly in 'consumer' oriented applications such as cellular radiotelephones, satellite receivers (tv, data and positioning) and communications (fiber - optic - cable tv, data and utilities) equipment. It is worth pointing out, however, that at least one of these (satellite tv) has given MMIC production 'a rough ride' to date. Firstly, the 4GHz TVRO (Television Receive Only) market in the U.S. (of which MMIC front-ends make up a small but increasing percentage) de-accelerated very considerably in 1985 with the advent of coded (or 'scrambled') transmissions requiring further decoders. Secondly, the introduction of European DBS (Direct Broadcast from Satellite) systems has been slowed down considerably, both by political and technical problems, effectively before 1990- a market where millions of low-cost 12GHz receivers will be needed.

Before this article continues to provide some examples of monolithic circuits, from an historical perspective and through some milestones to the present day it is appropriate to briefly review the areas of technology and circuit design.

2. ACTIVE DEVICES

As far as GaAs is concerned the main active components that have been integrated successfully into manufacturable ICs are field-effect transistors using Schottky barrier gates (MESFETs), Schottky barrier diodes (used as mixers and voltage level shifters) and to a lesser extent PIN diodes (e.g. refs 1,2,3 and 4).

Although junction FETs (JFETs) and metal-insulator gate FETs (MISFETs) have been employed in MMICs, by far the largest amount of work has been achieved using MESFETs (Fig 1(a)) where a Schottky barrier is used to control the flow of electrons in the transistor channel. Using either epitaxially grown or ion-implanted semiconductor active regions beneath the Schottky electrode, together with short channel lengths, leads to very high frequency performance. N-type dopants are used in both the channel and the ohmic regions.

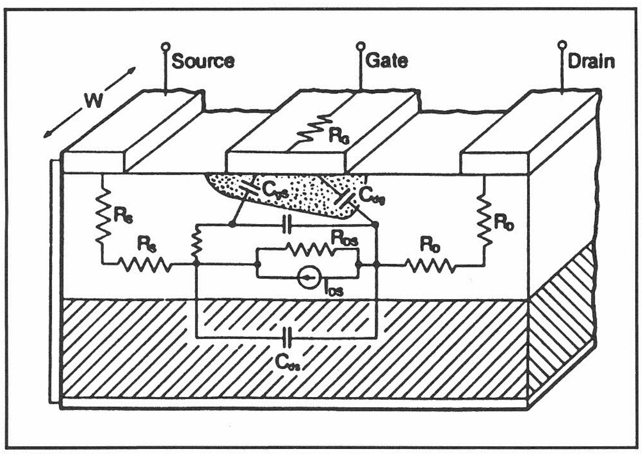

FIGURE 1a.

Typically FETs with gate lengths of 0.5um have useful performance to over 20 GHz and 0.25 μm devices to over 40 GHz. Since the small voltages applied to the gate electrode can control large currents between source and drain the FET is most often considered as an amplifying device having a voltage controlled current generator with an associated transconductance g_m. Normal microwave FETs are so called 'normally-on' or depletion mode FETs where by applying *negative* gate voltage the channel height is decreased so reducing the source-to-drain current. The voltage at which this current has been substantially reduced to zero is called the 'pinch-off' voltage. The current-voltage relationship of a MESFET is shown in Fig 1(b). The gate voltage can only be made approximately +0.7 volts before Schottky gate diode breakdown occurs resulting in excessive gate current.

The FET has associated 'parasitic' resistances and capacitances which limit its high frequency performance. Some of these parasitics can be reduced markedly by proper device design and technological processes. For example, the parasitic resistances between gate and source, which effect the noise figure, gain and stability of the transistor can be reduced by employing optimized ohmic contacts, multiple gate stripes (to reduce gate metalization resistance) and gate recesses into the active channel regions. Fig 1(a) shows the sources of the various FET intrinsic (wanted) and extrinsic (parasitic) equivalent circuit elements whilst Fig. 1(c) shows the full equivalent circuit model for the MESFET used most often in MMIC circuit design.

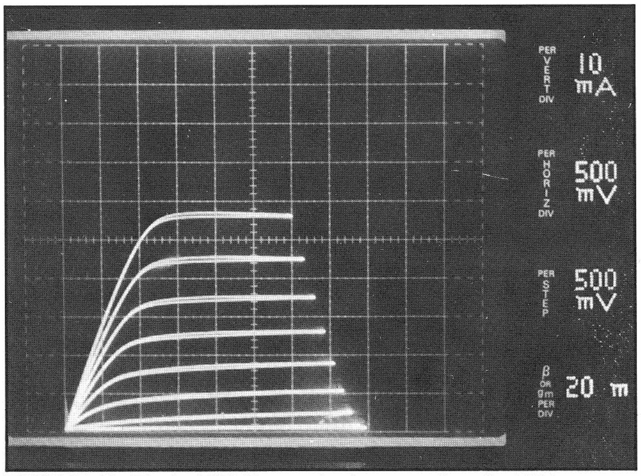

FIGURE 1b. Typical I-V Curves for 1μm gate length, 1200μm gate width power FET.

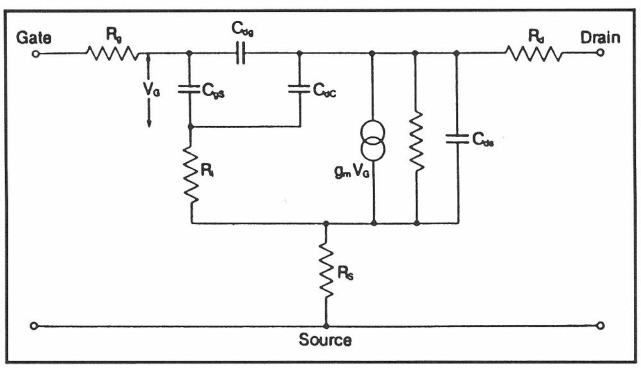

FIGURE 1c.

As gate length is decreased (in the direction between source and drain) gate resistance increases because cross-sectional area decreases. The effective gate resistance can be decreased in two ways, one by increasing the number of parallel gates (Fig 2(a)) for the same total gate width or by increasing the thickness of the gate metal. The latter usually involves the use of special photoresist steps and other processes to produce T or mushroom gates as shown in Fig 2(b) whereby the effective gate length (where the Schottky contact meets the GaAs surface) is maintained but the cross-sectional area of the gate metal is increased markedly (e.g. ref. 5). Decreases in gate resistance quite dramatically improve the high frequency performance of MESFETs. The most popular Schottky metals used for gates are Pd or Pt with Ti used as an intermetalic diffusion barrier to the

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Au that is used almost exclusively elsewhere in the ICs. The Ti-Pt(Pd)-Au system has been chosen for its proven long-term reliability (ref. 6). Ohmic contacts are usually alloyed using the Ni-Ge-Au system (ref. 7) again chosen for its low contact resistance, reproducibility and reliability.

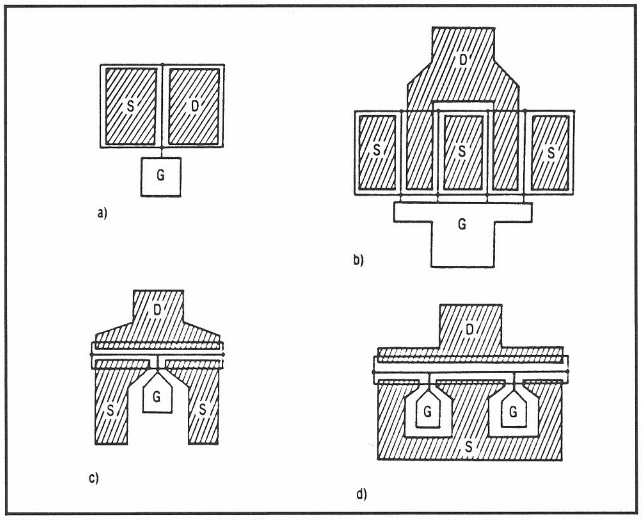

FIGURE 2a. Several FET configurations: a) Single Finger, End-Fed FET; b) Multiple FInger, Interdigitated Gate FET; c) T-Gate FET; d) Pi-Gate FET.

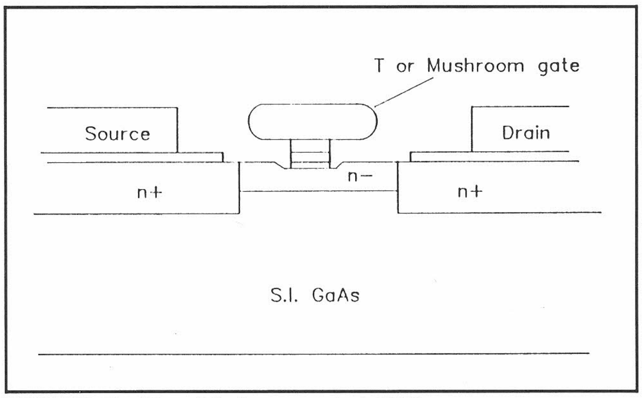

FIGURE 2b. T or Mushroom gated FET.

Unlike discrete transistors where short gold wires or ribbons can be used to connect the gate, drain and source bonding pads to microwave circuits or RF grounds it is often inconvenient to place transistors at the edge of an IC enabling wires to be bonded to ground (Fig 3(a)). Such ground bonds need to be kept very short, particularly at high frequencies, since their inductance decreases the gain of the transistor. In order to overcome this limitation 'through GaAs' vias (holes) have been introduced into many MMIC processes (Fig 3(b)). Since the final thickness of the GaAs IC is usually either 100 or 200 microns these holes, when metalized, can be used very effectively to connect the 'top' of the IC to the metalized 'bottom' of the GaAs - the latter being another feature of MMICs not often encountered in Si ICs unless they use bottom-contact collectors, for example. Fig 4 shows a typical through - GaAs via produced using reactive ion etching of the material (ref. 8). As frequency increases it is necessary to be able to connect the electrodes of a multi-cell FET together effectively. This can be done efficiently using an approach called 'air-bridging' whereby FET sources are connected to one another using

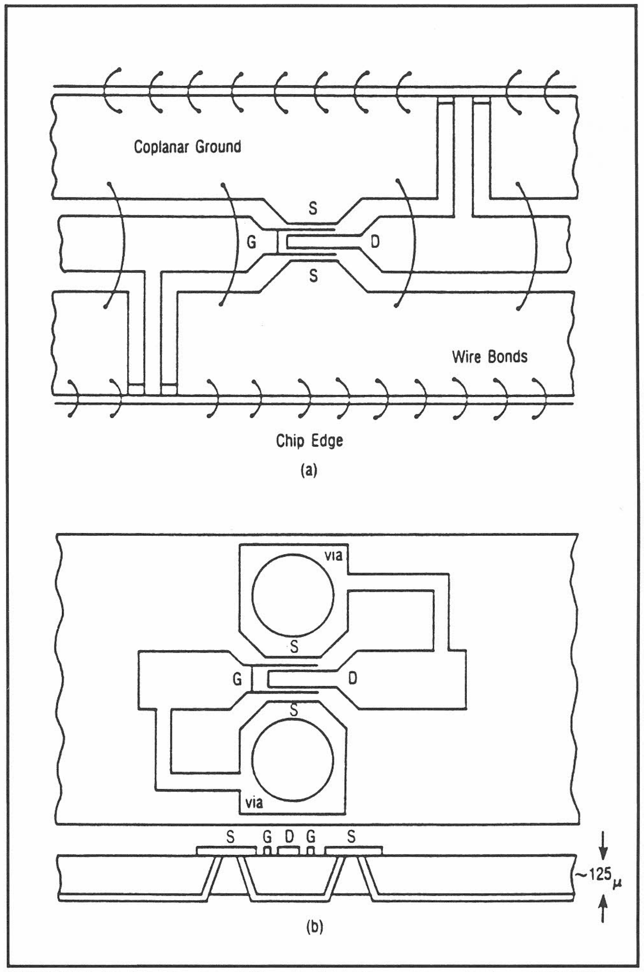

FIGURE 3. Methods of Grounding Components in a MMIC: (a) Coplanar Waveguide; (b) Through GaAs Vias.

plated-gold 'bridges' spanning the channels and drain electrodes with only air between the bridge and the FET itself. Fig 5(a) shows a scanning-electron microscope photograph of such an airbridge interconnected FET. This technology was mainly transferred from discrete power FET production.

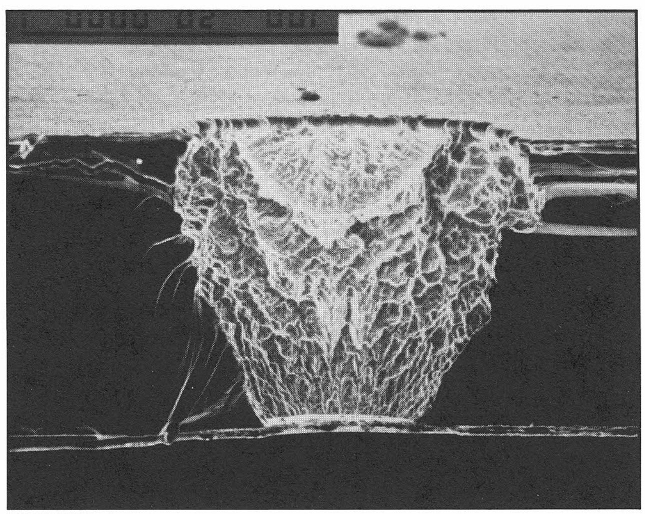

FIGURE 4.

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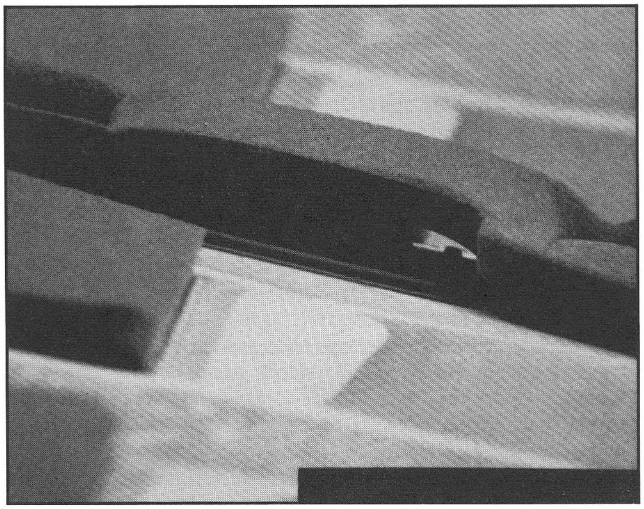

FIGURE 5.

Although most of the design and fundamental technological processes described so far have been directed toward small-signal MESFETs, they apply equally well to power FETs. Currently MMIC amplifiers have been realized giving nearly 10 watts of RF power at around 6 GHz (ref. 9). In order for this to be done efficiently, a number of other features are required in power FET design, which are not needed to the same degree for small-signal FETS. These added features include:

- High channel current;
- High gate-to-drain and gate-to-source breakdown voltages;
- High DC to RF conversion efficiency;
- Efficient heat removal and low channel temperatures.
- Good power combining efficiency.
- Maintenance of high transconductance at high gate voltages.
- Ability to source or sink gate current.

Some of these requirements will now be briefly reviewed.

High breakdown voltages are needed since in normal Class A power FET operation (using a common source FET configuration) the drain voltage will be 10 to 12 volts with a quiescent gate voltage of around - 2 volts allowing the quiescent drain - source current to be approximately 1/2 Idss (Idss being the maximum or saturated drain - source current). When RF signals are applied to the gate, the gate-to-drain sinusoidal voltage peaks may well rise to 16 volts or so. Thus, breakdown voltages somewhat in excess of this are required. High channel currents are needed to ensure that the load-line has a value which is convenient to the transfer of microwave power from the FET to the rest of the circuit (load). The ability of the gate to effectively modulate the channel over a wide range of gate voltages is necessary allowing high power gain. This is controlled by the donor concentration, depth and shape of the epitaxial or ion implanted layers used. Most commercial MMIC processes use ion implanted channels so the reader is referred to refs. 10 and 11 for further information.

A typical MMIC power FET operating in Class A will have a power-added efficiency of 40%

$$\eta = \frac{P_{rf(out)} - P_{rf(in)}}{P_{DC}} \times 100\%$$

up to approximately 10GHz (eg. ref. 10, 11). This power-added efficiency results in considerable heat being produced which, if not removed effectively, will increase the temperature of the active region not only reducing performance (due to decreased mobility) but also reliability. For example, the generation of microwave power at around 500 mW/mm of gate periphery is common place. Assuming that the operating channel current of a 1mm gate width FET is 120mA with an applied drain voltage of 10 volts results in a quiescent dc power dissipation of 1200mW. If the device is operating at 10GHz with 10dB power gain and 40% power added efficiency, the peak RF output power will be 533mW resulting in 667mW being dissipated as heat.

In military systems it is common to have maximum operating temperatures as high as 125 °C. It is generally accepted that channel temperatures in FETs should not rise above 175 °C (for reliable operation) giving a 50 °C maximum channel temperature rise above ambient. Thus, the total thermal resistance between the FET channel (on the top-side of the IC) and the heat-sink (attached 'eventually' to the backside of the IC) should be no greater than 42 °C/watt. Fig. 6 shows a graph of thermal resistance and channel temperatures when operating at an ambient temperature of 90 °C as a function of one of the important physical design parameters of power MESFETs - gate-to-gate spacing in a multi-gate device. This graph compares results for 100μm and 200μm thick die. Reducing die thickness below 100μm is not practical because of the extreme fragility of the material, bearing in mind that 3'' (or now 4'') diameter wafers are used. Since the thickness cannot be conveniently further reduced and since GaAs has poor thermal conductivity (Table 2 gives a comparison for GaAs with Si and alumina) the heat source must be spread over a greater

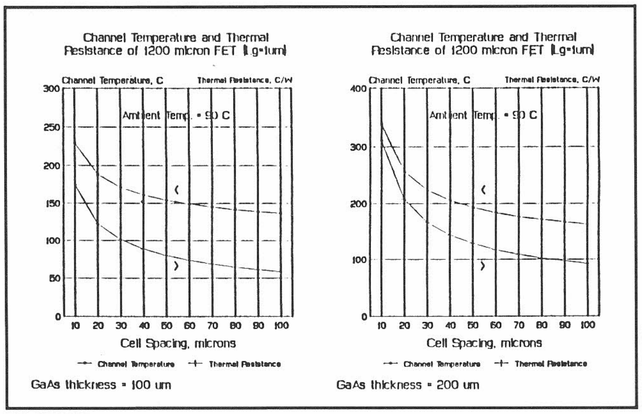

FIGURE 6.

TABLE 2. MECHANICAL AND THERMAL PROPERTIES OF MATERIALS

PARAMETER	Si	GaAs	Al_3O_3	BeO	Al	Cu	Kovar
Dielectric Constant	11.8	13	9.6	6.8			
Thermal Conductivity (cal/cm-s-K)	0.354	0.1	0.07	0.65	0.57	0.95	0.034
Expansion Coefficient (1/K x 10^{-6})	2.62	6.5	6.6	6.3	23.2	16.1	8.4
Young's Modulus (psi x 10^{-7})	23.6		5.4	5.0	1.0	1.92	2.3
Density (g/cm³)	2.33	5.32	3.83	2.9	2.71	8.94	8.37
Band Gap (eV)	1.11	1.43					

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area thus reducing heat density. MMIC amplifiers required to produce considerable microwave power, therefore, use physically larger FETs than their discrete counterparts - Fig. 7 shows such an example.

In addition to the FET device itself the gold-based metalization used for other conductors and the resistive layers (used for resistors) must be capable of passing the high currents required in the transistors with reliable current densities (and low voltage losses for conductors).

FETs are also used extensively as microwave switching devices in ICs as a most viable alternative to the conventional PIN diode used in hybrid circuits. If no voltage is applied to the drain or source of the FET it acts as a low value resistor when no voltage is applied to the gate electrode ('on' state of switch). If the channel is 'pinched off' using negative gate voltage a high value resistor is produced ('off state'). The simplest equivalent circuits of the FET in its 'on' and 'off' states are shown in Fig. 8 where it can be seen that the high frequency performance of the FET, used as a switch, is limited by parasitic capacitances.

Even so, using suitable circuit techniques it has been possible to manufacture excellent low loss, high isolation switches up to 20 GHz using 1 μm technology (ref. 12) and up to 40 GHz using 0.3 μm technology (ref. 13). Switch designs capable of switching RF power levels of 10 watts are now commercially available.

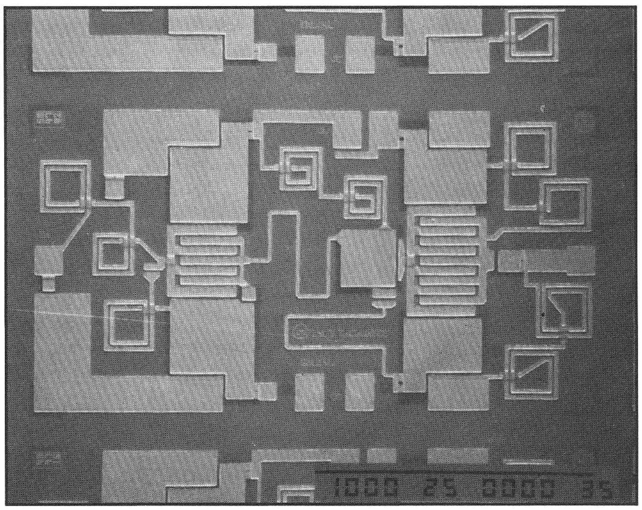

FIGURE 7.

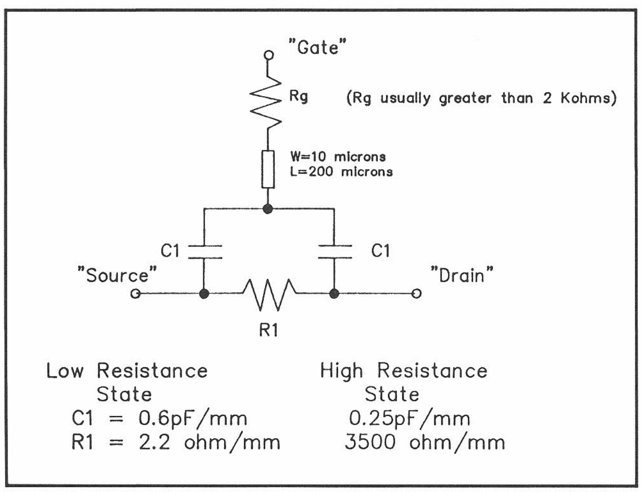

FIGURE 8. Model of 0.5 micron gate length switching MESFET.

Further extensive theory and description of FET production is contained in ref. 14.

IC compatible diodes need to have anode and cathode contacts which are both accessible to the top-side of the die. This is the basic limiting factor in their performance when compared to discrete versions where access to the reverse side of the chip is available. Much work has been achieved with GaAs mixer diodes, in particular (ref. 15 and 16, for example). In such cases the high frequency performance of the diodes is limited by their parasitic capacitance and resistance. The forward resistance of the diode determines to a large extent the 'conversion loss' of the diode as an up-or-down conversion component. The main contributors to this resistance are the ohmic contact and 'bulk' resistances between ohmic contact and Schottky barrier. The latter is substantially reduced by either selective epitaxy or deep ion implantation of n+ donors as shown in Fig. 9. These resistances may also be substantially reduced by 'paralleling' a number of Schottky contacts although this will increase parasitic capacitance. Since a considerable percentage of the capacitance of a diode is due to fringing capacitance owing to the 'feed' to the Schottky contact, this can be reduced substantially by using the same 'air bridge' technology used in MESFETs to connect the diode itself to other circuit elements. Air-bridging has been extended further to the development of the so-called 'multi dot' diode approach (ref. 17) (Fig. 10) whereby the Schottky contacts are produced by a number of dots (approximately 1 μm diameter) rather than fingers (linked by air-bridges) giving lower diode capacitances with reduced resistances leading to higher frequency operation. Such techniques are needed for 'state-of-the art' performance millimeter-wave diode converters. However, much more straightforward processing can be used for diodes that are only used as level shifting devices between dc-coupled FET stages (the reader is referred to ref. 18 for a more detailed description).

Schottky diodes can also be used as switching elements and limiters although little work has been reported for the former function (ref. 19). Voltage-controlled capacitors can be produced by using an optimized FET structure where the source and drain contacts are electrically connected and the gate-to-source and gate-to-drain capacitances are varied by applying 'gate' voltage (ref. 14). Capacitance changes of approximately 8:1 have been produced using such structures and employed in circuits to well over 20 GHz.

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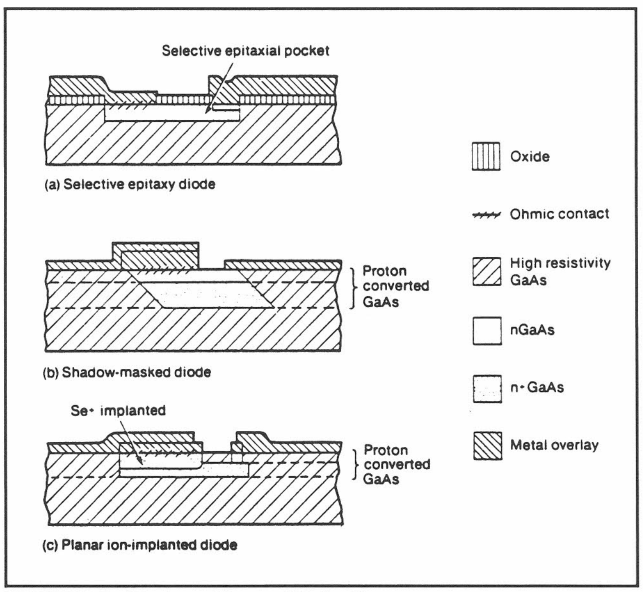

FIGURE 9. Various Planar Diode Structures.

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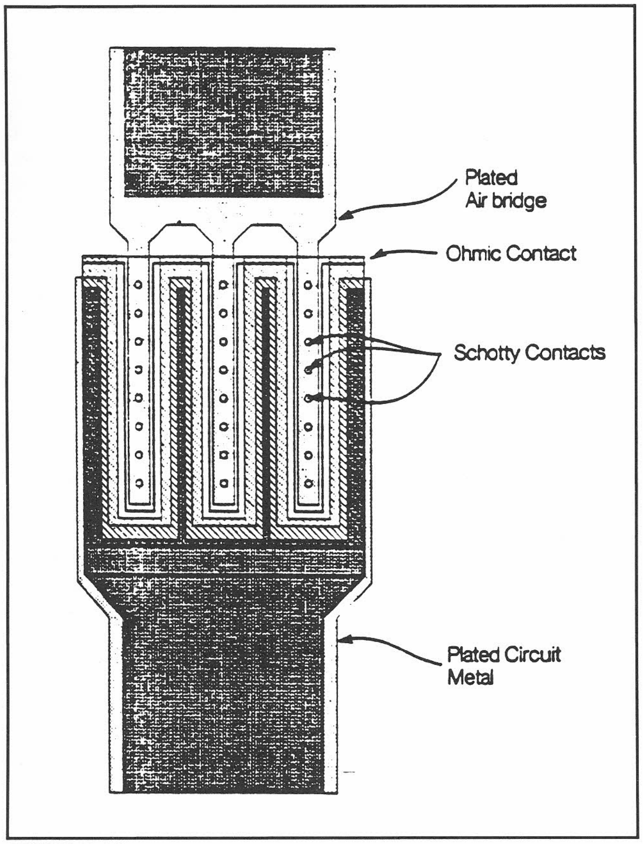

FIGURE 10.

Planar PIN diodes use a rather different technological process to the diodes described above. Like mixer diodes it is necessary to 'bring out' both contacts to the topside of the IC - thus a deep n+ layer is used below the 'I' layer. The n+ and I layers both need to be about 2 μm thick requiring selective epitaxy. The p+ top contacts use a zinc diffusion (ref. 19). Since the construction of such devices is not possible using ion implantation they have not been integrated with FET based MMICs to any significant extent. However, PIN diodes may become useful at millimeter wave frequencies where the technology is more compatible with mixer diodes and they have low capacitance compared to FETs for similar 'on' resistances.

Before reviewing briefly the other major components used in MMIC design, a description of a typical GaAs MMIC process will be given enabling the reader to understand the sequence of circuit fabrication. Fig. 11 is a flow diagram of a planar selective ion implantation process employing air-bridge second level metal interconnects and through GaAs via holes. After qualification of the starting GaAs wafers (normally Czochralski grown material) the wafers are pre-etched and coated with a thin layer of silicon nitride ($Si_3 N_4$) which will act both as an annealing cap after implantation and also as a means of keeping the GaAs surface clean and oxide free. The wafers are then coated with thick photoresist in the areas where no ion implantation is needed and then implanted usually with Si ions using various doses and energies to provide the necessary active region profiles. This implantation, achieved selectively, may be repeated a number of times to produce n-FET channels, n+ ohmic contacts, n-diode areas, etc.

The wafer is then annealed at 850 °C in hydrogen for 15 minutes to remove lattice damage which occurred during implantation. Following this process the ohmic contacts for FETs, diodes and resistors are defined after removal of the annealing cap. After this process the maximum channel currents in FETs, for example, can be monitored by wafer probe and compared to expected values from the implant conditions. The final saturated drain currents and pinch-off voltages of the MESFETs are usually determined by defining the gate in a 'recess' produced by etching into the channel. The deposition of the gate metal also simultaneously provides the first level metalization in many IC processes. Since this metal is usually only approximately 0.5 μm thick it is not suitable as a 'low loss' microwave conductor for other (larger) components. Thus most microwave components will be produced in second level metal. $Si_3 N_4$ is deposited over the active areas of FETs, diodes and resistors to provide both protection and long term uniformity. This nitride layer (or, sometimes, a separate one) is used to provide the dielectric for parallel-plate (or overlay) capacitors. Following definition of such capacitor dielectrics, second level metal is defined providing other microwave components, interconnects and top plates to overlay capacitors. Depending on the exact technology used this metal layer may either be deposited to

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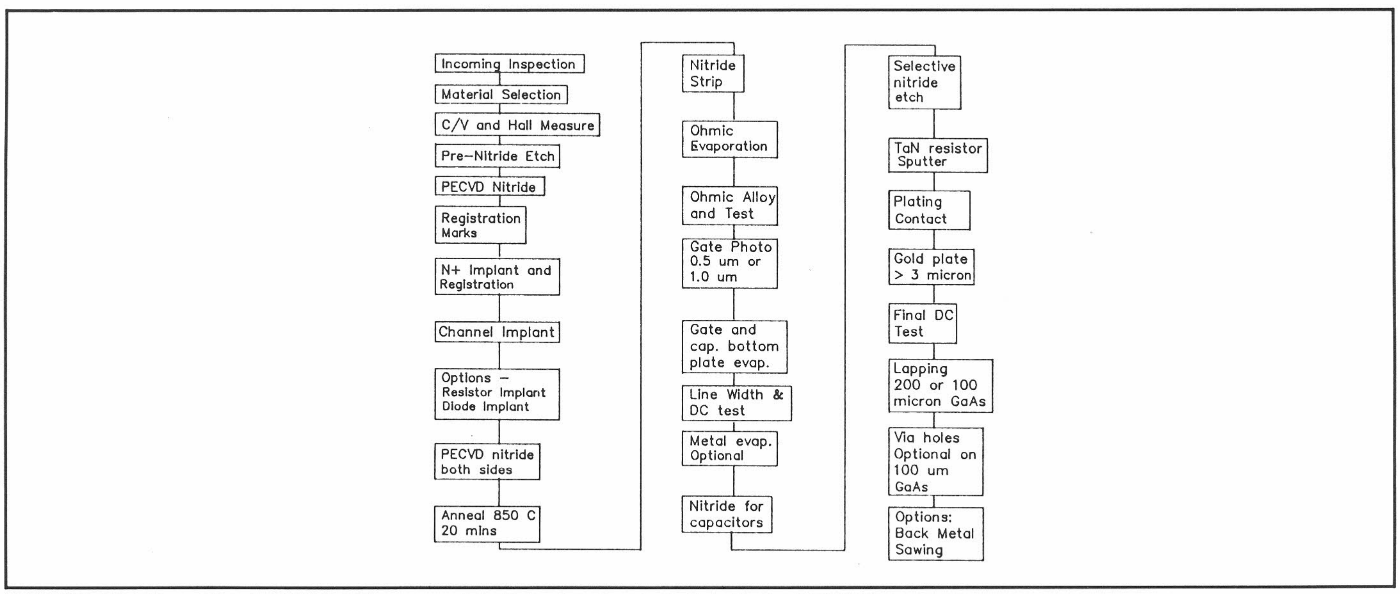

FIGURE 11. Flow Chart of Major Steps used in Selective Implantation GaAs MMIC Process.

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approximately 3 μm thickness and ion-beam milled to define the required structures or be a thin sputtered layer which is then electro-plated to a similar thickness. Air-bridges are formed by depositing a thin layer of gold between the two metal areas requiring connection on top of a thick photoresist layer, plating up the bridge and then removing the photoresist beneath the bridge. All airbridges whether for FETs, diodes or inductors (Fig. 12) are produced simultaneously. At this point the GaAs MMICs can be fully tested at DC by wafer probing.

In some processes further stages are required to implement thin-film resistors and through GaAs vias. Tantalum nitride or nichrome are the most used thin films for resistors where considerable care is needed to provide stable and reproducible resistivity values. Through GaAs vias are produced by etching away the GaAs using either/or a combination of 'wet' or 'dry' etching techniques. Before this can be accomplished the GaAs substrate has to be reduced in thickness from 600-800 μm to approximately 100 μm. Infra red microscopy is usually used to align topside metal with the via positions. Because the etches used are non-isotropic the vias produced are best described as being 'oblique cones.' Following via formation the sides of the vias and backside of the substrate are metallized. These holes usually have average diameters) of approximately 75 to 100 μm.

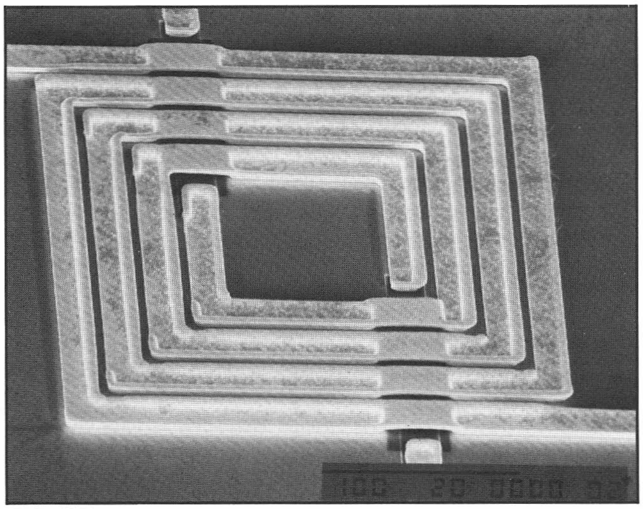

FIGURE 12.

3. PASSIVE COMPONENTS

As important as diodes and transistors to MMICs are passive components such as resistors, capacitors, inductors and transmission lines. Only a brief overview of these will be given here (the reader is referred to a number of texts on the subject - ref. 14, 20 and 21). Resistors are implemented using either ion-implanted layers (usually the n-channel or n+ ohmic implants) or thin films of tantalum nitride or nichrome. A fairly wide range of resistivities is then available covering approximately 50 to 500 ohms per square. Implanted resistors have a high temperature coefficient of resistance (approx. 2500 ppm/ °C) whilst TaN has a low one (-200 ppm/ °C) but because ion-implanted resistors are defined at the same time as FETs and diodes they have tended to become the preferred type.

Capacitors are formed using either overlay structures (so called MIM (metal-insulator-metal), (Fig 13(a)) interdigitated structures (where the capacitance is formed by fringing between the fingers (Fig 13(b)) or by the use of varactor diodes. MIM capacitors have an average capacitance density of approximately 300 pF/mm² for Si_3 N_4 dielectric whereas interdigitated capacitors have a capacitance density of only 13 pF/mm².

Inductors employ either high-impedance microstriplines for low values or spiral structures for values up to approximately 25nH. As the inductance values increase (by increasing the number of turns of the spiral) the resonant frequency of the structure decreases (the frequency at which the inductor becomes capacitive). Fortunately, only high values of inductance are required at low frequencies so such resonant frequencies are usually not a problem. However, as with all components in a MMIC, it is necessary to have complete equivalent circuits (or parameters) for these structures so that their resistive, capacitive or inductive parasitics can be properly accounted for.

Transmission lines normally take one of two forms on MMICs-microstrip and coplanar waveguide.(Fig.14). Microstriplines use single strips of gold metallization on the top surface of the MMIC and depend for their impedance on the strip width and distance from the ground plane which is on the reverse side of the chip. Impedances from approximately 30 to 100 ohms can be readily produced within the limits of convenient chip usage on the one hand and fine line lithography limits and microwave loss on the other. The lines are normally at least 3 μm thick to minimize loss. Since the characteristic impedance of the lines depends on the effective dielectric constant of the GaAs, the impedance varies somewhat with frequency (dispersion) and this is accounted for during the CAD phase.

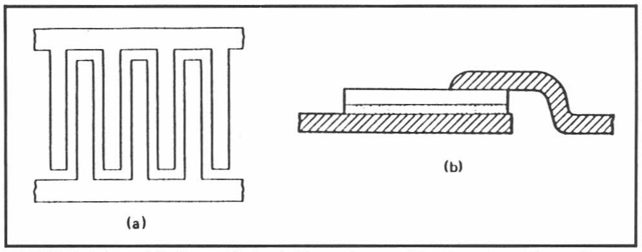

FIGURE 13. (a) Interdigital Capacitor; (b) Overlay Capacitor.

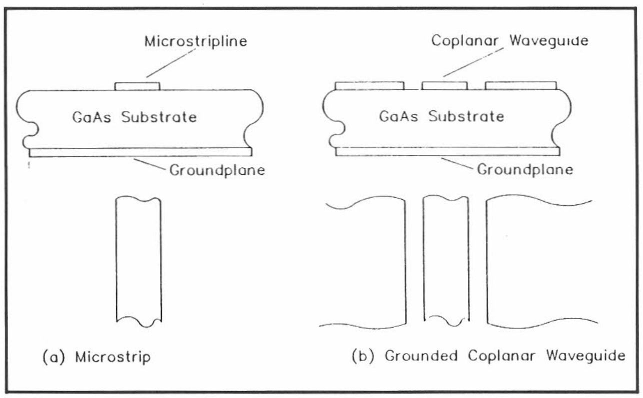

FIGURE 14. Two different transmission lines on GaAs.

Coplanar waveguide (CPW), unlike microstrip, does not require a ground plane on the reverse side although in practice many workers use so-called 'grounded' CPW because it is convenient to have gold-based metalization on the reverse side to aid die attach and, in many cases, decrease the thermal resistance of the IC. The advantage of CPW is that RF grounds can be accessed almost anywhere on the top of the IC without having to connect through to the reverse ground-plane using vias. The characteristic impedance of CPW is determined by the spacing between the signal line and the grounds. In the case of grounded CPW it is also influenced by the thickness of the GaAs.

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4. HISTORICAL PERSPECTIVE

The concept of single-chip microwave functional units was brought about by requests for proposals from DARPA (Defense Advanced Research Projects Agency) and NASA in the late 1970's. The proposals called for advanced subsystems such as TX/RX modules and millimeter-wave receivers to be developed on single chips of GaAs with no internal wire-bonding.

MMICs covering frequencies from DC to over 100 GHz with instantanous bandwidths in excess of 40 GHz have been realized using circuit techniques that would not be possible with conventional hybrid techniques. Demonstrated circuits include small-signal and power amplifiers, oscillators, phase shifters, switches, mixers and multifunction subsystems including single chip TX/RX modules.

The earliest reported work in MMICs was done at Texas Instruments (TI) in the mid-sixties as preparation for and as part of the MERA program for the US Air Force. This program grew out of earlier Air Force programs at Westinghouse to develop 'molecular electronics.' These were to be new materials synthesized to perform some desired circuit function directly, without utilizing conventional circuit components. An excellent account of these early years was given by McQuiddy, et al. (ref. 22).

The first monolithic circuit was a silicon SPDT switch developed by Ertel (ref. 23) at TI in 1965 for application in an X-band T/R module. The circuit used surface-oriented PIN diodes and had an insertion loss of 1.5 to 2.0 dB and an isolation of 25 dB from 8 to 9 GHz. Also in silicon was a monolithic X-band mixer reported at the 1966 International Solid-State Circuits Conference (ISSCC) by Portnoy and Hyltin (ref. 24) in which an active layer of selectively grown epitaxial silicon was deposited into etched pockets in a high-resistivity substrate. These early circuits suffered from problems related to the low resistivity of the silicon substrate material after processing and to the complexity of the process being used.

GaAs was proposed as a semiconductor substrate material for MMICs in 1964 by Uhlir (ref. 25). In 1966, Hyltin from TI patented a 94-GHz MMIC receiver consisting of a Gunn-diode oscillator, a multiplier, and a balanced mixer all formed on GaAs. This work was published in 1968 by Mehal and Wacker of TI. The process used selective epitaxial growth of GaAs in etched pockets in the semi-insulating material to produce the n+/n−/n+ structure for the Gunn diode and the n on n+ layers for the Schottky barrier diode. This is an aggressive process technology even today; in 1968 it was too complex to deliver good-quality, reproducible results.

Based on its previous work on FETs, Plessey received funds from the British Ministry of Defence in 1973 to develop a GaAs monolithic integrated circuit amplifier. This led in 1974 to the first GaAs MMIC amplifier, which had 3-dB gain and a 10-dB noise figure at 10 GHz. By 1976, Pengelly and Turner (ref. 26) published results on a monolithic single-stage amplifier with 4.5-dB gain and a 6-dB noise figure from 7.5 to 11.5 GHz. These early amplifiers used interdigital capacitors for RF matching and off-chip overlay capacitors for bypassing. Grounds were achieved using gold mesh over the chip edges, since via holes had not yet been developed.

In the US, DARPA funded Westinghouse in March 1978 to develop 5-to-10-GHz power amplifiers based on 3-in. diameter Czochralski-grown GaAs and direct ion-implantation. Even at this early date, this program was designed to develop a high-volume, inexpensive process and ignored other material technologies, such as vapor-phase epitaxial (VPE) growth, which were more advanced and would have provided better microwave results. The first amplifier developed on this program was designed for a 10-percent bandwidth using interdigital capacitors and over-the-edge grounding; results were published in 1979 (ref. 27).

The amplifier designed by Pucel, et al. (ref. 28), of Raytheon was a one-stage amplifier that delivered 400 mW at 9.5 GHz on a 200-x-250-mil chip and was the first MMIC to use via holes to achieve source grounding. This amplifier was developed as part of a proposal effort and went from conception through RF test

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TABLE 3. MMIC MILESTONES

EVENT	YEAR	DESCRIPTION	COMPANY
FET proposed	1952	Shockley	Bell Labs
Patent on MMIC	1964	Mixer on GaAs for MERA	TI
First MMIC	1965	Si PIN switch	TI
First GaAs FET	1966	Schottky-barrier MESFET	CIT
First Microwave FET	1970	1 μm gate, f_{max} = 30 GHz	IBM
First FET amplifier	1972	Hybrid	IBM
First MMIC amplifier	1974	5 dB gain, 8 to 12 GHz	Plessey
First MMIC power amplifier	1979	10 dB, 1.25 W, 9.5 GHz	TI
SPDT switch	1980	0.5 dB loss, 40 dB isolation, 8 to 11 GHz	Raytheon
RF generator	1981	Mixer/oscillator/amplifier	HP
Oscillator	1981	13 GHz, 8 mW, 4 percent efficiency	Plessey
Mixer	1981	31 GHz diode, 12 dB noise figure	MIT
Broadband amplifier	1981	2 GHz BW, low-noise, first commercial GaAs IC	Siemens
VCO	1982	10 mW, X-J band	TI
Traveling-wave amplifier	1982	5 dB gain, 1 to 13 GHz	Raytheon
Vector Modulator	1982	S-band, 360 deg., analog	Plessey
4-B phase shifter	1982	Single-chip, X-band	Raytheon
Multichip T/R Module	1982	X-band amp/phase shifter/T/R switch	Raytheon
Power amplifier	1984	25 dB conversion gain, 4.5 dB noise figure	LEP
MM-wave oscillator	1984	69 GHz 0.25 μm FET, 1 mW, 1 percent efficiency	Hughes
S-band T/R module	1984	LNA/phase shifter/power amplifier	Plessey
Volume production	1985	MMIC receiver	Pacific Monolithics
First HEMT MMIC amplifier	1986	X-band single stage amplifier	Thomson

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in three weeks. In 1979, TI also demonstrated a four-stage X-band amplifier that developed over 1-W with 27dB gain from 8.6 to 9.2 GHz. This amplifier, fabricated on both VPE and direct ion-implanted layers, also used off-chip by-passing and over-the-edge grounding (ref. 29).

In 1979, DARPA funded Raytheon and TI to develop X-band TX/RX modules using GaAs ICs. It also contracted with Raytheon and GE for development of L- and S-band TX/RX modules using silicon on sapphire technology. Both of the lower frequency circuits were eventually modified to use GaAs circuits. The prospect of airborne arrays with 1000-to-2000 active elements, ground based arrays with 10,000-to-20,000 elements; and space-based radar with 100,000 or more modules spurred a number of radar system houses in the US and Europe to begin MMIC development in earnest. Each company selected components and frequencies of importance to their current and projected radar business and tended to concentrate their MMIC development activities around these. One of the more challenging components that required development for module applications was a broadband phase shifter with good amplitude and phase characteristics. Since the pointing accuracy and sidelobe levels of the radar system are determined by the phase and gain accuracy of the modules, the components must either be inherently accurate and flat with gain and temperature or else compensation and calibration schemes must be devised to correct for their errors. MMIC phase shifters have been developed using power FETs to switch line lengths or high-pass/low-pass filters, using dual-gate FETs as switched amplifiers, or using vector modulation schemes. Early efforts concentrated on switched-line length designs and were, generally, too large to be economical.

As CAD techniques and lumped-element modeling improved, compact phase shifters with good performance and small size emerged. Two phase shifters from Raytheon illustrate the dramatic size reductions available with lumped-element design. A 4-bit phase shifter used switched line lengths and loaded line bits and occupied a 6.4-x-7.9-mm chip. The smaller circuit utilized low-pass/high-pass filters, which incorporated the FET switch parasitics into their design. Equivalent performance was obtained with 6:1 improvement in chip area.

Another approach to phase shifters that has received much attention is the vector modulator. In this design a pair of controllable amplifiers or attenuators are driven 90 deg. out of phase and the outputs are connected in parallel. By varying the gain of the respective gain stages, any phase shift between 0 and 90 deg. can be obtained. In particular, GE has presented phase shift results using a novel segmented dual-gate FET operated as a variable attenuator.

By switching various segments of a large dual-gate FET, a steppable S_{21} is obtained. The 90-deg. phase difference is provided by an all-pass filter. This design is interesting because the phase shift of the circuit is independent of the absolute S_{21} of the FET, since it is the relative widths of the switched FETs that determine the gain differences between the two channels. Octave bandwidth performance with phase shift flat to ± 1 deg. has been reported.

While the bulk of MMIC development funding has gone into TX/RX modules, a large number of other interesting and novel circuits have been developed in the area of broadband circuits, receivers, low-frequency electronics, and millimeter-wave circuits.

Of all of the MMIC circuits developed to date, perhaps the most interesting is the distributed amplifier (Fig 15). Developed in the 1930s for broadband triode circuits, the distributed amplifier utilizes a number of amplifying elements positioned periodically between input and output transmission lines. The device parasitics, normally matched using conventional filter techniques, now become part of an artificial transmission line that exhibits low-pass

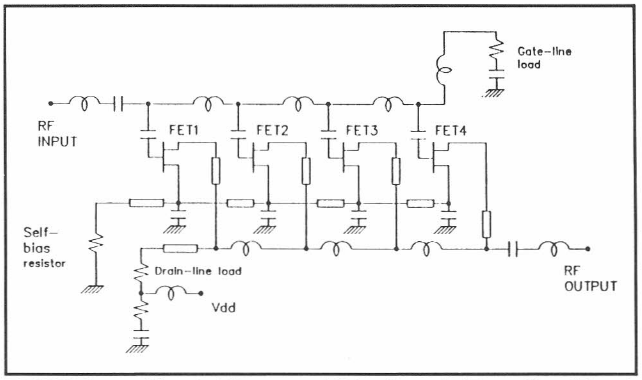

FIGURE 15. Circuit Diagram of Distributed (Travelling-Wave) Amplifier.

characteristics. Using this approach, small-signal and power amplifiers with greater than decade bandwidths have been demonstrated with upper cutoff frequencies greater than 50 GHz.

With the advent of dual-band radars, shared-aperture radars, EW systems, and disposable active decoys, wideband amplifiers, in particular, have become increasingly important. The first MMIC distributed amplifier was presented by Ayasli, et al., in 1982 (ref. 30). It consisted of four common-source 300-um FETs connected with high impedance transmission lines on a 2.5-x-1.65-mm chip. Source grounding was accomplished using via holes. A gain of 9 dB was achieved from 1 to 13 GHz.

Since this first paper was published, there have been dozens of versions of distributed amplifiers. Major improvements have come from the use of 0.5- and 0.25-μm gates to achieve gain through 50 GHz, dual-gate FETs to increase the reverse isolation of the device and to achieve higher gain per stage, and novel gate matching structures and drain combining techniques to achieve around 1-W output power over a wide band. Some particularly important - MMIC milestones are given in Table 3.

Part II of this article will include several examples of MMIC's, projections for the future of the GaAs IC industry and the effects of the U.S. DOD MIMIC program on the manufacturability of MMIC's.

RAYMOND PENGELLY

Mr. Raymond Pengelly was awarded a BSc and an MSc in Electronics in 1969 and 1973 respectively, from Southampton University. Mr. Pengelly joined Tachonics Corporation in November 1986 as Director of MMIC Design. He came from Plessey Research in England, where he was Technical Research Executive, responsible for the design and development of MMICs and GaAs FETs as well as advanced development of HEMT and HBT devices. He has been program manager and technical director on a number of British Government programs including S-Band phased array modules incorporating a MMIC chip set as well as advanced downconverters at C and Ku-bands.

Mr. Pengelly has authored over 60 papers on microstrip, FETs and MMICs and has written and edited two books on FET and MMIC technology. He gives lectures and tutorials on low-noise and power FET amplifier designs as well as on MMIC engineering. He is a recognized authority on MMIC development, co-authored the first paper on an MMIC amplifier, and lectures widely in the field. He is a Member of the IEEE and a Fellow of the Institution of Electrical Engineers. He was a member of the European Microwave Conference, and has chaired a number of sessnions at that meeting. He is presently a member of the technical program committee of Military Microwaves, a member of MTT-S Committee 12 on microwave packaging and a member of the technical program committee for the IEEE GaAs IC Symposium.

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What's Your Message?

by Cheryl Reimold
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Scarsdale, NY 10583
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Imagine biting into a jelly donut and finding no jelly. Or opening a birthday card and finding no signature. How would you feel? Disconcerted? Frustrated? Maybe even angry?

That's what happens to people who are forced to read memos and reports that have no clear message. And it happens in business all the time. In all the letters, memos and reports I see, the greatest problem is lack of a clear main message. A technical report gives the details of a project but doesn't explain the significance of these details, or of the project itself. A memo announces a meeting but doesn't say why the reader should attend. In both cases, the writer omitted a crucial step in preparing his draft; he didn't ask himself why he was tellilng this reader these things.

What readers want — and what writers do

A memo is delivered to your desk. As you pick it up, what are the first thoughts that go through your mind? Don't read on for a minute. Close your eyes and think about it.

Was your answer something like: 'What's this about'? Is there anything of interest to me in it?' Those are the two questions busy people want answered right up front. The answers constitute the writer's main message. If you provide those answeres consistently in your first paragraph, you will be a prized member of your organization for you'll be one of the few who make their message clear.

Everyone wants other people to state their message clearly, up front. But most of us are reluctant to do so ourselves. Why? I think we're afraid the reader won't read on if he knows what it's all about. Better to keep him guessing, we reason. At least that way we'll keep him reading!

Don't try to delude people into reading something you think won't interest them. Instead, think of something about your topic that will interest them, then state up front what you have to say and why they'll want to know about it.

Find your mesage

Your message consists of your answers to two questions; answer them before you start writing. Write out your answers in complete sentences — any other way won't work:

1. What do I want to tell them (him/her)?
2. Why would it interest them?

Your answers should appear in your first paragraph.

In my writing classes, I often do a dialogue with the students to help them find and state their message. You can do a similar dialogue in your own mind. It goes somethig like this:

T(eacher): Imagine I'm your reader. What do you want to tell me?

S(tudent): About the safety seminar next week.

T: A complete sentence, please, with the relevant information.

S: There will be a safety seminar in the conference room next Wednesday at 9 a.m.

T: Right. But the safety seminar is the subject of your memo. What do you want to tell me about it?

S: Well, I want you to come to it.

T: Why should I? What would interest me there?

S: You'd learn how to avoid serious accidents in the lab. We're going to explain what can happen and show people the safety equipment they should wear when entering certain rooms.

T: Good. So, what;s your message? Remember, it includes what you want me to know and why it'll be of interest to me.

S: Okay, here goes. 'Come to the safety seminar in the conference room next Wednesday at 9 a.m. You'll learn what safety equipment you need to wear to avoid serious danger in some rooms in this lab.'

T: There's your first paragraph. Great. Here's another example, for a memo reporting test results. What do you want to tell me, your reader, in a whole sentence?

S: I have the results of the tests you wanted us to run.

T: Okay. Anything of particular interest to me in these results?

S: Let's see. Yes, they show that the uneven caliper on Sample B is probalby a result of an improperly maintained swimming roll in the press section.

T: Fine. How will you state your message, then?

S: 'Here are the results of the tests you asked us to run. They suggest that the uneven caliper on Sample B is probably a result of an improperly maintained swimming roll in the press section.'

T: Great. As your reader, I'd appreciate knowing that right away, before I get to the tables.

Before you write, ask: What's my message? To get it, answer these two reader questions: what do you want to tell me; why would it interest me? The answers are your message. Put it in paragraph one. Your readers will love you for it.

Book Review

Notes on Microwave Circuits Vols. 1 and 2,

Darko Kajfez, published by Kajfez Consulting, Oxford, MS. Vol. 1, 1984, 381 pp., $35; Vol. 2, 1986, 285 pp, $32.

As the title and preface indicate, this book consists of two bound sets of lecture notes prepared for a graduate course taught by Prof. Kajfez at the University of Mississippi. A review of the contents shows that the level of presentation is definitely appropriate for graduate studies. In order to understand the material, the reader's background should include a two-semester course on electromagnetic theory with substantial coverage of transmission-line concepts. Unfortunately, many undergraduate programs only provide a one-semester course with minimal coverage of transmission-line theory. Readers with this limited background will, I believe, have some difficulty in understanding the introductory material in the first volume.

Volume one consists of five chapters. It starts with a study of guided electromagnetic waves. The next two chapters cover the analysis of one-port and multiport networks. The relationship between the electromagnetic field and the network parameters is clearly presented. As expected, the impedance, admittance, and

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scattering matrices are used to characterize the networks. A detailed discussion of the numerical methods used in the analysis of cascaded two-port networks concludes the first volume. Most of the methods described are based upon the chain matrix formulation.

The second volume contains three chapters. Topic coverage consists of flow graphs, multiconductor lines, and filters. The chapter on flow graphs includes a study of error corrections for the automatic network analyzer, a very practical application. Commensurate-line filters and applications of Kuroda's identities are covered in the final chapter. The effect of dissipation on loss characteristics is discussed briefly. As in the first volume, the technical presentation is well done. Because of the general approach used throughout, the analytical techniques can be applied to a variety of important microwave problems.

It is this reviewer's opinion that such fine technical material should have been published in a professionally finished form. As the author indicates in the preface, the text is a direct reproduction of unedited class notes. As such, there are many printing errors that most readers will find disconcerting. For example, the print used is inconsistent, inserts are handwritten, words are misspelled, pages are repeated, and in some cases, the meaning is unclear (e.g., 'Due to conductor thickness t, the capacitance of the conductor was infinitely thin.'). Although the notes are useful in their present form, such fine material deserves better treatment.

Some suggestions are in order if the author decides to publish the material in finished form. First of all, the two volumes should be combined into a single textbook. Next, some of the chapters should be rearranged. For example, it seems that flow graphs (Chap. 6) should be placed immediately after multiports (Chap. 3). Finally, the text should be expanded to cover the important topic of waveguide circuits. This might include waveguide filters, circular polarizers, and hybrid junctions. A discussion of periodic structures would also be appropriate.

In summary, Prof. Kajfez has done a fine job in developing these comprehensive notes on microwave circuits. I am sure that they will be of use not only to those engaged in graduate studies, but to practicing microwave engineers as well.

Reviewed by Dr. Peter Rizzi

Dr. Peter Rizzi is a Professor of Electrical Engineering at Southeastern Massachusetts University in N. Dartmouth, Mass. He is author of "Microwave Engineering—Passive Circuits," published by Prentice-Hall, Inc. His research interests include microwave filters, ferrite components, and semiconductor device applications.

☐ **For a better visit to the doctor,** come with three questions about your condition. Patients who think through their concerns report less anxiety...feel more in control...and are more satisfied with their visits to a physician.

Herman Feiffel, PhD, chief psychologist at the Veterans Administration, Outpatient Clinic, Los Angeles, and clinical professor of psychiatry and the behavioral sciences, University of Southern California.

☐ **Taking a nap** to *prevent* sleepiness (prophylactic napping) is more effective at maintaining alertness than napping for *lost* sleep. *Application:* Take a nap before you have to stay up all night for work. You won't feel less tired but you'll enhance your performance.

Researchers at the Institute of Pennsylvania Hospital and the University of Pennsylvania School of Medicine, cited in *New Age Journal,* 342 Western Ave., Brighton, MA 02135. Six issues. $24/yr.

Microwaves in Brazil: Significant Research and Development Activites

by Alvaro Augusto de Salles

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INTRODUCTION

Significant R&D work in microwaves in Brazil started in the mid 60's, simultaneously with the installation of the national terrestrial microwave network. Since then and especially due to the effort of some groups and government support, R&D programs have been growing in universities and in some research institutes. In 1976, the TELEBRAS (Telecomunicacoes Brasileiras S/A) Research Center (CPqD/TELEBRAS) was created and among other objectives, the following was emphasized: (i) to perform R&D in several areas of telecommunications; (ii) to coordinate the support to Universities for applied research in selected areas of telecommunications; and (iii) to stimulate the installation of R&D centers in the industry and the transfer of the relevant technologies to Brazil. This scheme is naturally centralized and has shown some benefits and weaknesses. In universitites most of R&D programs are supported by TELEBRAS and FINEP, which is a Brazilian Government Agency. Some R&D programs in microwaves are also being performed by the Navy, the Army and the Air Force at their own research institutes. R&D in microwaves in industry started very recently and it is still very limited.

R&D ACTIVITIES IN UNIVERSITIES

This section will summarize relevant R&D activities in microwaves in Brazilian universities. These include University of Sao Paulo (USP), Catholic University of Rio de Janeiro (PUC/RJ), University of Campinas (UNICAMP), Air Force Technological Institute (ITA) and Maua Institute of Technology (IMT). Military Institute of Engineering (IME), University of Brasilia (UnB), University of Paraiba (UFPB), University of Rio Grande do Norte (UFRN) and University of Pernambuco (UFPe) also conduct some microwave R&D activities. In most of these universities, a great deal of effort is put in academic programs at the undergraduate and graduate levels.

University of Sao Paulo (USP)

Most of the R&D activities in microwaves at USP are carried out at the Microelectronics Laboratory (LME) and at the Astronomy and Geophysics Institute (IAG).

At the Microelectronics Laboratory (LME) the major R&D activities are concentrated on Microwave Hybrid Circuits, GaAs MMICS and SAW Components [1], [2]. Thin film technology on ceramic substrate and conventional photo-etching on soft substrates have been used to develop different hybrid circuits, such as a medium power FET amplifier (at 6 GHz, with P_{out} = 5 watts and gain 13 dB), a wide band (100 MHz to 4 GHz) amplifier with gain = 12 dB, LNA for the 3.7 to 4.2 GHz bandwidth (with NF ₓ 60K and gain > 60 dB) and frequency multipliers using dual gate GaAs MESFETs [3]-[6].

Passive and active components for MMICs are being developed and tested separately, such as a 1 μm gate GaAs FET by the lift-off and self-alignment processes, loop inductances, interdigital and $Ta_2 0_5$ MOM capacitors, titanium resistors and air-bridge structures.

SAW components on $LiNb0_3$ substrate for the 70 MHz band are being developed. These include a SAW filter for satellite reception and a convolver for applications in spread-sprectrum for satellite communications [7], [8].

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At the Astronomy and Geophysics Institute, R&D activities in microwaves are mainly concentrated on propagation. These include S-band and C-band weather radar data processing (for rainfall estimation, climatology, short-range forecasting, cloud physics, etc...) and Microwave Radiometry at 10, 21, 31.6 and 115 GHz for radio-astronomy and ozone measurements. Also, attenuation and propagation studies, such as rain drop-size distribution measurements in tropical regions, S-band weather radar reflectivity data for slant path attenuation studies and atmospheric boundary layer measurements using tethered balloons for microwave terrestrial links are carried out.

Catholic University of Rio de Janeiro (PUC/RJ)

At the Center for Studies in Telecommunications (CETUC) of PUC/RJ there are three groups involved in R&D on microwaves, antennas and propagation. Activities in microwaves comprise theoretical studies, modelling/optimization, design, realization and characterization of hybrid active and passive circuits, using thick film technology on ceramic substrates or conventional photo-etching techniques on soft substrates. Significant contributions to the areas of dielectric resonator oscillators and filters [9], [10], distributed elements analysis and synthesis [11], and single and dual-gate GaAs MESFET mixers [12] have occurred.

Recently, two areas of activity received special attention: (a) modelling and design of GaAs MMICs and (b) microwave performance of laser diodes [13] and photodetectors for high capacity optical communicaion systems.

The research activities of the antenna group at CETUC are centered around the development of antennas to be used in satellite communication systems, and fulfilling the current and future needs of the Brazilian Satellite Telecommunications System. Present emphasis lies on the following: Asymptotic and numerical analysis of reflector antennas [14]-[16]; Synthesis of off-set dual-shaped reflector antennas [17]-[18]; Numerical analysis of corrugated feeds; and radome analysis and synthesis [19].

In the radio propagation group at PUC/RJ, a substantial amount of effort is currently being directed towards the study of multipath effects on digital radio links [20]. In addition to measurements on existing links, ongoing work involves analog and digital simulation, as well as modelling and theoretical calculations [21], [22]. In addition, long-term statistics of rainfall rate and attenuation due to rain in different terrestrial line-of-sight links have been obtained [23], [24]. Radiometric measurements have been initiated at three sites (Rio de Janeiro, Belem and Manaus). Attenuation due to rain in slant paths in the 13 GHz frequency band, as well as the gain resulting from the use of space diversity, will be investigated. This program is performed in cooperation with the Commmunications Research Centre, Ottawa, Canada.

University of Campinas (UNICAMP)

At the Microwave and Optics Department (DMO) of UNICAMP, R&D activities in microwaves are mainly concentrated on integrated circuits, planar structures and antennas. More recently, an effort on Coherent Optical Communication was initiated through the installation of a research laboratory in this area, supported by FINEP and TELEBRAS.

The work done or in progress includes the development of microwave circuits, such as: oscillators, amplifiers, mixers, filters, couplers, phase shifters, ferrite devices, delay lines, limiters, circuits using PIN, Gunn and avalanche diodes, and semi-conductor lasers. Software for the design, analysis and synthesis of microwave integrated circuits was also developed. A major effort, still in progress, includes the determination of propagation characteristics of planar structures (stripline, microstrip and finline) on isotropic or anisotropic substrates [25]. This effort also includes studies on multilayer planar or cylindrical printed antennas [26]-[29] and radio propagation in layered media.

The objective of the research on optical communications is to achieve technical competence in this area [30] anticipating future applications in long distance communications as well as in high capacity local area networks. Currently, simulated homodyne and heterodyne communication systems with optical fibers are being developed. A local-oscillator using a high stability semiconductor laser should be developed in the immediate future, followed by the setting of an optical PLL, and coherent and heterodyne optical link systems.

Air Force Technological Institute (ITA)

Major R&D activities in microwaves at ITA are in the fields of acousto-optics, electro-optics, SAW devices, microstrip antennas, fiber optics and ferrite devices.

In acousto optic devices [31] the major interest is the use of quartz crystals, which are readily available in Brazil, for implementing both tunable filters and optical modulators. The results so far obtained involve device design, fabrication and characterization (e.g., measurement of diffraction efficiency and Bragg angles). In microstrip antennas, theoretical and experimental results include the effect of both electric and magnetic anisotropies of substrates and measurement of radiation patterns of several antennas which will be used by the Brazilian Air Force. Research in fiber optics is concentrated in fiber optics data transmission and optical fiber sensors. Work in ferrite devices includes phase-shifters and YIG tuners.

Maua Institute of Technology (IMT)

At the Maua Institute of Technology (IMT), most of the R&D activities involve industrial applications of microwaves. The two major fields of interest are measurement techniques for dielectric properties of solids and liquids, and high power devices and processes for microwave dielectric heating, drying, cooking of cereals and food [32]. Other activities include the development of microwave components, antenna and electromagnetic interference measurements.

Other Universities

Other Brazilian Universities are also involved in R&D in microwave. At the University of Brasilia (UnB) in Brasilia, the major activities are in microwave passive devices, such as filters [33] and dielectric resonators, and numerical methods for antenna analysis and synthesis [34]. At the University of Rio Grande do Norte (UFRN) in Natal, work completed or in progress includes theory and modelling of planar transmission lines (such as finline [35], microstrip [36] and stripline) considering dispersion and anisotropy, as well as the analysis of planar antennas and optical fiber characteristics. At the University of Pernambuco (UFPe) in Recife, a millimeter wave six-port reflectometer is being developed [37]. At the Military Institute of Engineering (IME) in Rio de Janeiro the major efforts are on numerical methods for the analysis of planar structures such as microstrip, stripline, slot-line and CPW [38], and on the development of some basic circuits such as low noise amplifiers, mixers and VCO's. At the University of Paraiba (UFPb) in Campina Grande, most of the activites are concentrated on numerical methods, analysis and characterization of waveguides, resonators, planar transmission lines and antennas.

R&D ACTIVITIES IN RESEARCH CENTERS

Research and development activities in Brazilian research centers include CPqD-TELEBRAS in Campinas, INPE (Space Research Institute) and IPD-CTA (Air Force Research Institute) in Sao Jose dos Campos, and IPqM (Navy Research Institute) and IPD/CTEx (Army R&D Institute), in Rio de Janeiro.

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TELEBRAS Research and Development Center (CPqD)

The CPqD activities in microwaves, antennas and optical communications are summarized below.

The basic aim in microwave circuits is to develop devices for the radio equipment of the Brazilian Telecommunication System. Several circuits in S, C and X-band have been developed, such as microwave low-noise/medium-power amplifiers [39], mixers [40], oscillators (PLL and DRO), frequency multipliers, filters, circulators and isolators [41]-[42]. These components have been used to develop up- and down-converters complying with INTELSAT specifications, a low-cost professional receiver for TV signals and a 2-GHz digital radio. CPqD has developed band-pass filters and delay line oscillators utilizing SAW techniques.

The TELEBRAS R&D Center is endowed with facilities for designing and manufacturing of thin and thick film technology hybrid circuits and microwave circuits on soft substrates. In the future, CPqD intends to increase its efforts on miniature MICs and GaAs MMICs.

The principal task of the CPqD Antenna Group is development of earth station antennas for the Brazilian Satellite Telecommunication System. Ongoing research includes the design of microwave components for reflector antenna feed chains, as well as reflector surface synthesis for axially symmetric antennas compatible with CCIR and FCC requirements.

A software package specially developed for the analysis of circular corrugated structures and coupling between corrugated and smooth walled waveguides [43] has been successfully utilized in the design of wideband corrugated horns, low return loss mode converters for widely separated frequency bands [44], and wideband diplexers [45] for four port feeds operating with frequency reuse. Presently a series of four and two port feeds is being developed for C band (Rx: 3.625 - 4.2 GHz / Tx: 5.850 - 6.425 GHz) circular and linear polarization operation. The four port feed chain consists of a pair of multihole corrugated directional couplers which can be connected to a dual-depth corrugated horn for operation throughout the extended band (3.4 - 4.2 GHz / 5.850 - 6.775 GHz) allocated by WARC'79.

Computational tools are available for single and double reflector antenna analysis and synthesis. Secondary effects such as scattering by struts are taken into account and second order diffraction effects are analysed by GTD. Near field horn-subreflector interactions are also considered [46] and the resulting antenna patterns are efficiently calculated by sampling techniques. Double reflector 6.0 and 4.5 meter earth station antennas for C band operation compatible with CCIR Rec. 580-1 [47] were designed and have been industrialized.

Effort is now being applied to the development of necessary theoretical tools for the design and analysis of simple and double reflector offset antennas for terrestrial and on-board applications. Alternatives for the fully corrugated horn with compatible performance are also being investigated [48] in order to reduce manufacturing costs.

The TELEBRAS Optical Communications Program aims at mastering the technologies related to equipments and systems and to manufacturing processes of optical fibers and opto-electronic components considered to be of critical importance for telecommunications in Brazil.

The main achievements of the program were:

a) An optical interface unit (ELO-34) designed to transmit a 34 Mbit/s signal on a multimode fiber, in the 850 nm spectral region, making it possible to install optical links with distances up to 15 km between repeaters.

b) The second is an equipment designed to transmit a TV signal, being used in the interconnection of TV signal generation/distribution centers and local TV stations (ELO-TV).

c) Optical fibers and opto-electronic devices [49]-[51]. In this segment of the program, CPqD developed low loss optical fibers (multimode and singlemode) and high reliability GaAlAs lasers (over 100,000 hours of operational life expectancy) manufacturing processes.

CPqD is currently carrying out the development of the ELO-434 equipment, which is designed to transmit 4 digital signals, 34 Mbit/s each, on a singlemode fiber, to be applied in high capacity and long distance links. The development of higher capacity systems (over 1Gbit/s) is under study. InGaAsP lasers and LEDs to operate in the 1300 nm region and InGaAs PIN photodetectors in the final development stage. Lasers to operate in the 1550 nm region, photodetectors with internal gain and optical modulators built on $LiNbO_3$ substrates are also under development. Activities in the areas of integrated optoelectronic devices and halide fibers are being planned.

Up to the present, all optical fiber links in the Brazilian Telecommunications System resulted from technology developed by CPqD. In order to reach this goal, in addition to the product and activities mentioned above, the CPqD, in a joint program with local industries, has further developed multi-fiber cables, accessories, tools and instruments necessary for the installation, operation and maintenance of such systems.

Space Research Center (INPE)

Microwave R/D activities at the Space Research Center in Sao Jose dos Campos, mainly consist of (a) development of on-board subsystems for environmental data collection satellites, and (b) applications to remote sensing.

The on-board subsystems being developed are intended for the first and second satellites of the Brazilian Space Mission. This Mission includes the development, construction, launch and operation of two types of satellites: the first one for collection of environmental data provided by platforms, the second one for remote sensing of the earth. The main items being developed are: a data collection transponder, which receives signals at 400 MHz, and retransmits them at 2.2GHz to an earth station for processing and dissemination; an S-band TT & C transponder; helicoidal antennas for these transponders and a 10W X-band amplifier.

In the area of applications to remote sensing, microwave techniques are used for the development of measuring methods for soil parameters like humidity. The effectiveness of X-band radiometry is being investigated.

Radiometric experiments are carried out at 22, 30, 43 and 90 GHz at Itapetinga [52].

Air Force, Navy and Army R&D Institutes

At the Air Force Research and Development Institute (IPD/CTA) in Sao Jose dos Campos and at the Army Research and Development Institute (IPD/CTEx) in Rio de Janeiro, the significant R&D programs in microwaves are devoted to military systems and sub-systems. These include several types of radars (such as air and ground surveillance, fire control, etc...), missile telecommand equipment and missile radar transponders [53].

At the Navy Research Institute (IPqM) in Rio de Janeiro, the R&D activities in microwaves are devoted to ECM and EW.

R&D IN INDUSTRY

Microwave activities in the Brazilian industry are basically concentrated on development and manufacturing, with some efforts on research in specific areas.

Among the main companies one can mention: Sul America Teleinformatica (SAT), NEC do Brasil, Control, Equitel, Telemulti, Mapra, Avibras, Amplimatic, Harald/Brasilsat, Elebra, SID/Telecom,

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Microline, Engesa and Celta. The main products developed by SAT are 6 and 8 GHz TX/RX (1800 channels) equipment, 5 GHz Digital TX/RX (140 Mbits/s), 6 GHz Amplifiers, and VHF/UHF (160 MHz to 1.5 GHz) TX/RX equipment. The products developed by NEC are down/up - converters, LNAs and digital/analog microwave transceivers from 2 to 8 GHz. The main products developed by Control are attenuators, power dividers, amplifiers and filters, mainly for 4/6 GHz TX/RX earth stations. Equitel is participating in the development of a digital radio system (140 Mbits/s) at 4/6 and 8 GHz bands. At Telemulti, the major developments are in digital and analog TX/RX at UHF and SHF. Microline has developed products such as isolators, power dividers and combiners. RF-multiplexers and coaxial lightning arrestors. Celta has developed one/two octave directional couplers (100 MHz to 12 GHz), 100W attenuators and loads, as well as log-periodic VHF/UHF antennas.

Antennas for terrestrial microwaves and earth station satellites are produced by MAPRA, AVIBRAS, AMPLIMATIC and HARALD/BRASILSAT.

Optical fibers are produced by ABC/Xtal. Elebra, SID/Telecom, Engesa and Avibras are also able to produce them. Optical fiber equipments are produced by NEC do Brasil, ABC/Xtal, Telemulti and Elebra. The optical cables are produced by Pirelli do Brasil, Marsicano, Ficap, Bracel, Imbrac, Conduli, Montedeste and Furukawa.

CONCLUSIONS

This paper has reviewed the relevant R&D programs in microwaves, antennas, propagation and optical communications in Brazil. As a conclusion, it can be mentioned that significant work is under way in some universities and research centers, and that in industry R&D activities started recently and are still very limited. As the needs for telecommuncations services and equipments are increasing rapidly, Brazilian researchers and engineers have been working hard to increase R&D activities. This task is not easy, especially in experimental programs, partly due to difficulties in buying foreign laboratory equipment and materials. International cooperation has already shown significant results and must be stimulated.

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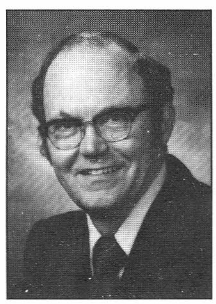
PCs for MTT



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DO PCs MAKE YOU MORE PRODUCTIVE?

If you're anything like me, you probably spend a good portion of your day sitting in front of, and staring at, your computer terminal. Among other ill effects alleged to this pastime are eyestrain and potentially dangerous radiation. I have no comment about the latter, and as far as the former is concerned, my slowly changing eyesight over time has led to the most annoying problem that even bifocals don't seem to compensate for reading at a distance from my computer screen which is most convenient. I'm either backed

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up far enough that my upper far-distance lenses provide a sharp, but alas rather small image, or I have my nose nearly pressed against the screen so that the lower, close-up part of the lenses can be used. Having to peer out the lower half of my glasses at a screen about at eye level is also not the best arrangement for my neck which always seems to be developing cricks as a result of the unusual contortion that I ask it to accept. Wouldn't it be neat if, in the spirit of the Xerox/Macintosh desktop screen format, your computer screen could be located more nearly level with the desk surface to provide a more natural viewing angle? How about in addition we were to be given an easily dialable image size so that the problems just mentioned could be minimized. Perhaps a projection system with a zoom lens would do the trick.

But there's another effect associated with using computers on a regular basis about which I've developed a theory. In particular, I refer to the fact that evidently more of us are using computers for word processing, organizing ideas and data, developing graphics and presentations, and a variety of other creative applications. In my own case, I began using a Mac for essentially all of my writing and record keeping almost as soon as I acquired one in early 1985. Becuase I can type faster and certainly more legibly than I can write long hand in particular, it seems to me that the raw volume of output that I can produce per unit time using my Mac is substantially greater, say a factor of two or three, than was previously the case. I've also noticed that I seem to be more tired at day's end than was the case in my pre-Mac life.

Even allowing for the fact that all of us are monotonically growing older, though perhaps some with a smaller or greater slope, I believe there is a link between these two observations. If we assume that we have a certain amount of creative energy to expend on our activities, then it would follow that producing more output, albeit admittedly more efficiently, would use up more of our 'creative-energy budget', thus leaving us feeling more tired. If any of you have had similar experience or thoughts or on the other hand strongly disagree with me, I'd like to hear from you.

A little different perspective on this problem is given by D.J. Deal in a letter appearing in the November 21, 1988 issue of *Business Week* magazine. Mr. Deal observes that 'At my staff-level desk job I routinely use voice mail, electronic mail, a facsimile machine, and a personal computer. None of those technologies has had a liberating effect on the way I do my work. To the contrary, I find myself chained to my desk into the evening hours more and more often. The reason? All forms of electronic communication serve to bring work across my desk faster than ever before, and the people I work with expect immediate follow-up. Certainly a personal computer allows me to be more productive, but the partners and managers at my firm have merely adjusted their expectations accordingly.' Mr. Deal's observations sound a little like the comments that might have been made by a hand craftsman who was converted into an assembly-line worker during the industrial revolution. That might be a relevant comparison if we observe that just as machines were found to provide leverage for muscle power, computers provide leverage for mental power. Undoubtedly we can do more, but is there also an unanticipated cost that has to be paid as well?

FURTHER REPORT ON *COMPUTERS IN PHYSICS*

Although it's only entering its second year of publication, the new bimonthly journal *Computers in Physics* from the American Institute of Physics, is rapidly becoming one of my favorites. As mentioned previously, it has an interesting format which includes Special Features, the Journal Section, New Products, and a variety of departments. Right now I want to mention some items in the latter two areas. Two of the authors of a book mentioned in the December 1986 PCs for AP, *Numerical Recipes,* write a regular column of the same title. In the November/December 1988 issue, Press and Teukolsky discuss an algorithm for finding weak periodic signals in unevenly spaced data, and provide a Fortran program for the procedure. A second regular column to appear every other issue is Spreadsheets by R.A. Dory and J.H. Harris. Their first column is titled 'Fourier Analysis Using a spreadsheet', and is accompanied by several examples and templates suitable for a package like Excel or a similar spreadsheet. Both columns would be of interest to many of you, and if you haven't already done so, I suggest that you take a look at *Computers in Physics.* Incidentally, in some ways I am envious that we in the IEEE haven't begun a similar journal, say Computers in IEEE or some such thing.

The other item that I wanted to mention from Computers in Physics is the New Products section which surveys 'Where To Buy Electricity and Magnetism Software' in this same issue. The survey contains 42 programs for 11 different vendors, in two basic categories: 'programs that discuss no more than several topics, and those that contain a library of physics programs covering a wide range of units.' The programs listed are tutorials and simulations, and are available for a variety of computers such as the Apple series, IBM PC and compatibles, Atari, Commodore Pet, and even the PLATO Delivery system 2, although most packages are individually targeted to specific PCs. Most prices are less than $100.00. Although covering quite a variety of sources and programs, this listing omits some of those I've found through Kinko's Academic Courseware Exchange.

PHYSICS EDUCATION SOFTWARE

Another source of education software, this time specifically physics oriented, is the Physics Courseware Laboratory (PCL), Department of Physics, North Carolina State University, Raleigh, NC 27695-8202, Telephone (919) 737-7059. The PCL is a laboratory facility designed to investigate courseware in physics instruction. Its activities include full classroom integration of computer-assisted instruction, teaching students physics through the use of computer simulations and tutorials, investigating learning using the microcomputer as a tool, *producing directories of commercial and public domain courseware,* supplying materials and public domain software to interested physics teachers, programming utility software for classroom management and testing, and offering *PHYSQUIZ* over Western Carolina University's Micronet to high school students in North Carolina. The project began in 1982 and includes courseware for both high school and college levels.

Some of the questions being investigated by PCL are:

- What kind of courseware is available?
- How can courseware be used effectively for instruction?
- What is the effective and meaningful way to utilize new technology in education?
- How do students develop problem-solving skills?
- In what ways can courseware be used to help students learn physics?

Among the materials available from PCL, two in particular might be of interest. These are:

Commercial Physics Courseware—A list of over 900 commercial educational software packages in physics and related mathematical topics sorted by computer type (Apple II, Atari, Commodore 64, Commodore PET, Control Data 110, IBM PC, Macintosh, and TRS-80), a total of 40 pages, priced at $2.50. Includes major and minor subjects, instructional level, type of usage, cost, and addresses.

Public Domain Physics Courseware—A list of over 1100 individual programs on 150+ diskettes in physics and related topics sorted by computer type (Apple II, Atari, Commodore 64, IBM PC, and TRS-80), 16 pages, priced at $2.00.

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PCs FOR MTT continued from page 55

DO WE NEED A SOFTWARE CATALOG?

Which brings me to some questions for you. If you've read this column in the past you may remember that on occasion I've mentioned software that might be of interest to EMers. Indeed, one of the reasons for beginning the column in the first place was to provide a vehicle, if not a mechanism, for software exchange. A necessary at least, if not sufficient, condition of achieving this goal is putting together a catalog of resources that satisfy whatever criteria might be appropriate. Foremost of such criteria would be accessibility of the items in the catalog by anyone who is willing to meet the provider's conditions, usually some money cost for purchase. Other aspects also should be considered, about which I'll say a little more below.

Partly because it seems reasonable to expect it should be the case, I am receiving more inquiries about whether I know about or have myself developed, such a software catalog. With each such inquiry, I have become a little more embarrassed about not having a catalog designed for the EM community, although I can direct people to a variety of sources. If you have any thoughts about initiating such an activity within AP, MTT, EMC, etc., it would be nice hearing from you. But just your agreeing that a catalog would be worth developing is not really all that helpful. It would be much more useful if at the least you would send me (or whomever would serve as a cataloger) information about software that might be included in the catalog. Even more helpful would be receiving your review/assessment of how that software has worked for you. So, question number 1a is, should we begin a EM software catalog? But, you can only answer in the affirmative if your answer to question 1b, are you willing to help? is also affirmative.

The second question concerns developing a little different approach for this opportunity. We in electromagnetics have been writing modeling software for more than 20 years, and are increasingly producing education-relevant software as well. It would probably be agreed that most codes that are produced as a part of research have no useful life beyond results generated for a report and/or paper. However, an increasing number of codes acquire a more archival nature for various reasons, and it's this category to which my remarks are addressed. Various kinds of approaches have been tried to promote software distribution, among which are the AP computer-code descriptions several years ago, and the ACES computer-code listing. But these activities have relied primarily on voluntary input, and can miss most proprietary software as well a products which might be of interest to others but about which they never learn because the developer sees no acceptable way of advertising them. Is it now time for the IEEE to revisit the question of software? This is question 2 for you, for which I present a modest proposal as my own response.

Suppose that we consider a two-pronged approach to the problem as follows:

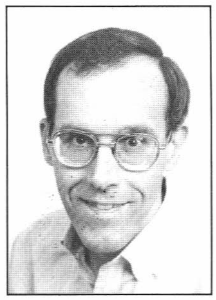
1) Periodic surveys will be conducted to collect information about EM software, which, subject to some minimal screening will be included in a catalog (data base, at least one form of which will be electronic) available to IEEE members.

2) Software that is selected on the basis of some appropriate criteria (one example being a summary and sample output) will be reviewed by volunteers on much the same basis now used for paper reviews, and the accepted software will be made available through an outlet(s) arranged by the IEEE.

As an example, Macintosh software might be handled by Kinkos. Alternatively, IEEE could set up its own distribution mechanism along the lines of the IEEE Press. The selected software should be documented in a new IEEE publication (something like *Computers in Physics?*) accompanied by the review, or the reviews alone could be published alone, in either case for the benefit of prospective users and buyers. For those software developers to whom journal articles are important, the former route could be the preferred one, whereas other developers might feel that a fair, published review, is all that is necessary. We have been nibbling around the edges of this problem for quite awhile, in that some software gets described in the Newsletter, but that appears to depend on the developer taking the initiative to see that this is done. Since we do book reviews routinely, the idea of software reviews should be acceptable, the only difference being the book authors don't normally summarize their book in an article such as is being proposed for software authors.

Editors note: As you know, Ed's point-of-view is electromagnetism (this column is written for the AP Newsletter but appears both in MTT and EMC Newsletters also). The MTT Newsletter is a ready forum for your comments regarding MTT-specific applications.

MTT-S By-Laws Changes



by D. Gary Lerude

Two changes to the Society's By-laws were approved by the Administrative Committee at the October meeting. As provided by the MTT-S Constitution (Article IX, Section 2), these changes will take effect 30 days after being publicized to all Society members (i.e., following publication of this Newletter).

STANDING BUDGET COMMITTEE

At the January, 1988, Administrative Committee meeting, the Long Range Planning Committee proposed creating a standing Budget Committee to oversee the financial operations of the Society. As a result of this recommendation, the following addition to the By-Laws was approved by AdCom:

> *Section III-A-11. Budget Committee*
>
> The Budget Committee shall be responsible for creating the budget for the Society for the following year, reporting the budget to and seeking approval of the Administrative Committee, monitoring the financial operations of the Society in the current year, and recommending priorities and guidelines on income and expenditures. The committee shall receive all requests for discretionary expenditures and recommend approval or disapproval to the Administrative Committee, based on an analysis of the impact on the budget.
>
> The Budget Committee shall include the following Administrative Committee members: the Vice President, who shall chair the Budget Committee, the most recent past President, the Finance Committee chairman, and two other Administrative Committee members appointed by the President. The President may also appoint members of the Society who are not on the Administrative Committee to serve on the Budget committee.

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MTT-S BY-LAWS CHANGES continued from page 56

MEMBERSHIP DRIVE SUBCOMMITTEE

Al Estes, the Membership Development Officer, requested that the description of the Membership Drive Subcommittee contained in the By-Laws be modified to change the wording 'welfare' to 'well-being' to better reflect the charter of the subcommittee. This request was also approved by AdCom, resulting in the following wording (new wording in bold):

> *Section III-A-9-(b)-(2) Membership Drive Subcommittee*
>
> The Membership Drive Subcommittee shall be responsible for promoting increased membership for the purpose of the improved **well-being** of the Society and IEEE.

Changes to the MTT-S By-Laws may be requested by anyone. However, they must be approved by a two-thirds vote of the Administrative Committee members voting. Once approved, such changes take effect after the IEEE Technical Activities Board (TAB) has been notified and 30 days after the change has been publicized to the MTT-S membership.

Intersocietal Relations

by Ferdo Ivanek
Coordinator

In the Summer/Fall (#122) Newsletter, we started the "Intersocietal Relations" column with a panoramic overview and an introductory summary of our involvement in the IEEE Committee on Communications and Information Policy (CCIP).

In this issue we want to first provide information on the changes in the list of our representatives. For the benefit of new members who start with this Newsletter issue we shall present an update of the complete tabular overview from the preceding issue. The recent changes are indicated in boldface type.

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**
Technical Activities Board		**V. Gelnovatch** (ex officio)
	Committee on Man and Radiation (COMAR)	
	Solid-State Circuits Council (SSCC)	P. Greiling V. Gelnovatch
	Steering Committee of the Journal of Lightwave Technology (JLT)	N. Dietrich
United States Activities (USA)	Aerospace R&D Committee	W. Brown
	Committee on Communications and Information Policy (CCIP)	F. Ivanek
	Defense R&D Committee	**D.N. McQuiddy, Jr.** **G. Thoren**
	Energy Committee	W. Brown J. Tancredi
	Engineering R&D Committee	**H. Sobol** **R. Gutman**
	Health Care Engineering Policy Committee	K. Carr
	Professional Activities Council for Engineers (PACE)	L. Medgyesi-Mitschang R. Moore

In addition, the MTT-S participates in the organization of two related IEEE conferences, and is represented at two Societies outside of the IEEE:

Conferences	GaAs Symposium	P. Greiling
	Picosecond & Optoelectronics	P. Greiling
Other Societies	International Microwave Power Institute (IMPI)	J. Osepchuk
	International Scientific Radio Union (URSI)	A. Oliner

In this Newsletter issue we continue with introductory summaries on MTT-S' involvement in the various IEEE committees and other Societies. Prominent among these is the Technical Activities Board (TAB) where we are represented by the MTT-S President.

I repeat my invitation to interested MTT-S members to contribute to this column with their letters. We welcome your comments and proposals. Please mail them to: Ferdo Ivanek, Communications Research, P.O. Box 60862, Palo Alto, CA 94306, or call (415) 329-8716.

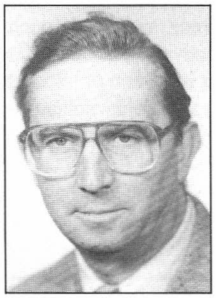
ERRATUM

Correction to report "Committee on Communications and Information Policy (CCIP)," of MTT-S Newsletter Number 122, Summer/Fall 1988.

The first paragraph of the second column on page 41 should read as follows:

- On March 22, 1988 Peter Panousis, Director, VLSI Technology Laboratory, AT&T Bell Laboratories, gave a presentation on AT&T's participation in Sematech, and Palle Smidt, Sr. V.P., Plans and Programs, Microelectronics and Computer Technology Corporation (MCC) described the MCC activities.

Standards Coordinating Committee



by E. Belohoubek

Why standards? What are they good for? These often asked questions can be answered very scholarly by lengthy definitions of the IEEE Standards Board. More likely, however, one gets an appreciation for their importance when one considers why and how standards originate. Standards come about when individuals, groups or whole corporations feel a strong need that something has to be done to provide order in a chaotic situation. Standards or the less formal recommended practices and guides are required to insure that everybody involved does things within certain agreed-on boundaries or specification and puts the same meaning into certain expressions or definitions.

The MTT Standards Coordinating Committee has the broad responsibility to deal with all standard topics affecting directly the interests of the MTT-Society. The major objectives of this committee are:

- Solicit inputs from MTT Technical Committees for areas in need of standardizing efforts.
- Identify key people to head and form working groups for standard generation. This includes enlisting representatives from other interested Societies to participate in the working group. If a strong interest in a particular topic is expressed by several Societies, a standard coordinating committee under the auspices of the IEEE Standard Board can be formed.
- Maintain and revise existing standards. Older standards have to be updated or declared inactive. Generally, existing standards should be reviewed every 5 years.
- Provide support and guidance for working groups in interaction with the IEEE Standards Board and other Societies.
- Increase awareness of ongoing standard efforts within the MTT membership.

The creation of a standard proceeds along the following general outline: original ideas and suggestions for standards are forwarded to the Standards Coordinating Chairman who will assist in the preparation of a Project Authorization Request (PAR) for submittal to NesCom of the IEEE Standards Board. After approval by the IEEE a working committee with a chairman is formed to prepare the draft for a new standard. This may take anywhere from 6 months to a few years depending on the complexity of the undertaking. The draft is then balloted, possibly modified and submitted to RevCom of the IEEE Standards Board. Upon their final approval the new standard is issued by the IEEE.

Currently a number of standard efforts are underway at MTT. Listed below are the topics together with the responsible chairman for the activity.

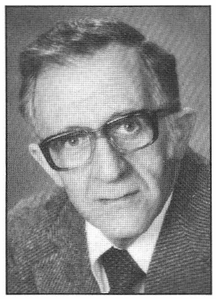
Active PAR's in which MTT has key responsibility:
- Standard for Waveguide and Waveguide Component Measure ments (Revision of an old standard); Arthur Blaisdell, M/A-COM.
- Standard for Improved Waveguide Flanges; Mario Maury, Maury Microwave Corp.
- Standard for Mode Nomenclature of Dielectric Resonators and Waveguides; Jerry Fiedziuszko, Ford Aerospace.

Active PAR's in which MTT has a liason member:
- Standard for Precision Coaxial Connectors; M. Maury, Maury Microwave Corp.
- Standards Coordinating Committee SCC26 (Photonics); Liason member to be determined.

PAR's planned for he near future:
- Standards for Microwave and Millimeter Wave Packaging; Fred Rosenbaum, Washington University
- Standard for a Microwave Eolectronic Design Interchange Format; Dan Nash, Raytheon
- Standard on Microwave Metrology; A. Blaisdell, M/A-COM

Individuals interested in participating in standard efforts should contact E. Belohoubek, David Sarnoff Research Center, Princeton, NJ 08543 or call: (609) 734-2629.

TAB Report



by Theodore S. Saad

The TAB meeting (November 17-18, 1988) adopted a different format this year by having two sessions on succeeding days, with the Presidents' Forum in between. Below are some of the items of MTT-S interest.

- Rex Dixon, VP of TAB, called attention to the 2 day format and asked for reactions. There was a Chapters' Workshop meeting in Spain, Region 8, with 25 Chapter Chairmen, plus several Society Presidents in attendance, along with other IEEE people. Meeting was very well received.

  Re the Presidents' Forum: if the Society President cannot attend the Forum, he can appoint an individual to attend with a proxy to vote—provided it is done in writing—in advance.

- A number of Society Presidents gave reports on their activities.

  The Laser and Electroptics Society held their first annual meeting along with a number of other groups. The total attendance was 7000. Attendance at the LEOS technical meeting was 1200.

  The Power Engineering Society is working with the Edison Electric Institute on an education project. PES and EEI have a great concern for continuing education. They plan to assess the outlook of the university and the needs of PES members for continuing education. They expect to publish a paper on the project in January 1989. They are also planning a new magazine titled *Computers in Power.*

  The Aerospace and Electronic Systems Society has plans underway to celebrate the International Space Year in 1990.

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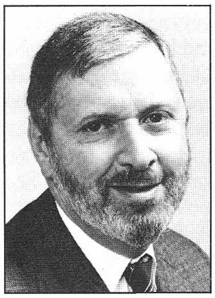
The Engineering R&D Committee



F.J. Rosenbaum

One of the responsibilities of the IEEE is to monitor national technical matters in order to educate its membership, and the general public, on the possible impact and significance of these matters. In a narrower, but no less worthy sense, it is important that IEEE assess the impact of particular national issues on the technical community and on its members in particular. Trends or actions which affect the practices of engineering, such as R&D funding, research priorities, registration, legal cases, etc., must be recognized, analyzed, comprehended, explained, and communicated, not only to IEEE members, but to national decision makers and legislators. Given the stature of IEEE as the world's largest engineering society, it has the responsibility and the prestige to influence national debates and the decisions that flow from them.

The purpose of the IEEE Engineering R&D Committee is to develop an understanding of the role and workings of the National Science Foundation and the National Institute of Science and Technology (NIST), formerly the National Bureau of Standards.

The Committee convenes 5 times per year at the USAF office in Washington, DC. There are annual briefings on the NSF and NIST budgets and meetings with representatives of these agencies and with those from the Office of Management and Budget. These meetings give us a chance to learn, but also to communicate IEEE concerns.

There has been considerable misunderstanding of what engineers do and in particular, of the role of engineering research and development. One recent task of the committee was to draft a definition of 'Engineering R&D.'

An on-going task is the preparation and presentation of testimony at Congressional hearings. Often an 'IEEE position' is called for on short notice. This requires the authorization of someone to prepare the testimony and to circulate drafts to obtain a concensus opinion of the committee. the fact that we have such access and are well respected is high praise for the individuals who volunteer for this work. And the impact those inputs have on engineering should not be discounted. The testimony is heard by legislators, and is reported in the Congressional Record.

Another item of recent concern is the reduction of NIST activities in microwave metrology. The concerns of the MTT-S PNMS Committee have been discussed and the actions of NIST monitored. Unfortunately, a positive effect on the budget for microwave metrology has not yet been evidenced.

Through the Engineering R&D Committee of IEEE and the other R&D committees, we individual volunteers have a unique opportunity to be heard and to use our expertise to encourage good decision making. IEEE's work in this aspect of engineering broadens its more traditional role as technical communicator into a most important area.

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The Ocean Engineering Society is planning their conference, *Oceans 90* and they want other Societies to participate.

The Social Implications of Technology Society has received $1,000 from the Engineering Management Society. SIT has no source of funds of any consequence.

The Reliability Society is working with the Air Force to help train universities to understand reliability. The Society is sponsoring 4 professors, with $20,000, to help train students in college.

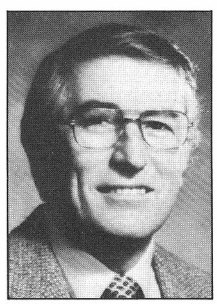
The Education Society plans to have a meeting in Austria in 1990 with ASEE, an international organization. The subject will be 'Frontiers in Education.'

The Systems, Man and Cybernetics Society held a conference in Red China.

The Engineering Medicine and Biology Society will hold its first conference outside the U.S. It will be held in Paris in 1992.

- Ted Saad reported on the TAB Finance Committee.
  A committee is presently studying a method for the electronic transmission of financial data to all Societies.
  The non-member subscription formula for IEEE publications was not changed. The Single Sheet reporting system for each Society and Council was approved.
- IEEE By Law 109.2 Re. Society Life Membership was revised to enable IEEE Life Members to attain Society Life Membership by completing 5 year Society membership, after they become IEEE Life members.
- After much discussion and with a six word deletion a revision to a policy statement on the Auditing Conferences was approved. All Conferences will still have to be audited, but conferences with actual or budgeted income or expense of $250,000 or more must be audited by an independent professional auditor.

The Advisory Role of HCEPC



by Kenneth L. Carr

In 1979, the IEEE formed the Health Care Engineering Policy committee (HCEPC) as part of its United States Activities (IEEE-USA).

The principal objective of the Committee is to assist in the rational formation of health care legislation, regulation, and policy of the United States through the provision of sound technical and professional counsel. The Committee may address any aspect of health care activites effected by policies of the national, state, or local governments where the professional and technical knowledge

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HCEPC continued from page 59

and skills of the IEEE members can make a constructive contribution. The Committee provides a central focal point for presenting the sound technical and professional views of the IEEE membership to the appropriate element of government and to the public.

The Chairman of the HCEPC is Dr. Joseph Bronzino, appointed by the USAB Chairman. Dr. Bronzino, past President of the IEEE Engineering in Medicine & Biology Society, is the Director of the Trinity College-Hartford Graduate Center Program in Biomedical Engineering.

The membership of the Committee consists of appointed members, members-at-large, and consultant members and may not exceed a total of 22. The appointed members are nominated by the various IEEE Societies.

The primary objective of the Committee is, therefore, to apply engineering knowledge to problems of public health to insure that safe and effective standards are used. It is not the function of the Committee to generate standards.

A major and current activity of HCEPC is the development of a list of technical experts within the IEEE capable of providing technical advice to Congress and the various Government agencies regarding health care legislation. In addition, HCEPC will identify specific Federal committees involved in health care legislation in an attempt to influence the placement of engineering professionals.

To illustrate the significance and need for HCEPC's advisory role, let us examine the field of microwave medical technology. Microwave technology, useful in the generation of heat and the measurement of temperature and motion, is playing an increasingly significant role in the medical field. The detection of disease-related temperature differentials (i.e., the passive measurement of natural electromagnetic radiation from the body) using microwave radiometry is gaining considerable interest. Unfortunately, technologies are often placed in competing situations, particularly in times of limited funding. This competition is regrettable since, in medical application ... and particularly in the area of cancer detection, no one technology can offer the complete solution. In the early published material by Barrett, et al, [1], results indicated that microwave radiometry would prove useful in the detection of breast cancer, particularly when used in combination with infrared thermography. A combination of two nonionizing methods gave results comparable to mammoraphy alone. Microwave and infrared thermography should not be considered as competing technologies, but rather as adjunctive procedures to mammography and clinical examinations. The concept of a nonionizing diagnosis or screening procedure is attractive and, when used in combination with one or more modalities, will prove effective.

A similar situation has evolved in the treatment of cancer. Hyperthermia, the application of heat to effect cancer cell death using microwaves, has been accepted as a treatment modality. Acceptance to date, however, is limited to superficial lesions due primarily to the inability to achieve a controlled heating pattern (i.e., the ability to induce a uniform distribution of temperature at depth). It is now well established that hyperthermia, in combination with ionizing radiation, is a more effective treatment than either hyperthermia or radiation therapy alone.

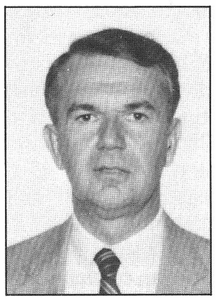
In addition to the involvement of multiple technologies, the public concern regarding the biological effects of microwaves must be considered. The biological effects of microwaves have been studeid extensively, yet controversy continues over the question: *Is exposure to low level microwaves a hazard?* In an excellent article, Foster and Guy[2] point out that controversy continues in part because some of the data provided by approximately 6,000 studies in the past 40 years are inconsistent and inconclusive. Given the inconclusive state of the published data, how should future research proceed and on that basis should any new policies be set?

Medicine today is heavily dependent upon technology. In view of the need to combine technologies in order to provide a complete solution—coupled with complex issues, such as the controversy associated with the biological effects of microwaves—the role of the HCEPC becomes increasingly important. Representation of the various IEEE Societies, including individuals from the universities, research organizations, Government agencies, and industry, is necessary since they will provide a sound and balanced technical council to assist in the national formulation of health care legislation, regulation, and policy ... bringing the many interests and capabilities of the Institute to bear on national health and policy isues.

[1] A.H. Barrett, P.C. Myers, and M.L. Sadowsky, 'Detection of Breast Cancer by Microwave Radiometry,' *Radio Sci.*, vol. 12, no. 6(S), p. 167, 1977.

[2] K.R. Foster and A.W. Guy, 'The Microwave Problem,' *Scientific American*, vol. 255, no. 3, pp. 32-39, September 1986.

The 1988 National Professional Activities Council for Engineers (PACE) Workshop



By Louis Medgyesi-Mitschang
MTT PACE Representative

The gavel fell. The prominent senator stood at the lectern. Facing him were better than two hundred electrical engineers from all parts of the United States, representing the entire technical spectrum of the IEEE.

So opened the 1988 National PACE Workshop in Phoenix, Arizona, held during the Labor Day weekend. The Workshop marked the fifteenth anniversary of the formal establishment of the professional activities agenda in the IEEE.

The keynote speaker, Senator DeConcini, spoke from the perspective of a chairman and member of several important U.S. Senate committees and subcommittees (Technology and Law; Patents, Copyrights and Trademarks; Defense, etc.). His theme was the "power of ideas whose time has come." The Senator addressed the issue of a national strategy to reverse the decline of innovation on the part of U.S. firms and citizens (the top six recipients of U.S. patents were foreign corporations in 1987), U.S. trade competitiveness, and the partnership between government and business. In the Senator's view, U.S. technologists in general, and within the IEEE in particular, have a critical role in reviving the innovative capacity of the U.S. This central topic undergirded much of the discussion in the various panel sessions of the Workshop.

This year's Workshop spanned five sessions: (1) employment and career management, (2) financial planning for the engineer, (3) specialty certification, (4) PACE communication with the membership, and (5) membership surveys. Each of these sessions was organized as a combination of formal presentation, followed by break-out into discussion groups that reported the members' views to the plenary session.

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Employment/Career Management: Career opportunities for engineers are affected by a variety of dynamic and interrrelated factors, such as general economic activity within the U.S., defense spending, demographics and, of course, technological trends. The IEEE, through its United States Activities (USA), has been assessing the relative importance of each of these issues. Through various public forums (testimony to cognizant committees of Congress, for example) and position papers, IEEE-USA, through its Washington Office, is a spokesman for our profession. In addition, IEEE-USA has developed various practical programs for career/employment management such as the Employment Assistance Workshop. A comprehensive set of IEEE-USA publications, such as the *Employment Guide for Engineers and Scientists,* is available to guide the member's career plans.

Financial Planning: The portability of pensions for engineers has been an important concern since the inception of professional activities within IEEE. George F. McClure gave a highly cogent discussion on 'Orchestrating Your Retirement.' This was followed by George Dean's comprehensive review of the IEEE's position paper on pension portability. Key Congressional committees (Education and Labor, Ways and Means) have been briefed by the IEEE-USA Pension Committee. Several pieces of legislation incorporating some of the IEEE proposals are before Congress.

Specialty Certification: This topic generated much debate. Representatives of the Society of Manufacturing Engineers and the American Society of Quality Control were invited to share their experiences on their certification programs. An informal straw vote indicated little support for the IEEE to start a certification program. The salient points in this discussion were the following:

- IEEE is too large and diversified to implement a successful certification program;
- If proof of competency is required, it should be through the Professional Engineering Licensure process;
- IEEE should monitor the certification activities of other technical societies; and
- Professional Engineering Licensure should be a prerequisite for certification.

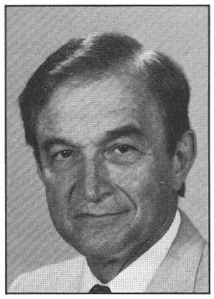
PACE Communication/Membership Surveys: As pointed out by George Abbot, PACE chairman and the organizer of the Workshop, 'PACE was created to communicate with U.S. IEEE members, especially at the local level.' PACE's principal goal is to facilitate two-way interaction on professional matters between the members, government, and community representatives. Various initiatives were described to accomplish these goals, including use of PACE meetings at the local level and at national technical conferences, Speaker's bureaus and involvement with student groups. The use of membership surveys has been expanded to assist in tailoring PACE programs to members' needs. It was emphasized that the Washington Office of IEEE-USA is always willing to support worthwhile activities at the local and national level.

Finally, an innovative pilot effort, called the Young Scientist Program initiated under the auspices of IEEE and PACE was described by Peter Bergsneider. Patterned after national organizatons such as the Boy Scouts and the Little Leagues, the program involves parents and children in science-oriented projects. The pilot program in Fort Huachuca, Arizona is a great success. Peter challenged interested volunteers to try this program in their cities.

At the Sunday Workshop luncheon, the attendees heard from Roger Boisjoly on 'Ethical Decisions: Morton Thiokol and the Space Shuttle Challenger Disaster.' As his incredible experiences showed, ethics and career issues are often intertwined. Mr. Boisjoly was honored at the Workshop. Previously, the American Association for the Advancement of Science (AAAS) and the National Space Society honored him similarly.

In summary, PACE has established a multifaceted agenda to address the professional concerns of the IEEE membership. If you would like to assist in this activity or to obtain more information about PACE, contact me, your local PACE representative or the IEEE Washington Office.

International Microwave Power Institute



by John M. Osepchuk

'...It is worth noting that, before electrical engineering was pressed into service by power engineering, it was almost exclusively occupied with electrical communication problems (telegraphy, signalling, and so on). It is very probable that history will repeat itself: at present, electronics is used mainly in radio-communnication, but its future lies in solving major problems in power engineering.'

P.L. Kapitza

These words[1] of the celebrated Soviet physicist perhaps express a spirit of the 60's when Herold[2] saw non-communications or power applications as the principal future for electron tubes and some U.S. engineers (W.C. Brown, E.C. Okress) and Canadian professors (Voss, Tinga...) organized IMPI as a forum on *microwave* power engineering (since broadened to 'electromagnetic' or 'radio frequency').

History[3] records that when IMPI was formed, the consumer microwave oven market was not foreseen but a big market in industrial applications was foreseen. It was believed that big opportunities awaited in power transmission, biological applications, textiles, materials processing, food technology and many others. This meant establishing a dialogue with non-engineers ranging from M.D.'s to food technologists and IEEE did not seem willing to house such a broad endeavor. Hence the birth of IMPI. Since than IMPI has held annual Microwave Power Symposia as well as specialized meetings and short courses.

Over the years various promising applications have come and gone, e.g., microwave power transmission by overmoded guides, weed-zapping.... In addition to the fabulous unanticipated consumer microwave oven market, however, certain industrial applications have matured successfully, e.g., meat tempering, bacon processing, rubber curing.... Today the greatest microwave component market is that of 10 million cooker magnetrons per year.

In recent years IMPI (still with less than 1000 members) has been dominated by food economists and food technologists (Cooking Appliance Section-CAS) but the engineers and scientists still pursue new applications (Industrial, Scientific, Medical and Instrumentation section - ISMI). The most popular areas today include microwave plasma processing of materials (e.g., diamond growth) and medical hyperthermia. There also remains much to be done in the area of microwave oven science and technology. In a mature

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INTERNATIONAL MICROWAVE POWER INSTITUTE
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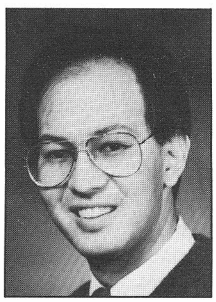
market, however, this proceeds only slowly. At present, a hot item is the thin metal film 'susceptor' used in food packaging for microwave ovens.

MTT-S and IMPI have maintained a liaison since the early 70's. In 1978 IMPI and MTT-S jointly sponsored a symposium on microwave bioeffects in Ottawa. In 1984 the two Societies jointly sponsored a workshop on Industrial Applications of Microwaves. It is logical and beneficial for both Societies to maintain a liaison. Interdisciplinary communication is not easy, however. Home economists and even M.D.'s are not very tolerant of speakers spraying Maxwell's Equations. On the other hand many MTT-S members display disinclination for straying from their narrow specialty. In the early 70's an AdCom member opined that MTT-S should stick with Maxwell's equations, and health and safety questions should be left to the M.D.'s. Later when a well known tube scientist submitted a pioneering field analysis of microwave ovens its acceptance in the *Transactions* met with some resistance because it didn't seem like the thing MTT-S members are interested in. It is true that the overwhelming majority of MTT-S members are involved in 'high tech' military or commercial systems. It is also true that 'low tech' applications are making a much greater impact in the civilian economy and are more likely to be the subject of an offhand inquiry at your next cocktail party.

References

1. V.A. Vanke, V.M. Lopukhin and V.L. Sarrin, 'Satellite Solar Power Stations,' *Sov. Phys. Usp. 20(12)*, 989-1001, Dec. 1977
2. E.W. Herold, 'The future of the electron tube,' *IEEE Spectrum* 2, 49-55, Jan. 1965
3. J.M. Osepchuk, 'A history of microwave heating applications,' *IEEE Trans. MTT-32* (9), 1200-1224, Sept. 1984

Meetings of Interest



by Frank Occhiuti

GENERAL INTEREST

SOUTHERN ELECTRIC SHOW & CONVENTION (SOUTHCON '89). Mar. 21-23, Georgia World Congress Center, Atlanta, GA. Contact: Ms. Alexes Razevich, Electronic Convention Mgmt., 8110 Airport Blvd., Los Angeles, CA 90045. (213) 772-2965.

ELECTRO '89 / MINI/MICRO NORTHEAST. Apr. 18-20, Jacob K. Javits Convention Center, New York, NY. 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.

AEROSPACE MILITARY

1989 IEEE AEROSPACE APPLICATIONS CONFERENCE. Feb. 12-14, Beaver Run Lodge, Breckenridge, CO. Contact: Douglas J. Theis, 1201 Key West, Corona Del Mar, CA 92625. (714) 644-5545.

1989 IEEE/AESS NATIONAL RADAR CONFERENCE. Mar. 29-30, Sheraton Hotel, Dallas, TX. Contact: Russell Logan, Chairman, Texas Instrument, P.O. Box 801, Mail Station 8045, McKinney, TX 75069. (214) 952-3151.

NATIONAL AEROSPACE & ELECTRONICS CONFERENCE (NAECON '89). May 22-26, Dayton Convention Center, Dayton, Ohio. Contact: Roger Lorelle, Publicity Committee Chairperson, ADBA Associates, P.O. Box 31586, Dayton, OH 45431. (513) 256-4739.

COMMUNICATIONS

INTERNATIONAL CONFERENCE ON COMMUNICATIONS (ICC '89). June 11-14, Sheraton Hotel, Boston, MA. Contact: Ed Elowe, Infocorp International, P.O. Box S, Brunswick, ME 04011. (207) 833-5403.

1989 AFCEA INTERNATIONAL CONFERENCE. June 20-22, Washington, D.C. Convention Center, Washington, D.C. Contact: AFCEA General Program Office, Fairfax, VA . (703) 631-6125.

COMPUTERS

INFOCOM '89. Apr. 24-27, Westin Hotel, Ottawa, Canada. Contact: Celia Desmond, Telecom Canada, 483 Bay St., 5th Floor So., Toronto, Ontario, M5G-2E1 Canada. (416) 581-2318.

1989 11TH INTERNATIONAL CONFERENCE ON SOFTWARE ENGINEERING. May 15-18, David L. Lawrence Convention Center, Pittsburgh, PA. Contact: Larry Druffel, General Chairman, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA 15213-3890. (412) 268-7740.

1989 16TH ANNUAL CONFERENCE AND EXHIBITION ON COMPUTER GRAPHICS AND INTERACTIVE TECHNIQUES. July 30-Aug. 4, Hynes Auditorium, Boston, MA. Contact: Mr. Chris Herot, Javelin Software Corporation, 1 Kendall Sq., Bldg. 200, Cambridge, MA 02139.

ELECTROMAGNETICS & OPTICS

8TH INTERNATIONAL ZURICH SYMPOSIUM & TECHNICAL EXHIBITION ON ELECTROMAGNETIC COMPATIBILTIY. Mar. 7-9, Zurich, Switzerland. Contact: B. Szentkuti, Publicity Chairman, c/o Swiss PTT, R&D Division, VD 24, EMC Group, CH-3000 Berne 29, Switzerland.

INTERNATIONAL CONFERENCE ON COATINGS AND SENSORS May 9-11, Penn State University, University Park, PA. Contact: Prof. Vijay K. Varadan, Dept. of Eng. Science & Mechanics, 227 Hammond Building, University Park, PA. 16802. (814) 865-2410.

1989 PROGRESS IN ELECTROMAGNETIC RESEARCH SYMPOSIUM (PIERS). July 25-26, MIT, Cambridge, MA. Contact: Prof. J.A. Kong, MIT, Room 26-305, Cambridge, MA 02139. (617) 253-5625.

INSTRUMENTATION

IEEE INSTRUMENTATION & MEASUREMENT TECHNOLOGY CONFERENCE (IMTC-89). Apr. 25-27, Key Bridge Marriott Hotel, Washington, D.C. Contact: Robert Meyers, Conference Coordinator, 1700 Westwood Blvd., Suite 101, Los Angeles, CA 90024. (213) 475-4571.

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MICROWAVES & ANTENNAS

1989 RF TECHNOLOGY EXPO. Feb. 14-16, Santa Clara Convention Center, Santa Clara, CA. Contact: Dr. Tim Healy, RF Technology Expo Program Chairman, Microwave and Communications Laboratory, Santa Clara University, Santa Clara, CA 95053. (408) 554-4482.

6TH INTERNATIONAL CONFERENCE ON ANTENNAS AND PROPAGATION. Apr. 4-7, Coventry, UK. Contact: ICAP 89 Secretariat, Conference Services, IEE, Savoy Place, London, WC2R OBL, UK.

43RD ANNUAL FREQUENCY CONTROL SYMPOSIUM. May 31-June 2, Denver Marriott City Center Hotel, Denver, CO. Contact: Raymond L. Filler, Publicity Chairman, US Army Laboratory Command, Electronics Technology and Devices Laboratory, Fort Monmouth, NJ 07703-5302.

1989 IEEE MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM June 14-16, Hyatt Regency Hotel, Long Beach, CA. Contact: C.W. Swift, C.W. Swift Associates, 15216 Burbank Blvd., Van Nuys, CA. 91411, (818) 873-4778.

1989 IEEE AP-S INTERNATIONAL SYMPOSIUM & URSI/USNC RADIO SCIENCE MEETING. June 26-30. Red Lion Inn, San Jose, CA. Contact: Ray J. King, General Chairman, Lawrence Livermore National Laboratory, L-156, Livermore, CA 94550. (415) 423-2369.

1989 IEEE AP-S INTERNATIONAL SYMPOSIUM & URSI/USNC RADIO SCIENCE MEETING — AMTA WORKSHOP — Testing Phased Array Antennas and Diagnostics. June 30, Red Lion Inn, San Jose, CA. Contact: Dr. Andrew Repjar, (NIST), Workshop Coordinator, (303) 497-5703 or Livio Poles, (RADC), Technical Coordinator, (617) 377-4214.

IGARSS '89 URSI-F 12TH CANADIAN SYMPOSIUM ON REMOTE SENSING July 10-14, Vancouver, Canada. Contact: John S. MacDonald, MacDonald, Dettweiler & Associates, 3751 Shell Road, Richmond, B.C. Canada V6X 2Z9, (604) 278-3411.

1989 SBMO INTERNATIONAL MICROWAVE SYMPOSIUM July 24-27, Sao Paulo, Brazil. Contact: Dr. Edmar Camargo, Publicity Committee Chairman, LME-EPUSP, CP 8174- CEP 01051, Sao Paulo, SP.-Brazil. Tel. No. (011) 8159322, ext. 255.

1989 INTERNATIONAL SYMPOSIUM ON ANTENNAS AND PROPAGATION, JAPAN (ISAP '89, JAPAN). Aug 22-25, Nippon Toshi Center, Tokyo, Japan. Contact: Dr. Takashi Katagi, Chairman of ISAP '89 Publicity Committee, Mitsubishi Electric Corporation, 325 Kamimachiya, Kamakura, 247 Japan. Tel. No. +81-467-44-8862.

POWER

1989 IEEE/PES TRANSMISSION AND DISTRIBUTION CONFERENCE AND EXPOSITION. Apr. 2-7, New Orleans Convention Center, New Orleans, LA. Contact: Donald Preston, General Chairman 1989 IEEE/PES T&D Conference, Louisiana Power & Light Company, P.O. Box 6008 (L-319), New Orleans, LA 70174-6008. (504) 363-8735.

AMERICAN POWER CONFERENCE. Apr. 24-26, Palmer House, Chicago, IL. Contact: Dr. Robert W. Porter, American Power Conference, Illinois Institute of Tech., Chicago, IL 60616. (312) 567-3203.

RELIABILITY

1989 INTERNATIONAL RELIABILITY PHYSICS SYMPOSIUM. Apr. 11-13, Hyatt Regency Hotel, Phoenix, AZ. Contact: Bruce Euzent, General Chairman, 1989 IRPS, Intel Corp., 2250 Mission College Blvd., SC9-06, P.O. Box 58125, Santa Clara, Ca 95052-8125. (408) 765-9400.

SOLID STATE

36TH INTERNATIONAL SOLID STATE CIRCUITS CONFERENCE. Feb. 15-17, New York Hilton Hotel, New York, NY. Contact: John Wuorinen, #2 School St., P.O. Box 304, Castine, ME 04421. (207) 780-4601.

EIGHTH BIENNIAL UNIVERSITY/GOVERNMENT/INDUSTRY MICROELECTRONICS SYMPOSIUM. June 12-14, Massachusetts Microelectronics Center (M^2C), Westborough, MA. Contact: Richard B. Gold, General Chairman, Massachusetts Microelectronics Center (M^2C), 75 North Drive, Westborough, MA 01581. (508) 870-0312.

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.

☐ **Buy milk in cardboard** containers instead of plastic. Vitamin A and riboflavin are light-sensitive and easily destroyed in translucent containers. *Especially sensitive:* Low-fat milk.
Working Mother, 230 Park Ave., New York 10169. Monthly. $12.95/yr.

☐ **Schedule more time alone** if you are continually cranky or forgetful...don't know what to do when you have free time...feel the need to take a nap more often than usual...start fights with your mate over trivial matters...are unable to finish projects. *Easy refuge:* The shower.
Linda Barbanel, MSW, a New York-based speaker on mental health and the psychological aspects of money.

☐ **Too busy to exercise?** Do isometrics instead. Tense each muscle in your body (either separately or two at a time)...hold for a slow count of 10...repeat for a total of 10 repetitions. Isometrics can be done anywhere.
SporTreks, Box 98, Barnard, VT 05031. Monthly. $36/yr.

☐ **Communicate better** with your spouse by asking yourself: *Is what I'm about to say true? Is this a good time for this discussion? Am I stating this in a positive, specific way?* If you answer, *Yes,* have the discussion. If not, rethink before bringing up the subject.
Don't Sweat the Small Stuff by Michael R. Mantell, PhD, Impact Publishers, box 1094, San Luis Obispo, CA 93046. $8.95.

Experiment in Electronic Distribution of Information on CD-ROMS

TWELVE TEST SITES SELECTED IN THE U.S. AND ENGLAND

New York, NY, January 16: The Institute of Electrical and Electronics Engineers, Inc. (IEEE), the London-based Institution of Electrical Engineers (IEE), and UMI (University Microfilms, Inc.) of Ann Arbor, MI have entered into a joint agreement to create and test a CD-ROM image database system for IEEE and IEE publications issued from January 1988 onward.

The ultimate aim of the test program, called IEEE/IEE Publications Ondisc (IPO), is to serve the organizations' members better by making a complete source of annual publications available in an easily accessible form. On as few as 25 to 30 CD-ROM discs, the entire collection of IEEE and IEE 1988 journals and conference records/proceedings, IEEE 1988 magazines, plus a complete set of IEEE standaards—a total of about 200,000 pages of text—can be stored. New 1989 information will be added to the test as it is published. The IPO program enables users to call up information quickly by subject or author, using INSPEC searching terms, and obtain exactly the information they need.

The 12 corporate, university, and government library test sites selected for the experiment include: Polytechnic Institute, New York City; University of Michigan, Ann Arbor, MI; University of Illinois, Urbana, IL; Stanford University, Stanford, CA; National Institute of Standards and Technology, Gaithersburg, MD; Naval Research Laboratory, Washington, DC; General Electric Company, Schenectady;, NY; Xerox Corporation, Webster, NY; Hughes Aircraft Company, El Segundo, CA; Hewlett-Packard Company, Palo Alto, CA; Imperial College of Science and Technology, London; and GEC Hirst Research, Wembley, Middlesex, England.

UMI is responsible for encoding the literature on CD-ROMs, and is also providing the workstations adn software for the search and retrieval of documents for the 'user-friendly' systems. CD-ROMs of IEEE's and IEE's information are supplied, one CD-ROM for searching indexes and abstracts and others for images of published pages. Both IEEE and IEE maintain their ownership for their respective materials. Facsimile copies of the articles can be printed out on laser printers.

The experiment is designed to provide data on how practical and marketable the use of CD-ROM technology is as an alternative means of supplying technical information. Information on user patterns—both the frequency of use and the types of material requested most often—will be examined, as will the differences in use at the university, government and business levels. Reactions to various pricing strategies for the system will also be explored. After the experiment has continued for six months, all results will be analyzed while the program continues. By the fall of '89, based on the program's findings, decisions will be made regarding the project's future.

It is estimated that less than 200 places in the world have all the documents contained in this experiment, while at least 15,000 libraries will have some of it. CD-ROMs, with their large storage capacity, could be issued every couple of weeks and contain whatever was published during that time. In concept, each library or information center could have a one-of-everything CD-ROM service. This might be of particular interest to individuals and organizations overseas where airmail service of publications is very expensive.

Contact: Beverly A. Knudsen -or- Pender M. McCarter (212) 705-7866 (202) 785-0017

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