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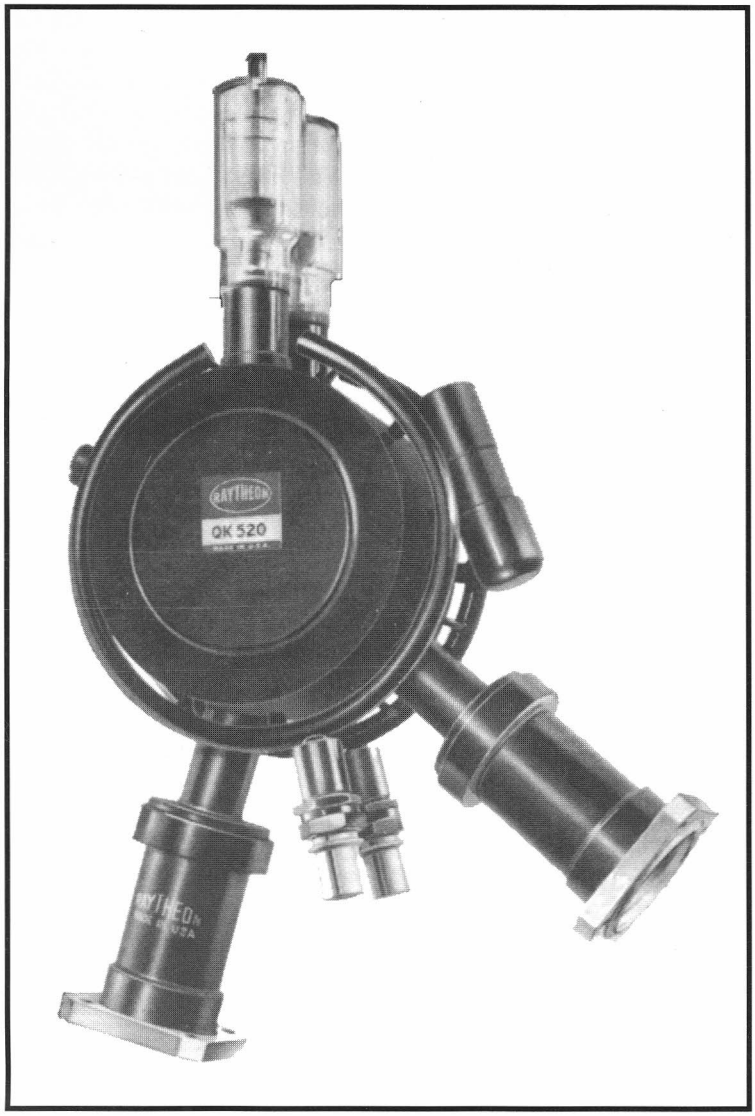
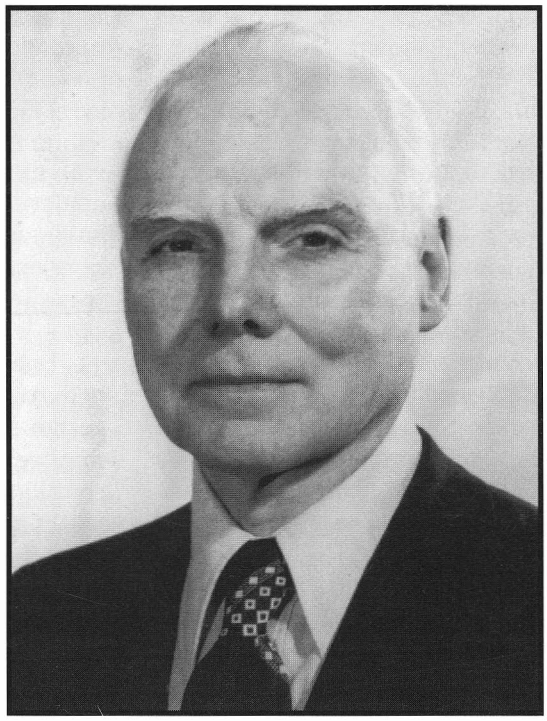
MICROWAVE THEORY
AND TECHNIQUES

NEWSLETTER

Number 141
Fall 1995



Raytheon advertisement in the August 1, 1957, issue of the magazine Electronics *describing the features of the platinotron but referring to it as the Amplitron. Explanation of this confusion is given in text.*



William C. Brown 1995 Pioneer Award Recipient

(See feature article on page 29)

From the Editor

Hello. I am Austin Truitt, the new editor of the *MTT-S Newsletter*, taking over for my good friend John Wassel, who is now the AdCom Vice President. This is my first newsletter and it owes a lot of its content to John. I hope to maintain the high quality that John has established for this newsletter. The publisher, Shari Wilburn of Shari Graphics, will continue to publish the newsletter. This has made the transition very smooth since Shari does all of the work.

I would appreciate any constructive comments on the newsletter. I received a comment on the wafer seal of the newsletter—that little piece of tape that keeps the newsletter closed while it is mailed. A reader suggested we do away with the pesky critter. After looking into it (it is an added expense and does mess up the newsletter), I decided the reader had an excellent suggestion and the wafer seal is, hopefully, not on this edition. If it is, it is a mistake! So if you have any suggestions, recommendations or criticism, please send them my way.

I need articles for future editions of the newsletter. The number one suggestion I have gotten from members is that we need more articles. I have a couple of articles lined up, but certainly need for members to mail in articles. I would also appreciate any suggestions the readers may have for articles—a topic and possible authors would be very helpful.

I am in the process of getting the MTT-S Directory in order for the winter edition of the newsletter. If you appear in the directory, either as an AdCom member, committee member or chapter chairman, and you want to make sure the information in the directory is correct, please mail, fax or e-mail your contact information. Please include your e-mail address. Volunteers can have an e-mail alias assigned to them by sending an e-mail message to aliases@ieee.org. In the message include your name, e-mail address, daytime phone and fax numbers. The e-mail aliases will use your first initial and last name with the @ieee.org trailer; my e-mail alias is a.truitt@ieee.org.

If you would like to make suggestions or offer up articles for publication, please contact me at:

Austin Truitt
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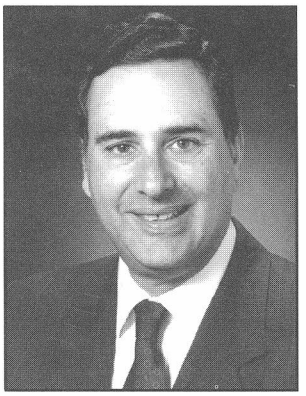
Correction

In the Spring 1995 issue of the *Newsletter* (page 10, "Progress and Change in Microwave Radio Communications") the item should have read:

- MTT/AP/EC Chapter, Toronto, Ontario, Canada—Emilie van Deventer, May 16

Please accept our apologies.

President's Message



by Eliot Cohen

MTT-S AdCom was saddened by the sudden loss of its Vice President, Mario A. Maury, Jr. Mario died from cancer on March 30 at the age of 58. He was a long time friend and colleague. In addition to being a very successful microwave businessman and a devoted husband, father, and grandfather, he was a tireless and exceptionally effective volunteer for the Microwave Theory and Techniques Society. Mario was a member of MTT-AdCom since 1986. During the past nine years, he served on many AdCom committees including Meetings and Symposia and Membership Services. No job was too large or small for Mario to undertake and he did them all well and cheerfully, always demonstrating his love for MTT-S. He will be very much missed.

Unfortunately, on June 5, the 1995 recipient of the MTT-S Microwave Career Award, William J. Getsinger, also died. The Microwave Career Award is the highest honor bestowed by MTT-S. It recognizes an individual for a lifetime of meritorious service and technical excellence in our field. Bill Getsinger personified these qualities. He compiled an incredible record of achievements throughout his engineering career spanning the technology areas of microwave passive and active circuits, measurements and computer-aided design. A summary of his achievements can be found on page xxviii of Volume 1 of the *1995 Microwave Theory and Techniques Symposium Digest of Technical Papers*. He too will be deeply missed.

As a result of Mario Maury's untimely death, special AdCom elections were held during our meeting on May 12. John Wassel was elected as Vice President and Keith Huddleston was elected as a member of MTT-S AdCom. John has been an exemplary AdCom member from day one since his election in 1992. He has not only performed the Herculean task of putting out an outstanding *MTT-S Newsletter* four times a year, but also serves as our Operations Committee chairman and as our unofficial photographer. He can always be counted on to deliver a first-class product and is consistently cheerful, even when under a great deal of pressure. I'm looking forward to working closely with him during the coming months. John will be succeeded as *MTT-S Newsletter* editor by Austin Truitt, a colleague of his at Texas Instruments, who has been doing an excellent job as Associate Editor. Jerry Fiedziuszko will be stepping up from Vice Chairman of Operations to Chairman of Operations. Jerry previously served in the tough job of being AdCom Secretary and is another person who can be counted on to provide the best. Keith Huddleston is no stranger to anyone who attended the 1995 International Microwave Symposium. Keith was co-chairman of the 1995 IMS Steering Committee. I'm sure that anyone who attended the Symposium in Orlando will agree that it was spectacular in every respect: quality and quantity of papers, exhibits, panel sessions, banquet and pleasantness of facilities. We look forward to another stellar IMS next year in San Francisco under the stewardship of Jim Crescenzi. Jim was an incredibly helpful mentor to me during his presidency last year. Next year's Microwave Week will be June 17 through 21 and a call for papers is already available for your use.

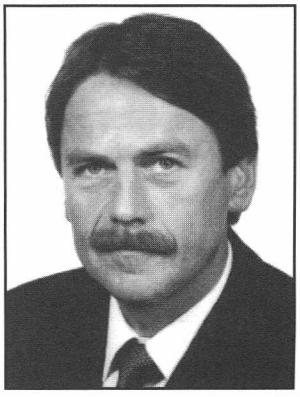
Glenn Thoren, chairman of our new Publicity and Marketing Committee, undertook a survey during the past several months to determine MTT-S member satisfaction. Glenn had a prompt response from over 25 percent of the people receiving his questionnaire. Of 106 total replies, 83 indicated that MTT-S publications are one of the most important aspects of membership and 52 indicated that the Symposium was one of the most important aspects. Only 4 respondents believed that the Symposium could be improved but 16 provided suggestions for improving the publications. These centered on making MTT-S publications more applications oriented and providing more tutorial articles. We plan to respond to these suggestions but we need your help—please contribute appropriate and readable articles for inclusion in our publications!

Tim Kemerley is searching for topics and candidate speakers for 1996 Distinguished Microwave Lecturer. Please contact Tim if you have an exciting topic and/or speaker in mind. He can be reached by fax at (513) 476-4807 or by e-mail at t.kemerley@ieee.org.

During the last AdCom meeting, sites for both the 2002 and 2003 International Microwave Symposiums were selected. Seattle will be the host city for 2002 and Philadelphia for 2003. Representatives from both cities offered excellent presentations, making the choice between them very difficult. Choosing both solved this happy problem.

Don't forget to contribute your application and tutorial articles to the MTT-S publications. Have a wonderful summer.

Division IV Director's Report



by Rolf H. Jansen

Having been in office as the IEEE Division IV Director since January this year, this is my first message to all Societies within the Division and I would like to express my thanks to all of those who contributed to my successful election. It appears that I have received a particularly high number of votes from the membership outside of the United States, namely from Regions 8, 9 and 10, which I consider at least partially as a recognition of my long years of activity in the MTT-S Transnational Committee. Thanks again to all of you. I shall do my best to contribute in my new function to the globalization of the IEEE and to the promotion and support of the membership in the named regions.

In early March I participated in the TAB meetings and board of directors meetings at Calgary, Canada. These meetings, and the many enjoyable and good contacts I had in parallel, gave me an idea of the areas on which I should concentrate my IEEE activities during the next two years. In particular, I had the chance to meet most of the Presidents of the Societies within Division IV personally and got the impression that we all will make a very good team.

One of the first official obligations I had—and that was finalized successfully with the help of Ken Dawson, the previous Division IV Director—was the nomination of the candidates for the new Division IV Delegate Director Elect position. Under Ken's leadership during the last year, the Division IV societies had decided to opt for such a Delegate Director Elect nomination in order to create continuity for the Division IV director office in the future. The elections will take place in November this year and we have now three excellent candidates:

Stanley H. Charap	(Mag)
William G. Duff	(EMC)
Orhan Nalcioglu	(NPS)

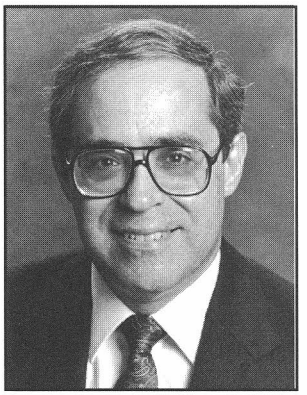
All of these have been Society Presidents and all are IEEE Fellows. The one who is elected will serve in 1996 as Delegate Director Elect overlapping with my second year of office to create the desired continuity in the Division IV Director knowledge. The candidate elect will automatically become the Division IV Director for the two years 1997/98 following my term of office. With Ken Dawson's strong support (he acted as the Division IV Nominating Committee Chairman), the plan of our Societies regarding the Director Elect position has now been set on a regular path for the future.

An additional important item of my activities at Calgary was my joining of the global RAB/TAB Transnational Committee as a member and participation in the respective meetings. This is the key committee now to elevate my previous transnational activities on the Society level to a combined effort covering all or most Societies of Division IV. In various discussions with Society Presidents I received positive reactions already to this plan and also the promise for support from the RAB/TAB Transnational Committee Chairman, Dr. Tsuneo Nakahara. The key idea is to establish a Society related Transnational Committee in each of the Division IV Societies and to expand the mechanisms explored by myself in the past to the promotion of membership and chapters to all Division IV Societies.Synergies like joint chapter operations will be looked for as much as possible, keeping in mind that there is a natural overlap of technical interests between the Division IV Societies. It is also hoped that an initiative currently conducted between MTT-S and ED-S with strong participation by myself can be spread out over the Division. I shall bring this into the next RAB/TAB Committee meeting to be held on June 22, 1995, and discuss with the colleagues then how this can be done best.

Please let me have your input if you think you can contribute to this idea. I shall be happy to learn from you and plan to give a first report about the progress made in a couple of months.

Rolf H. Jansen
Phone: +45-241-803900
Fax: +49-241-8888294
e-mail: jansen@ithe.rwth-aachen.de

Call for MTT-S AdCom Nominations and Committee-Appointment Suggestions



by Barry E. Spielman
Chairman
Nominations and Appointments Committee

The nomination of candidates for election to the MTT-S Administrative Committee (AdCom) will be conducted by the MTT-S Nominations and Appointments Committee (N&A Committee). The N&A Committee will handle the nominations with the same procedure as in past years specified in the MTT-S Bylaws and Procedures Manual. In addition to the elections, the N&A Committee seeks interested and qualified individuals who will be recommended to the incoming President for his consideration to serve on various MTT-S committees.

At its fall meeting, the MTT-S AdCom elects members to serve on AdCom. The Bylaws state that the Nominations Committee will present a slate of at least two members for each vacancy which will occur the following January 1. The Nominations Committee shall consider in their selection the geographical and organizational distribution, as well as AdCom effectiveness. AdCom members who have served three consecutive terms by the following January 1 are ineligible for nomination by the N&A Committee.

The Bylaws provide three means by which one may be nominated for AdCom consideration. They are as follows:

- Nomination by the Nominations Committee
- Nomination by petition signed by 25 MTT-S members and submitted to the Nominations Committee prior to July 1, 1995
- Chapter nomination submitted prior to July 1, 1995

All nominees will be contacted to ascertain that they will accept the nomination and will commit themselves for active participation in at least two meetings a year, held at various locations in the United States.

The geographical and affiliation distributions of current AdCom members are given in the table below.

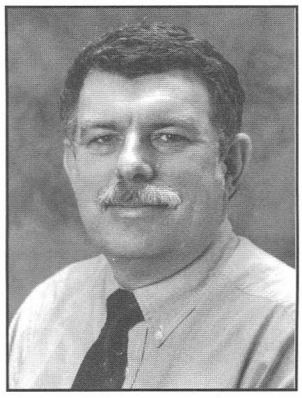
The Nominations Committee needs your suggestions for potential nominees to serve our membership as AdCom members. Please submit your suggestion by July 1, 1995, to your local Chapter Chairman and/or to:

B. Spielman
N&A Committee Chairman
Washington University
One Brookings Drive, Box 1127
St. Louis, MO 63130
Fax (314) 935-7500

Present Elected AdCom (1995): Total = 18

Mid-Atlantic & Eastern U.S.	5	Industry	12
Southeastern U.S.	2	Government	3
Middle Region U.S.	2	University	3
Southwestern U.S.	1		
Western U.S.	5		
Europe	2		
Asia-Pacific Region	1		

Membership Services Fall '95



by John T. Barr, IV

The MTT-S would like to welcome the formation of three new chapters:

- Nanjing Chapter, joint with AP and EMC, chair: Prof. Wen-Xun Zhang
- Ukraine Chapter, joint with ED and AP, chair: Prof. Nikolai N. Voitovich
- Russian/St. Petersburg Chapter, joint with ED, chair: Prof. Sergei Tretyakov

MTT-S now has 81 chapters. A significant part of this recent growth and a number of others in process is due to strong recruitment activity, lead by Rolf Jansen, in Eastern Europe and former Soviet Union area.

Chapter Chair Meeting at IMS-95 in Orlando

Representatives from over 30 chapters met at the recent International Microwave Symposium (IMS) in Orlando. The meeting was or-ganized by ***J. K. McKinney (j.mckinney@ieee.org)***. It was a highly successful (but perhaps a bit long) meeting with the Chapter representatives, members of the Membership Services Committee, and members of the MTT-S AdCom. After presentations by Membership Services committee members, the Chapter representatives overviewed the activities at their individual chapters. Many Chapters are highly successful in operating joint programs with other Societies, increasing the breadth of potential topics and potential attendees. Also, the Chapters that had special activities—workshops, short courses and vendor exhibits—found these to be very successful for increasing membership attendance and providing additional chapter funding. Some problems reported were lack of funding from Sections and difficulties in promoting meetings.

Future Chapter Chair meetings will occur at the European Microwave Conference, Asia Pacific Microwave Conference and, of course, next year at the IMS-96 meeting in San Francisco. Due to feedback received at this year's meeting, we will be working on a meeting agenda that provides time for more interaction between Chapter representations.

Membership Booth at IMS-95

An annual activity at each IMS is the New Member Booth. This year's booth, organized by Jitendra Goel, was exceptionally successful with 303 new MTT-S members, 66 of them new to IEEE. This remarkable result suggests that there are many people attending IEEE and MTT-S events that are not yet members. Chapters should consider running a local membership drive at chapter meetings or workshops.

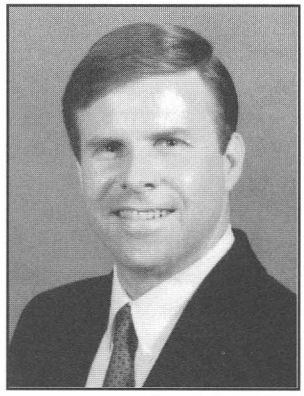
Membership Renewal Problems

Due to a computer system upgrade at IEEE Headquarters, many members have experienced problems with renewal of their IEEE membership. In some cases this has affected the distribution of publications. The IEEE Staff is actively working on the problem and hopes to have a resolution soon. If you are still having problems, call or write ***IEEE Membership Services (member.services@ieee.org).***

Here to Help

The MTT-S exists for the benefit of its membership, and the Membership Services Committee exists to aid in providing that benefit. Contact ***John Barr (j.barr@ieee.org)*** or ***Ed Rezek (e.rezek@ieee.org)*** with any suggestions on how the MTT-S can better serve its membership. If you have ideas for improvements in *TransceiveR* (a special newsletter for Chapter Officers), or if you are not receiving it, contact ***Joe Staudinger, j.staudinger@ieee.org)***. Need a meeting speaker? Try the Microwave Distinguished Lecturer. Contact ***Kris Agarwal (k.agarwal@ti.com).*** Starting up a new Chapter? Need help in acquiring e mail access? The Membership Services Committee is here help. See the Spring '95 *MTT-S Newsletter* for a more complete description of the Membership Services Committee. Drop us a note and let us know how we are doing.

Members Speak Out in MTT-S Survey



by Glenn Thoren
Publicity and Public Relations Chairman

Isn't it time someone asked you to tell the MTT-S what's really important to you as a member? If you were asked would you answer? Does the membership really care about the programs, policies, publications, local and national events of the society? These questions are only a few of the issues being addressed by the Publicity and Public Relations Committee. Why? Because the Administrative Committee of the MTT-S is convinced, and committed that what the membership thinks, feels, and wants is vital to the growth and health of the society. So let's not just talk about it, let's do something!

We did, and we will.

A random survey of 500 members was conducted this spring. A single page survey sheet was devised that asked for a straightforward ranking of the key areas of the society including publications, chapter activities, the International Symposium, programs, IEEE insurance, IEEE investment programs and personal networking. In addition, some demographic information on the survey participant was requested. The most intriguing and perhaps informative section was the comments section. Some members just aren't that shy about telling you what's on their mind. Hundreds of comments were received and AdCom is listening. The response to the survey was very good.

More than 140 responses were mailed or faxed to my office. That 28% response rate far exceeds the 2-12% response expected from random surveys and the 10-20% response expected from typical surveys in professional organizations.

Most people hate surveys, so we made this one "user friendly". It was one page; could be faxed back immediately (many were) or mailed at the participant's expense with my promise that I would reimburse the sender with one crisp dollar for his time and effort. For those without a fax machine this turned out to be an attractive option.

Late returns are still trickling in. But as of the end of June some clear messages are emerging.

1. Our publications are the most important feature of membership but almost 22% of the respondents expressed a need for some improvement.
2. The International Symposium is second in importance and there were very few suggestions for improvement. It is highly regarded and appreciated.
3. Chapter activities were notably less important to members, even less than insurance programs. A need for improvement was also identified.
4. IEEE insurance was a greater factor for membership than IEEE investments.
5. 72% of the respondents had MTT-S as their primary society. Antennas and Propagation was the most frequent primary society of the other 28%.
6. Continuing Education programs were not of significant importance and scored the highest don't care rating.

The distribution of respondents indicates a large population with more than 20 years of membership. It would be interesting to compare this with other "growing" societies. Is member retention the key? Or is it capturing new members?

Several recurring themes can be seen in the written comments.

1. The transactions are academic and not as useful to the practicing engineer. More "applications" papers are strongly desired.
2. Commercial and wireless (also commercial) technology should be receiving more emphasis in the society.
3. MTT-S is doing a good job according to many respondents.
4. Notably absent are comments on chapter activities.
5. We should look at Antennas and Propagation Society publications. Several respondents had favorable remarks about them.

An additional 2000 surveys were distributed to the International Microwave Symposium attendees in their registration material at Orlando. I will report on these results in the next *Newsletter*.

What can we deduce from the input thus far? What actions are appropriate?

First, the symposium is our most successful activity. Very few surveys or

comments expressed a need for improvement. We should continue our focus and investment in the symposium. Chapter activities need further review. We are not reaching our membership through chapter activities. IEEE insurance has a greater impact than chapter activities. That does not seem right. There is an opportunity to improve our publications in the opinion of the membership. More commercial and practical content is being requested.

The Survey data collection is continuing. This activity has probably been overdue, and I strongly recommend continuing surveys to measure the needs of the membership. We are reviewing AP-S publications and other newsletters. "Applications" and tutorial articles will be encouraged for publication. More effective chapter activities are constantly being pursued. There will be more surveys to reach those who are not yet MTT-S members.

A word of appreciation is due to Eliot Cohen, Charlie Jackson, John Barr, Peter Staecker, Harlan Howe and several other AdCom members for reviewing the survey and recommending changes in the content and survey methods.

The value in listening to the MTT-S membership comes from making the changes that better serve our membership and attract new members. So look forward to more opportunities to participate and to communicate as we seek your advice and solicit your energy to make the Microwave Theory and Techniques Society an exciting professional organization meeting your needs.

For those of you who participated, thank you. Your remarks are important and they are heard!

Glenn Thoren
Chairman
Publishing and Marketing
Committee
Phone: (603) 885-2988
e-mail:
thoren@ncavax.sanders.lockheed.com

Charlie Jackson
Vice Chairman
Publishing and Marketing
Committee
Phone: (310) 812-0283
e-mail: c.jackson@ieee.org

The raw data are:

"The most important feature(s) of membership is (are)"

1. Publications	129
2. International Symposium	82
3. Personal Networking	31
4. IEEE Insurance	29
5. Chapter Activities	22
6. IEEE Investments	13
7. Other	2

"MTT-S Activities Rating"

	Needs Improvement	Satisfactory	Don't Care
Publications: *Newsletter*	25	99	13
Transactions	30	100	3
Chapter Activities	29	67	29
International Symposium	8	104	15
Educational Programs	33	48	33

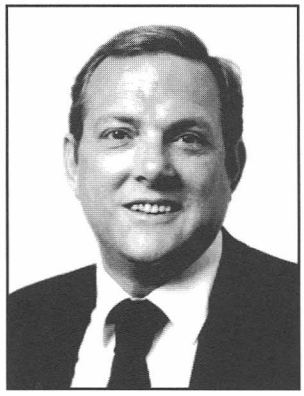
Survey Shows Pending Legislation Would Boost Engineers' Personal Savings

According to an IEEE-U.S. Activities survey released on May 22, electrical engineers would increase their personal retirement savings rates if Congress enacts pending savings-incentive legislation. The questionnaire, which appeared in the April 10 issue of *Electronic Engineering Times*, yielded nearly 150 responses on issues ranging from engineers' current saving patterns to their preferences on competing legislative proposals.

Survey participants were enthusiastic about pending savings-incentive legislation, and 90 percent indicated they would invest in proposed savings instruments. Said IEEE's United States Activities Board (USAB) Chair Joel B. Snyder, "The poll reveals an overwhelming consensus that engineers will do their part to rebuild the collapsing national savings rate—if Congress gives them the tools. Engineers are telling us that they're worried about retirement security, but they simply can't afford to increase their savings and their tax bite at the same time."

For more information or a copy of the survey results, contact Chris Currie at the IEEE-USA Office in Washington, D.C., (202) 785-0017, ext. 342 (phone); or c.currie@ieee.org (e-mail)

MTT Society Ombudsman



by Edward C. Niehenke

As your Ombudsman, I have received sixteen inquiries from MTT-S members in 1995. Nine inquiries were from the US, while the others were from Canada, India, Italy, Liberia, Spain, Sweden, and Yugoslavia. A summary of the inquiries is listed below.

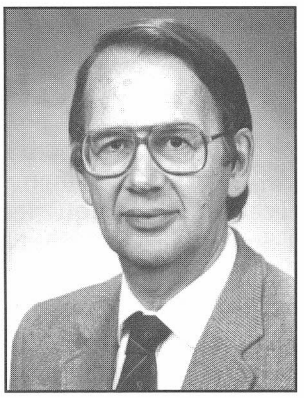
Please feel free to contact me by letter or telephone concerning any complaint you may have or any assistance you may need in obtaining membership services from IEEE and MTT-S.

Edward C. Niehenke
Westinghouse Electric Corp.
P.O. Box 1521, MS-3Kll
Baltimore, MD 21203
(410)765-4573
(410)765-2116 (Fax)

Summary of Inquiries (January-June, 1995)

Number of Inquiries	Request	Action Taken
4	Members paid dues and requested 1995 IEEE membership card as well as status of membership.	Determined status and in all cases except one special situation IEEE had processed renewal and mailed out membership cards. In the special situation involving Yugoslav members, membership cards are being sent.
3	Members requested periodicals be sent that were not received	Missing periodicals were sent to members.
3	Members requested information for eligibility for life membership.	Researched birthday and years of IEEE membership to determine life member eligible date. Informed members of their life member year.
1	Member requested MTT-S *Newsletter* and advance notice of meetings including the MTT-S International Microwave Symposium notice which he was not receiving. Member has received all other periodicals.	IEEE data base on person corrected. Will receive items in the future as entitled.
1	Member requested application for IEEE Senior Member including requirements and application procedures.	All necessary information and IEEE Senior Membership application sent to member.
1	Member requested 1995 International Microwave Symposium registration receipts for all members of a particular company.	Receipts were sent and received for company attendees.
1	A member advance registered for 1995 International Microwave Symposium and had to re-register at the symposium because preregistration was not in computer base. Member requested reimbursement of over-payment.	Payment of preregistration was received. Member will be reimbursed over-payment.
1	Life member requested delivery of certain IEEE periodicals be discontinued	IEEE periodicals were removed from the database.
1	Student member requested back issues of and MTT-S periodicals be sent to him, because he did not receive them.	Determined the IEEE student member was not receiving periodicals because he is not a member member of the AP-S or MTT-S. Encouraged the member to join to receive the periodicals. Explained the student fees are discounted 50%, for joining the society and 25% for periodicals that are not included in the society membership.

Education Committee Announces Graduate Fellowship Winners



by Denis Webb
Chairman

Graduate Fellowship Winners

Winners of 1995 Graduate Fellowships were announced at the International Microwave Symposium in Orlando, Florida, and received formal recognition at the plenary session. Each of the awardees received $5,000 to support their graduate work pursuant to a graduate degree in microwave engineering. The winners, along with their thesis advisors, institution and thesis research topic, are listed below:

1. *Andrew Adams*
   Advisor: Dr. Roger Pollard
   Institution: University of Leeds
   Research Topic: Microwave and Millimeter wave Oscillator Array Power Combining Techniques

2. *Chin Soon Teoh*
   Advisor: Dr. Lionel Davis
   Institution: University of Manchester Institute of Science and Technology
   Research Topic: Ferrite-Coupled Planar Microwave Devices

3. *Linda Mullen*
   Advisor: Dr. Peter Herczfeld
   Institution: Drexel University
   Research Topic: Application of RADAR technology to LIDAR systems-optical microwave interaction

Congratulations to all and a special thanks to Aditya Gupta for efficiently overseeing the selection process. Application deadline for the 1996 competition is 30 November 1995 (see announcement elsewhere in this Newsletter).

This year will also mark the first award of the Microwave Engineering Graduate Scholarship Fund (see announcement elsewhere in this Newsletter). The goal of this fund is to help support the education and accreditation of worthy future microwave engineers. It relies upon donations from MTT-S members, families and friends of members, trusts of deceased members, as well as companies and institutions. The grant will range from $2,000 to $5,000 and will be exempt from federal income tax. Donations can be made to honor a deceased member of the society. This year's award will be made in memory of one of our distinguished former members, Octavius Pitzalis. Contributions are welcomed for this year's award as well as future awards.

Education Committee Activities

In other Education Committee activities, a new program was initiated in 1995 to encourage girls to pursue careers in math, sciences and engineering. The program, called STAR (Student-Teacher and Research Engineer (Scientist) is sponsored jointly by MTT-S and ED-S. In this program interested society members couple with enthusiastic teachers in a local school to plan field trips, luncheons, etc., so the students can learn about real engineers and career options. Society members interested in participating in or leaning more about this program should contact:

Julia Brown
Hughes Research Labs
Phone: (310) 317-5068
Fax: 5483
e-mail: jbrown@madmax.hrl.hac.com

or

April Brown
Georgia Tech:
Phone: (404) 853-9447
Fax: 9171april.brown@ee.gatech.edu

1996 IEEE Microwave Theory and Techniques Society 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 achievements 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: 30 November, 1995

For applications contact:

Dr. Denis C. Webb
Microwave Technology Branch
Naval Research Laboratory
Washington, DC 20375-5347
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Requests for application materials must be received no later than 30 September 1995.

1995 GaAs IC Symposium San Diego

by Mark Wilson

The 1995 GaAs Integrated Circuit Symposium will be held October 29 through November 1, 1995, at the Sheraton Harbor Island Resort in San Diego, California. It is jointly sponsored by the EDS and MTT, and over the past 17 years has been the preeminent international forum on the most recent advancements in integrated circuits using GaAs, InP, and other compound semiconductor devices. Coverage embraces all aspects of the technology including materials issues, device fabrication, IC design and testing, volume manufacturing, and systems implementation.

Based on the history of the Symposium, it is anticipated that over 70 technical papers will be selected from world-wide submissions for oral presentation and publication in the *Symposium Digest*. In addition, there will be several invited papers and panel sessions on a wide range of topics of interest to the GaAs supplier and customer community. Of special interest is this year's short course covering the application and design of GaAs MMICs for use in cellular telephone systems. This short course will cover the application of GaAs MESFETs, PHEMTs, and HBTs to hand-held cellular telephones, as well as cellular base station switching systems. The short course will be held all day Sunday, October 29, preceding the conference.

Organizer:
Phil Wallace
Anadigics
Phone: (908) 412-5987
Fax: (908) 412-5985
e-mail: wallacep@aol.com.

For those new to the GaAs industry, the Symposium will again offer the popular primer short course, Basics of GaAs ICs, an introductory-level class intended for those with little or no experience in GaAs ICs. The Sunday evening course will cover materials and processes, device operation, and both analog/microwave as well as digital ICs. The course is tailored to provide the background needed to understand and appreciate the papers presented in the Technical Program.

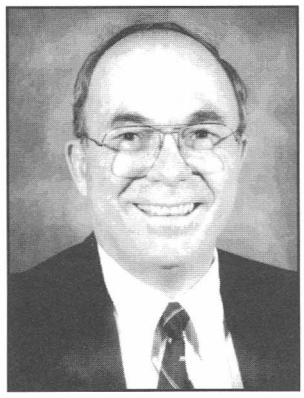
Attendees will have the opportunity to talk and visit with CAD tool, material, process equipment, and device suppliers at the vendor exhibition which is held on Monday and Tuesday in conjunction with the conference. In addition, there will be vendor product forums where the latest GaAs RF and telecommunication IC product offerings will be announced.

San Diego offers a wonderful setting for this year's conference. The Sheraton Harbor Island Resort is just minutes from San Diego International Airport, providing attendees easy access to and from the conference. Attendees should allow some extra time to enjoy the many activities San Diego has to offer, such as the world renowned San Diego Zoo, Sea World, or a simple afternoon at the beach.

For further information on the Symposium content please contact:

Ellisa Sobolewski
Advanced Research Projects Agency
Phone: (703) 696-2254
Fax: (703) 696-2203
e-mail: lsobolewski@arpa.mil.

Preparing for the 1996 International Microwave Symposium



by E. James Crescenzi, Jr.
Steering Committee Chairman

Your San Francisco IMS (International Microwave Symposium) Steering Committee is very active in its preparations for the 1996 Microwave Week. The symposium has a reputation of being the most comprehensive microwave industry event of the year, and we are planning on a few special features to enhance that legacy. Of course, San Francisco is a favorite location with many diversions to further entice our members to attend. The 1996 Microwave Week will be June 16-21—be sure to mark you calendars.

The process starts, of course, with our members' and colleagues' willingness to contribute excellent technical papers. We've attempted to improve the paper submission and evaluation process by expanding the first Call for Papers, which you should have received by now. Hopefully you've noticed the new features. The evaluation criteria are detailed clearly and precisely, and the process of paper evaluation is made more clear by listing the IMS Technical Program Committee structure, including the relevant technical areas covered by each committee. This will allow authors to tell us which committee area they believe is most applicable for consideration of their paper submission. Another new item for 1996 is that the traditional registrant's gift will be a CD ROM including all 1996 IMS papers (in addition to the hard-bound digest received as part of registration). If you wish to have your paper included on the first-ever MTT-S CD ROM, you won't want to miss the December 1st, 1995, paper submission deadline.

The quality and breadth of papers presented is a first priority for the symposium. In this era of expanding applications and changing markets, it is critical that papers included in the symposium represent the full breadth of activities of our profession. If you know of good technical work of interest to our members, please encourage the responsible individuals to submit it for consideration for publication. Give them a copy of the Call for Papers, and remind them of the very strong personal and institutional benefit of publication in this forum.

We are also excited about new plans for the 1996 International Microwave Exhibition. Early sign-ups indicate we have a good shot at setting a record for the number of exhibitors. In addition, we are planning a new series of Microwave Technology Tutorial and Applications Sessions as an adjunct to the exhibition. These sessions will allow companies and individuals to present applications and review material of general interest to practicing engineers and technicians. They will be in classroom facilities within the exhibition area. There will be no charge to attendees other than the modest exhibition fee, and we hope to expand the overall participation in Microwave Week through this new activity. Companies or individuals interested in presenting applications or tutorial sessions should contact:

Dr. Martin Grace
Phone: (408) 778-2000 (ext. 4371)
Fax: (408) 778-2039

Hopefully this article reflects some of the enthusiasm of our greater San Francisco area membership as they make preparations for what is sure to be a very special 1996 International Microwave Symposium. We look forward to and appreciate your support and participation. Please address any inquiries regarding Microwave Week to:

Dr. James Crescenzi
Phone: (415) 813-2506
Fax: (415) 813-2402
e-mail: j.crescenzi@ieee.org

See Call for Papers "Bridging the Spectrum" (page 56)

ARFTG Conference

by Harmon W. Banning
Publicity Chairman, ARFTG

Summary of 45th Conference of the Automatic RF Techniques Group

The 45th Conference of the Automatic RF Techniques Group was held May 19, 1995, in Orlando, Florida. Approximately 100 people attended. The subject was "Testing and Design."

The technical papers presented consisted of the following:

- Test Strategy for RF & Microwave Semiconductor Devices for Wireless Communications Market

  Antoni Niedzwiecki—Hewlett-Packard, Communications Components Div. (invited paper)

- Load Pull Templates: A Method for Benchmarking Nonlinear Device Models With Load Pull Measurements

  D. Bridges, M. DeHaan, M. LaBelle, S. Pritchett—Texas Instruments RF/Microwave Technology Center

- A New Measurement Method for Determination of Transistor Parameters

  Alexnader Chenakin—Kiev Polytechnic Institute, Kiev, Ukraine.

- VIOMAP, 16QAM and Spectral Regrowth: Enhanced Prediction and Predistortion Based on Two-Tone Black-Box Model Extraction

  Frans Verbeyst, Marc Vanden Bossche—Hewlett-Packard NMDG, Brussels, Belgium

- Production Testing for RF Power Modules

  Mark Roos—Roos Instruments (invited paper)

- On-Wafer Intermodulation Distortion and Third Order Intercept Measurements Using Computer Controlled Microwave Tuners

  M. DeHaan, E. Reese, S. Martin, K. Ross, R. Thornton—Texas Instruments RF/Microwave Technology Center

- Key Considerations in RFIC Production Test

  John Barr—Hewlett-Packard Systems Division (invited paper)

- The K-50L Coaxial Probe: Its Origin, Applications, and Benefits

  Robert Kornowski—Motorola Land Mobile Products Sector (invited paper)

- Calibration for PC Board Fixtures and Probes

  Joel Dunsmore—Hewlett-Packard Microwave Instruments Division (invited paper)

- Simplified Vector Network Analyzer Design Using An Electronic Calibrator

  Vahe Adamian—ATN Microwave

- Process Control Monitor to Device Correlation

  Laird Snowden Jr.—AT&T Microelectronics (invited paper)

- A Full Automatic On-Wafer High Frequency Measurement Station in Industrial Environment for Silicon Devices

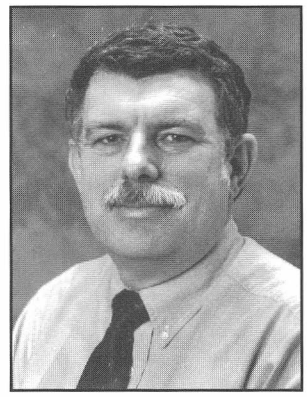
  J. L. Carbonero, G. Morin—SGS-Thompson Microelectronics Central R&D, Crolles, France; B. Cabon—Lemo/Enserg/INPG-URA CNRS, Grenoble

Upcoming 46th Conference of the Automatic RF Techniques Group

The 46th Conference of the Automatic RF Techniques Group will be held November 30 and December 1, 1995, at the Safari Resort in Scottsdale, Arizona.

The subject will be "Testing for Wireless Applications"; however, papers of other topics may be presented at that time.

ARFTG Highlights Winter '95



by John T. Barr, IV

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

45th ARFTG Conference Testing and Designing of RFICs

The 45th ARFTG Conference was held in Orlando, Florida, at the Orlando Visitors and Convention Center on May 19, 1995, as part of 1995 MTT-S International Microwave Week. The theme of this one-day technical conference with concurrent manufacture exhibits was Testing and Designing of RFICs. There were over 95 paid attendees and seven exhibits in the concurrent exhibitors' room. Below is a list of the presented papers:

- "Test Strategy for RF & Microwave Semiconductor Devices for Wireless Communications Market," A. Niedzwiecki
- "Load Pull Templates: A Method for Benchmarking Nonlinear Device Models with Load Pull Measurements," D. Bridges
- "A New Measurement Method for Determination of Transistor Parameters," A. Chenakin
- "VIOMAP, 16 QAM and Spectral Regrowth: Enhanced Prediction and Predistortion Based on Two-Tone Black-Box Model Extraction," F. Verbeyst
  *** Voted Best Paper by conference attendees ***
- "Production Testing for RF Power Modules," M. Roos
- "On-Wafer Intermodulation Distortion and Third Order Intercept Measurements Using Computer Controlled Microwave Tuners," M. DeHaan
- "Key Considerations in RFIC Production Test," J. Barr
- "The K-50L Coaxial Probe: Its Origin, Applications, and Benefits," R. Kornowski
- "Calibration for PC Board Fixtures and Probes," J. Dunsmore
- "Simplified Vector Network Analyzer Design Using An Electronic Calibrator," V. Adamian
- "Process Control Monitor to Device Data Correlation," L. Snowden
- "A Full Automatic On-Wafer High Frequency Measurement Station in Industrial Environment for Silicon Device" J. L. Carbonero

Poster Papers:

- "Requirements for Stable DC Biasing of High Gain Discrete PHEMTS During Wafer Level Screening," R. J. Finke
- "A Method for Deriving Large-Signal Input Impedance of Microwave Devices Using a Modified Source and Load Pull Technique," M. Jones
- "Accurate I-V Characterization of GaAs Hetrojunction Bipolar Transistors Using a Precision Pulsed I-V System," R. Stewart
- "Up To Date Version of a Computer-Driven Noise Figure Measuring System for the Simultaneous Determination of Noise, Gain, and Scattering Parameters of Microwave Transistors," A DiPaola
- "Single-Port Technique for Adapter Efficiency Evaluation," S. Pucic
- "A Generalized Self-Calibration Theory for Dual Six-Port Network Analyzers," H. G. Krekles
- "LYZ: A Self-Calibration Approach in Competition to the LRM Method for On-Wafer Measurements," H. Heuerman
- "Guidelines for Design and Testing at Millimeter Wave Frequencies," R. J. Finke
- "Waveform Analysis of GaAs FET Breakdown," Y. A. Tkachenko

The Conference Chair was Edward Godshalk of Tektronix, and the Conference TPC was David Walker of NIST.

A conference digest is available. Cost is $20.00 for an ARFTG member and $45.00 for a nonmember. An additional $9.00 is requested for airmail outside the USA. Please contact:

Henry Burger, ARFTG
1008 East Baseline Road, No. 955
Tempe, AZ 85283-1314

ExCom Activities

At the Orlando Executive Committee meeting, the ARFTG ExCom planned a number of future meetings.

As described below the 46th ARFTG Conference will be in Phoenix in December 1995; the 47th will be held jointly with the San Francisco MTT-S Symposium in June 1996; the 48th will be held in Tampa, Florida, in November 1996; and the 49th will be held jointly with the Denver MTT-S Symposium in June 1996. In addition, it was decided to continue the pre-conference Short Course, that was so successfully first given at last year's Boulder meeting, at each of the future Fall Conferences. Finally, a proposal to hold joint sessions with the MTT-S at the MTT-S Symposium was approved and was sent to the MTT-S TCC for approval.

Upcoming Activities 6th ARFTG Conference Testing for Wireless Applications

The 46th ARFTG Conference will be held in Phoenix-Scottsdale, Arizona, on November 30 and December 1, 1995. The theme of this two-day technical conference with concurrent manufacture exhibits will be "Testing for Wireless Applications." The expansion of the market for wireless is continuing at an explosive rate; however, the competitive nature of this market is putting tremendous downward pressure on the cost and development cycle time. Equipment manufacturers are in the unique situation of having to reduce test times and costs while maintaining a high level of performance and reliability by their quasi-consumer customer base. Papers are solicited relating to test requirements, methods and techniques, test equipment design, performance results and environmental considerations, leading to lower overall testing costs, reduced test time and high confidence levels. This includes on-wafer as well as fixture characterization techniques. Load-pull characterization for power, gain and efficiency, as well as linearity and stability, is of interest. Derivation of novel figures-of-merit and analysis or correlation of large signal RF to DC test parameters are of concern.

Papers are also invited on other areas of automated microwave and RF testing including improved techniques for calibration and verification, MMIC related measurements issues, CAD, millimeter-wave systems and other topics of current interest to the RF/microwave community.

In addition to the technical presentations, the attendees will have ample time for informal discussion among themselves during the breaks and during the provided lunches and dinner. (Your spouse is invited to the Awards Banquet at no extra cost.) There will be time for discussions with vendors and viewing of exhibits to see the latest in automation and measurement products. The registration fee includes technical sessions, exhibits, and all meals and break refreshments, one year membership in ARFTG and conference digest of the presented papers.

Those interested in participating should contact:

William Pastori, Conference Chair
Maury Microwave
2900 Inland Empire Blvd.
Ontario, CA 91764
Phone: (909) 987-4715
Fax: (909) 987-1112
or
Mike Golio, Conference TPC
Motorola
MS EL-609
2100 East Elliot Road
Tempe, AZ 85284
Phone: (602) 413-5947
Fax: (602) 413-4453
e-mail: m.golio@ ieee.org.

Those interested in exhibiting should contact:

Michael Fennelly
ATN Microwave
11 Executive Park Drive
Billerica, MA 01821
Phone: (508) 667-4200 x18
Fax: (508) 667-8548.

Deadline for earlier paper submissions is August 28, 1995, with the final camera-ready paper submission deadline is October 5, 1995. Potential presenters should request the ARFTG Author's Preparation Package.

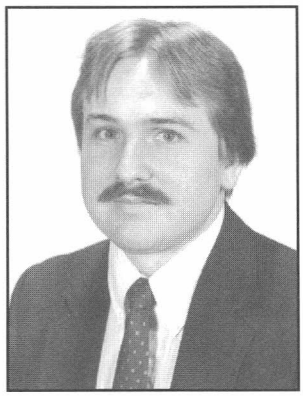
Measurement Professional? or Interested in Learning More?

We will be looking forward to discussing the latest in measurement automation and accuracy with you in Phoenix. ARFTG brings you the latest in RF, microwave and millimeter-wave analysis, design and measurement. State-of-the-art papers are presented twice a year. If you are involved in automated measurement techniques, come and join your peers and keep current with our ever-evolving technology. For more information on ARFTG or future conferences, write:

John Barr
Santa Rosa System Division 3US-Q
Hewlett-Packard
1400 Fountaingrove Parkway
Santa Rosa, CA 95405-1799

See Call for Papers: Fall 1995 Conference: "Testing for Wireless Applications" (page 59)

More on Free Electronic Job Searching



by Fred Schindler
Chairman
Electronic Communications Committee

Last winter we announced that the Microwave Theory and Techniques Society has made a new service available to its members. This is a follow-up to remind you of this service, and to solicit your feedback. Try the job search capability out, and send me an e-mail to let me know what you think.

We are providing the electronic job searching facility in cooperation with the Online Career Center, an established non-profit organization and a pioneer in electronic career services. This service allows MTT-S members to electronically search for jobs, free of charge. The only thing you need is Internet access. And if you don't have Internet access, we can still help you search for a job (more information on that later).

Accessing the Online Career Center

OCC job search facility is accessible interactively over the Internet three ways: 1) via gopher, 2) via telnet (which actually allows you to connect to their gopher), or 3) via Mosaic or other web browser. Internet access and gophers are available to most people where they work or go to school. If you belong to any of a number of dial-up services such as America Online, Compuserve, Delphi, etc., you can use their gopher server.

My employer, for example, has an interactive Internet gatekeeper, but not a gopher. If you do have a gopher available, you can type "gopher.occ.com", and you will be connected to OCC. (Alternatively, you can type only "gopher" and go through a series of menus, similar to what's described below. The object is to pick menus to get you "gopher servers" or "other gopher servers".)

If you don't have a gopher, you can telnet. You'll have to find out how to telnet out from your computer network. Generally it's quite simple. For example, I telnet to my employer's gatekeeper and it asks me where I want to connect to (telnet to), to which I respond "gopher.msu.edu". (This connects me to the gopher at Michigan State, which is where OCC resides.) Once you have made a telnet connection to gopher.msu.edu, proceed as follows:

Login: gopher [RETURN]
(Select from menu): Network & Database Resources [RETURN]
(Select from menu): Internet Resources by type [RETURN]
(Select from menu): Gopher Servers [RETURN]
(Select from menu): All the Gopher Servers...[RETURN]
Type: /
Type: Online Career Center [RETURN]

(This last step is a shortcut to avoid sifting through all the gophers in the world to get to OCC, which is a cumbersome process even if they are listed alphabetically).

Using the Online Career Center

Once you have connected to OCC, there are a series of menus you can go through to do whatever you would like. The first menu you see will look something like this:

Online Career Center (at Msen)
1. Questions and Comments to: occ@mail.msen.com.
2. About Online Career Center/
3. Company Sponsors and Profiles/
4. Employment Events/
5. Career Assistance/
6. FAQ—Frequently Asked Questions About OCC/
7. '94 College & University Resume Books/Diskettes/
8. * Search Jobs/
9. * Search Resumes/
10. * Other Employment Databases//
11. Recruitment Advertising Agencies/
12. "Online Career Center" On Campus/
13. Help Files: Keyword Search/Enter Resume/Print/
14. How To Enter A Resume.
15. Online Career Center Liability Policy.

Some hints when working with gopher menus: "u" takes you to previous menu, " " (space) takes you to next page of menu you are on, and "/subject name" takes you to menu line called subject name, or enter the number of the line you are interested in.

You can do keyword searches of jobs, resumes, etc. (items 8, 9 and 10 in the menu above). For simple searches, the procedure is straightforward. For a description of keyword search conventions, use the online help files (item 13 in the menu above).

You may also enter your resume into the OCC database. OCC resumes are not anonymous; you must include

your name, address, etc. Methods of including anonymous resumes are being studied for future implementation. Instructions on entering your resume are available online (use item 14 in the menu above).

The OCC may also be accessed through Mosaic or other web browser at "url:http://occ.com/" Mosaic is a graphical interface for Internet servers. Ask your computer network support organization if you have Mosaic available (I don't).

If You Don't Have Internet Access

If you don't presently have Internet access, there are a number of things you can do. First, check with the computer network organization where you work, you may have Internet access available, but just aren't aware of it. Second, check with a college or university. Generally, you can have Internet access through a college or university you are associated with. Frequently you can obtain access through a local college or university that you don't have any other association with. When you call a college or university, ask for their "computer services department."

You can also access the Internet through a number of dial up services. Some phone numbers are listed below. (No endorsements are implied):

AMERICA ONLINE—(800) 827-6364
COMPUSERVE—(800) 848-8990
DELPHI—(800) 695-4005
PSI WORLD-DIAL—(800) 827-7482—Ask for "World-Dial"
UUNET—(703) 204-8000—Ask for a "tac" account
MSEN, INC.—(313) 998-4562
INTERNIC—(800) 444-4345—An Internet information service which has a list of access providers.

Even if you do not find an easy way to have Internet access, you can post you resume at the OCC in a database used by potential employers. If you DO NOT have Internet access, you may mail your typed resume (cover letter optional) to:

ONLINE RESUME SERVICE
1713 Hemlock Lane
Plainfield, IN 46168

Your resume will be processed and entered online into the OCC resume database for six (6) months. Each resume submitted to ONLINE RESUME SERVICE must contain a "title line" not to exceed 45 spaces, for example: "Microwave Engr/5 Yrs MMIC/MIC Industry-NY." This service costs $10.00 for up to three (3) pages, including cover letter. (The fee is a nominal charge for a private typing service, and does not provide any income for either the OCC or MTT-S.) If you wish to submit your resume this way, include a check or money order made out to: **Online Resume Service.**

Let Us Know

I encourage you to try out this new electronic job searching facility. I'd be very interested in receiving feedback from you. Send an e-mail message to m.schindler@ieee.org, or fax me at (508) 470-9345.

A New Look at IMPI for IEEE MTT-S

by John M. Osepchuk, Ph.D.
MTT-S Liaison to IMPI

In early 1989 the *MTT-S Newsletter* published my review of IMPI (the International Microwave Power Institute) and the field of "microwave power" applications. I pointed out that IMPI was formed in the sixties because the IEEE was not interested in the "low-tech" field of power applications—heating, ovens, and that kind of thing. In 1989 I hinted that the "low-tech" applications are more likely to be of interest at a cocktail party than the typical "high-tech" innovation reported in *MTT Transactions*. Because of the end of the Cold War shortly thereafter and the painful downsizing that has occurred since, it may be that MTT members are more interested today in exploring the field of "power applications."

This field has always covered a wide range of subjects ranging from microwave-power transmission to the microwave oven, but the oven has been the singular worldwide success (unexpected in the sixties). Today there are about 200,000,000 microwave ovens in the world, all operating at about 2.45 GHz based on a magnetron of about 70 percent efficiency that costs

about $10 in very large quantities. This breakthrough spawned the investigation of many commercial and industrial applications which continues today. Established successes are 25 kW to 150 kW meat tempering machines, bacon cookers at similar powers, and microwave-powered ultraviolet sources for curing, etc. Hot areas of $&D include processing of ceramics, growth of diamond films in microwave-plasmas, waste remediation, tissue fixation, chemical analysis, and biomedical applications—e.g., hyperthermia, blood rewarming, etc. Another exciting development is that of the microwave "sulfur" lamp in which microwaves are concerted into a visible spectrum, mimicking that of the sun, with remarkable efficiency approaching 50 percent. Besides the annual IMPI Microwave Power Symposium, large meetings on microwave processing occur annually at the American Ceramics Society, the Materials Research Society, and to a smaller extent at other society meetings ranging from the American Chemical Society to BEMS (the Bioelectromagnetics Society). In January 1977, the First World Congress on Microwave Processing of Materials will be held in Orlando, Florida, with the sponsorship of EPRI (the Electric Power Research Institute).

The microwave oven business is quite mature and dominated by manufacturers in Korea and Japan. Recent articles in the IMPI literature and the outside world (e.g., the *New York Times)* have pointed out that microwave cooking has not caught on. Thus home economists have come and gone at IMPI. Still, as the August issue of *Consumer Reports* states, the microwave oven is here to stay even as just a rewarming device. The "susceptor," a thin aluminum film on plastic, led to the success of microwave popcorn and many other "microwavable" foods (by the way, the word "microwave" now means the appliance to many).

There remain many challenging problems, however, for the microwave oven and its industrial relatives. Among these is the ubiquitous problem of non-uniform heating, runaway during thawing, and the development of computer codes that shed useful light on practical situations. At this year's IMPI Symposium, the 30th, highlights included progress toward reliable pasteurization and sterilization of shelf-stable foods. One useful technique is that of the "hybrid mode" in which external magnetic rather than electric fields are sought. A surprise was the report of the development (in Korea) of an efficient (67 percent) 600 volt multi-beam klystron for 2.45 GHz. This poses a potential threat to the cooker magnetron.

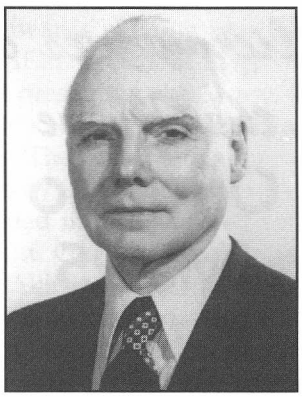
In August, the First International Workshop on Crossed-Field Devices will be held at the University of Michigan. Workers in the military applications area (CFAs) will meet with microwave oven and power application people for the first time. This comes fifty-five years after the initial (British) development of the modern multi-cavity magnetron and thirty years after the predictions by leading academicians that the magnetron was obsolete and would soon disappear. One of the recipients of such advice in the sixties was Prof. William Dow, who directed a large program of crossed-field studies at the University of Michigan. I am told that Prof. Dow survives to this day, at the rough age of 98. The success of the magnetron must be sweet contrast to the dire forecasts sent his way in the sixties.

The MTT-S has always been a supporter of IMPI and its interests—particularly in its support of the joint workshop in 1984. Even last year, when "power application" people were dismayed to see a paper on "nonthermal" damage of blood by microwaves at the MTT-S Symposium, the MTT-S responded to our criticisms. The MTT-S has always supported the IMPI community in national issues relating to questions of safety and electrophobia. Now there is a new array of regulatory and quasi-regulatory problems. These include:

- The coming conflict between microwave ovens and "wireless" applications. Tighter out-of-band noise specs are being proposed for the microwave oven and other ISM applications (industrial, scientific and medical). Can noise be suppressed in a cost-effective manner?
- The Department of Energy (unless scuttled by the new Congress) is hell-bent on applying regulations requiring increased efficiency in microwave ovens despite the basic conflict between low-noise and efficiency in the magnetron.
- Proposals are being made to take away spectrum from the ISM interests. Are they not as important for the future as amateur radio, radio astronomy or "wireless"?
- The FDA Food Code, issued in 1994, suggests that to prevent contaminated food illnesses that microwave heating or cooking should proceed as high as 190 degrees Fahrenheit. Can we find a way to remove this recipe for incineration?
- Despite advertised interest by NIST and the National Laboratories in the development of this field, federal support is misapplied to things like high-budget exploration of the possible application of Russian gyrotrons to power applications. A more logical program is to support the development and improvement of power sources (tubes and solid state). If breakthroughs occur with sources, e.g., for new frequencies like 5.8 GHz, then applications will flow thereafter.
- The fruits of electrophobia continue to hinder and retard power applications—particularly power transmission. Unscientific proposals for environmental limits, with zero averaging time, emanate from the EPA. Despite this, interest in power transmission grows—particularly in Japan where several large projects are underway and where an international symposium will be held in Kobe in October 1995.

The progress in this field remains slow. Yet surprises appear to be on the horizon. If so, the prophecy of Kapitsa (see the *1989 Newsletter)* may yet come true.

Wireless Power Transmission



by William C. Brown
MTT-S Representative to USAB
Aerospace Policy Committee

NASA's Solar Power Satellite

Two events that are of importance to those interested in wireless power transmission are occurring this year. The first item is NASA's initiative in taking another look at the Solar Power Satellite in which the sun's energy is captured in geosynchronous orbit. There the sun shines 99.5% of the time of the year on a large solar photovoltaic array that is rotating around the Earth at the same angular velocity of the Earth's rotation. The output of the array is converted into microwave power and beamed directly to Earth where it is converted back into DC power. Studies of the microwave system indicate overall DC to DC efficiencies of 50% or a little higher, while handling continuous power of several gigawatts.

Emphasis of the NASA study is to obtain a better idea of the cost of the Solar Power Satellite system whose architecture may be an updated system studied in 1977 to 1980 or may be radically different. The study comes out of Code XZ in NASA. John Mankins is the NASA manager. He has requested inputs from the USAB Aerospace Policy Committee.

International Wireless Power Transmission Conference

The other event is WPT95. WPT is an International Wireless Power Transmission Conference to be held at Kobe University in Kobe, Japan. It will be a three-day conference and feature a Japanese demonstration of a microwave powered blimp. There may also be a microwave powered helicopter demonstration from the University of Alaska. Anyone interested in the Conference should contact:

Professor Kaya
Kobe University
Fax: 011 81 78 803 1217

or

Ms. Gay Canough
Solar Works
Endicott, NY
Phone and Fax: (607) 785-6499

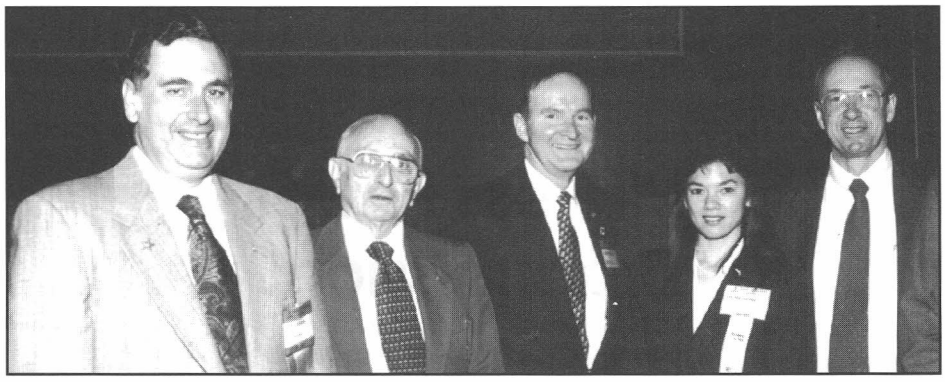
Snyder Urges Research on Industry Migration

IEEE-USA Board Chair Joel B. Snyder requested a study of the international migration of people and services in science and engineering, in a May 22 letter to Phillip A. Griffiths, chair of the National Academy of Sciences' Committee on Science, Engineering and Public Policy. Snyder explained that the realities of competition in a global market, the revolution in information technologies, and the increasing mobility of the large and well-educated international science and engineering work force are dramatically changing the nation's sci-tech enterprise. He stated that these changes are influencing how scientists and engineers live and work, and need to be understood.

The IEEE-USA leader said that the study should quantify the scale of transnational movements of engineers and scientists in the United States and around the world. Snyder noted that Griffiths' committee is uniquely qualified to conduct this research and assess the implications of technological globalization for the nation's scientific and engineering resources. In addition, he offered IEEE-USA's assistance in identifying panel participants to review analyses and reports.

Microwaves on the Move
Orlando IMS'95

by
Gene Keith Huddleston
and
Rudolph E. Henning
Co-Chairmen



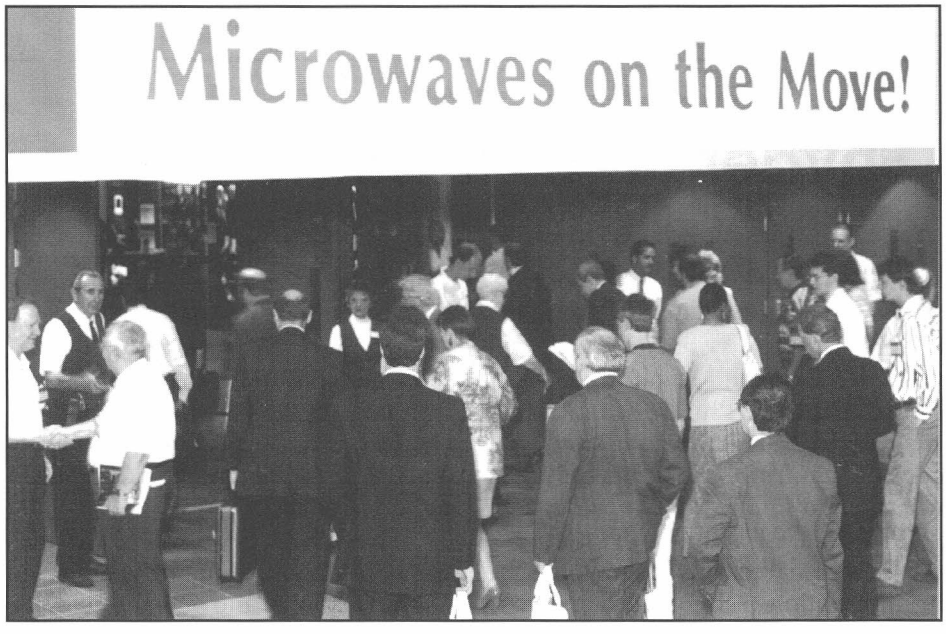
Left to right: Eliot Cohen, MTT-S President; Rudy Henning, IMS-95 Co-Chairman; Larry Brockman, Technical Chairman; Laurie Dunn, Local Arrangements Chairman; Keith Huddleston, IMS-95 Co-Chairman.

We are delighted to report the success of the 1995 IEEE International Microwave Symposium (IMS 95) that was held in Orlando May 14-19. The Orange County Convention Center and Karen Quill did their part in hosting 6482 total attendees during Microwave Week, including 1634 MTT-S attendees and 489 total exhibits. Judy Lilge and her team at the Housing Bureau reserved 12,594 hotel room nights, and our eleven hotels reported 9251 room nights actually used. Nora Miles at Gray Line of Orlando did a superb job in providing convenient transportation to and from all events. We and our Finance Chairman, Christos Christodoulou, are still sorting out the income and expenses and expect the financial outcome to reflect the success so evident at the meeting.

The Technical Program

"Microwaves on the Move!" was an aptly chosen theme as suggested by Rudy Henning. Larry Brockman's technical program was initiated by the wireless workshop on Sunday, attended by 158 persons, and reflected the interest in this one dynamic new application as well as the movement from defense to commercial arenas. Roger Rusch's presentation, "Moving Cellular Communications into Space," was very well attended at the Plenary Session on Tuesday and showed these new applications moving into space and all over the Earth, in the United States and abroad. Jim Wiltse and Parveen Wahid organized nineteen workshops occurring on Sunday, Monday, and Friday and had a total attendance of 881.

The five concurrent technical MTT-S sessions on Tuesday through Thursday presented 296 papers and occupied the attentions of the 1634 MTT-S registrants. The Open Forum arranged by Ed Rizzo was highly successful with 104 papers. The 489 technical exhibits drew 3395 exhibits-only registrants and must have been viewed by the total 6482 attendees during the week. The proceedings of the symposium are well recorded in Lynn Kirby's *Symposium Digest* and Plenary Session pamphlet, with dynamite covers by Steve Otte. The valuable continuity and active involvement of Larry and Margaret Whicker in the preparation of the massive digest publication, signs, ribbons, and early publicity is greatly appreciated. Local arrangements and signage were superbly provided behind the scenes by Laura and Dan Dunn working closely with Karen Quill at OCCC and Marlene Canterino at the Clarion Plaza Hotel. Martin Tanenhaus also worked behind the scenes to help ensure the technical quality of all the presentations. Mike Thursby and his team of reviewers ran the Student Papers contest and managed to keep the winners a secret until the announcement at the Awards Banquet. Selected technical proceedings will be recorded in the December issue of the *Transactions of the MTT-S*, prepared under the leadership of Amir Mortazawi.



Howard Ellowitz and Harlan Howe of *Microwave Journal* did an outstanding job of arranging the exhibits and providing new registration services—with much local help from Tim Durham, Mike Thursby, and the student volunteers organized by Mike. Special appreciation also goes to Christine Blanchard at Horizon House for preparation of the advance and final programs as well as other publicity items that we tend to take for granted. Jim Adair and Steve Stitzer arranged, set up, and took down a very successful historical exhibit, without the full benefit of air conditioning during what was probably a record-setting week for high temperatures and humidity. Everyone expects Florida to be hot in May—and it was!

It was our pleasure to provide for the other conferences held during Microwave Week in conjunction with IMS 95. With Terry Duffield's liaison efforts, the MMWMC conference hosted 539 attendees on Monday and Tuesday, including a well attended reception on Sunday evening at the Clarion Plaza Hotel. Madjid Belkerdid and Don Malocha and their team of volunteers from the Orlando Section hosted the National Telesystems Conference which opened on Wednesday in joint sessions with IMS and hosted 57 attendees, concluding on Friday with a very successful short course on digital receivers attended by approximately 50 persons. Larry Dunleavy provided local liaison for ARFTG which held its meeting on Friday and drew 85 attendees.

The Social Program

Jane Brochman worked with Quinn & Quinn, Inc., and arranged and hosted a very special Magic Night for all attendees on Monday evening in conjunction with the *Microwave Journal* reception at the Church Street Station entertainment complex in downtown Orlando. We were greeted as we debarked from the buses by straw hats, bandannas, a Florida panther and alligator, and the strains of a good Blue Grass band! The buses ran until midnight so that everyone could sample the many night spots whose admission was complimentary for all Magic Night attendees No one took a count, but you couldn't stir 'em with a stick!

The annual MTT-S Awards Banquet was attended by 425 persons on Wednesday evening at the Clarion Plaza Hotel. Under Rudy Henning's protocol and John Wassel's behind-the-stage support, Eliot Cohen and Dave McQuiddy ran a flawless program complete with large screen live video. They made three graduate fellowship awards and the Best Student Paper award, recognized ten new IEEE fellows and 17 Certificates of Recognition, and presented 10 major awards of our Society including the Microwave Career Award to William Getsinger. The awards evening was concluded with IEEE President-Elect Wallace S. Read presenting the Morris E. Leeds award to Roger Marks and Dylan Williams. The Awards Banquet was preceded by the traditional and very well attended industry-hosted cocktail reception. Our special appreciation to Rich Akins and Norma Montgomery for making these arrangements and recording this awards event so elegantly in the keepsake booklet and program. We also thank Skip Comstock for the excellent photographic coverage of all our main events.

Our guest program for spouses and guests was also a big success, thanks to Jane Brockman. Chris Rizzo. and Helen Wiltse. These arrangements with Premier Convention Services provided an opportunity to see and experience some of our favorite places on the nearby Space Coast and in Winter Park. Tickets were also available in the registration area for visits to Disney World, Universal Studios, Sea World and the many other attractions in the Orlando area.

On Friday of Microwave Week, as everyone was winding down, Bob Smallwood led the team to ship copies of digests to the 100 or so persons who had registered but who were not able to be at the symposium. Bob was also very active early in the planning stages as our Publicity Chairman. He was ready for a vacation in January after completing the :inputs for the advance and final programs! Last but not least, we thank our Secretary, Heather Huddleston, for recording and mailing minutes and announcements throughout the year.

On behalf of the Orlando Steering Committee, it has been our pleasure to host this premier microwave event. It has provided highly visible professional exposure for members of the Steering Committee. It has provided publicity for Orlando, Tampa, and Melbourne as the Central Florida center of MTT activity and interest. We look forward to attending and enjoying Jim Crescenzi's Microwave Week in San Francisco in 1996!

MTT-S 1995 Award Recipients

1995 N. Walter Cox Award
Dr. Krishna K. Agarwal (Kris)

The N. Walter Cox Award has been established in recognition of the qualities of N. Walter Cox and his service to the MTT Society prior to his untimely death in 1988. It is given aperiodically to a Society Volunteer whose efforts on behalf of MTT-S best exemplify his spirit and dedication.

This year's recipient is **Dr. Krishna K. Agarwal.** The citation reads: *"For Exemplary Service, Given in a Spirit of Selfless Dedication and Cooperation."*

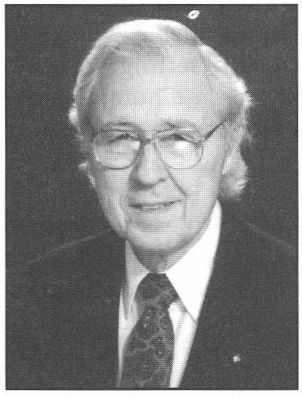
Dr. Krishna Agarwal joined the technical staff of Texas Instruments in Dallas in July 1995. He was a Professor of Electrical Engineering in the School of Science and Engineering at the University of Bridgeport, Bridgeport, CT, since 1993. He received his B.E. (Hons) degree in 1960 from Roorkee University, Roorkee (India), his Master of Technology degree in 1962 from Indian Institute of Technology, Kharagpur (India) and his Ph.D. degree in 1973 from North Carolina State University, Raleigh, NC, all in Electrical Engineering. In 1962, he served a one year fellowship at the Philips Research Labs in Eindhoven (Neth.). He subsequently became a research fellow in microwave magnetized ferrites in the Electrical Engineering Department at the Technical University of Eindhoven (Neth.).

In 1967, Dr. Agarwal became a member of technical staff in the Transmission Systems Division at Bell Telephone Labs, North Andover, MA. His research work primarily addressed applied microwave circuits and GaAs FETs for low-noise and medium power applications. He was credited with the first insertion of a 6-GHz low-noise FET amplifier in the Single Sideband system of the Bell System network. From 1980 to 1982 at TRW, and at Rockwell Collins from 1982 to 1987, he was advanced microwave circuit technology manager for point-to-point digital radio systems, then joined E-Systems' Electronic Warfare Division in 1987 to manage the development of high performance wideband receiver systems. He was a member of the corporate science and technology advisory board and chairman of the MMIC committee at E-Systems. He was inducted in the E-Systems Hall of Fame in 1992 and honored by E-Systems in 1993 when he was presented the highest award of E-Systems Corporation for his outstanding research efforts by the Chairman of the Board.

Dr. Agarwal has published over 25 papers in *IEEE/MTT-S Transactions* and other journals. He has presented many papers at International Microwave Symposia, chaired and organized several panel sessions and workshops. He served on the IEEE Press Board and on MTT-S AdCom as Chairman of the Education Committee, Technical Committees, and Co-Chairman of Membership Services. He now serves as Chairman of the Distinguished Microwave Lecturer program. He serves on the editorial boards of *MTT-S Transactions, Microwave & Optical Technology Letters* (Wiley) and *Electronic Letters* (London) and is a contributing editor to the *Applied Microwave & Wireless* magazine.

Dr. Agarwal is a Fellow of IEEE. He is a member of Eta Kappa Nu, Pi Mu Epsilon and Tau Beta Pi honor societies. A President of India Gold Medalist for merit, he received Philips, NASA and Ford Foundation fellowships for graduate studies. He enjoys jogging, gardening, and listening to light music.

1995 Microwave Career Award
William J. Getsinger



The Microwave Career Award is the highest honor bestowed by MTT-S. It recognizes an individual for a lifetime career of meritorious service and technical excellence in our field. This year's recipient is **William J. Getsinger.**

The award consists of a plaque, a certificate and a check for $2,000. The Career Award Citation reads: "For a

Career of Meritorious Achievement and Outstanding Contributions to the Field of Microwave Theory and Techniques."

William J. Getsinger was born in 1924 in Waterbury, CT. He attended public schools in Watertown, CT. During World War II he was a flight radio operator with the Air Transport Command of the U.S. Army Air Force. After the war he attended the University of Connecticut, from which he received the degree of Bachelor of Science in Electrical Engineering in 1949.

In 1950 Mr. Getsinger began work as a design engineer of microwave components at Technicraft Laboratories in Thomaston, CT. In 1952 he moved to the Westinghouse Electric Corporation, Air Arm, where he designed airborne radar waveguide packages. In 1957 Mr. Getsinger joined the outstanding team of microwave research engineers headed by Dr. Seymour B. Cohn at Stanford Research Institute (SRI), where he worked on the theory and design of directional couplers, filters, antennas, amplifiers and microwave circuit elements. During his employment at SRI he attended Stanford University, earning the MSEE degree in 1959 and the degree of Engineer in 1961.

In 1962 Mr. Getsinger moved to MIT Lincoln Laboratory, where he continued research on microwave components, measurements and computer-aided design. At Lincoln Laboratory, he developed parametric amplifiers and also directed the development of GCP, one of the first interactive microwave circuit analysis programs. In 1969 he joined COMSAT Laboratories as Manager of the Low-Noise Receiver Department. While at COMSAT, he was Project Manager for design, development and production of centimeter-wave beacons orbited on four Bell Laboratory's COMSTAR satellites. In 1981, he was appointed a Senior Scientist at COMSAT. At the end of 1983, he left COMSAT and became a consulting engineer in the areas of microwave circuits and transmission lines.

Mr. Getsinger's technical papers in IEEE publications span the years from 1960 to 1994.

Mr. Getsinger joined the IRE in 1948 and he was elected a Fellow of the IEEE in 1980. He organized and chaired technical sessions at various MTT-S International Microwave Symposia. For many years he was on the Editorial Board of the *IEEE Transactions on Microwave Theory and Techniques*. He was the first Chairman of the MTT-S Technical Committee on Computer Oriented Microwave Practices. He was Guest Editor of the *IEEE Transactions on Microwave Theory and Techniques* Special Issue on Computer-Oriented Microwave Practices in 1969, and also Guest Editor of the *MTT Transactions* Special Issue of the 1986 International Microwave Symposium held in Baltimore.

Sadly, William J. Getsinger passed away June 5, 1995, leaving his wife, Doreen Catterall Getsinger, and four grown children. *(See "In Memoriam," page 51.)*

1995 Distinguished Educator Award
Dr. G. P. Rodrigue

The creation of this award was inspired by the untimely death of Professor F. J. Rosenbaum (1937-1992), an outstanding teacher of microwave science and a dedicated MTT-S AdCom member and contributor. This award is to be presented to a distinguished educator in the field of microwave engineering and science who exemplifies the special human qualities of the late Fred J. Rosenbaum, who considered teaching a high calling and demonstrated his dedication to MTT-S through tireless service.

The award consists of a plaque and an honorarium of $1,000. The awardee must be a distinguished educator, recognized, in general, by an academic career. It is desirable for the candidate to have received other teaching awards. The effectiveness of the educator should be supported by a list of graduates in the field of microwave science who have become recognized in the field. Relevant letters of support are encouraged. The candidate shall also have an outstanding record of research contributions documented in archival publications. The candidate shall have a record of many years of service to MTT-S.

The 1995 recipient is **Dr. G. P. Rodrigue,** Regents' Professor at the Georgia Institute of Technology.

Dr. G. P. Rodrigue received B.S. and M.S. degrees in physics from the Louisiana State University in 1952 and 1954, respectively. He then studied under Professor C. L. Hogan at Harvard University where he completed his Ph.D. in applied physics in 1958. His dissertation dealt with microwave properties of ferrimagnetic garnets.

From August 1958 to August 1968 he worked for the Sperry Microwave Electronics Company in Clearwater, Florida. At Sperry he continued research on properties and microwave applications of ferrites, and worked on the development of parametric amplifiers, and microwave acoustic devices.

In 1968 he joined the faculty of the School of Electrical Engineering at Georgia Tech at the rank of Professor. He was made a Regents' Professor in 1977. At Georgia Tech he introduced new microwave course work at both the graduate and undergraduate levels, as well as in continuing education programs. His Ph.D. students have concentrated on the general areas of microwave materials, transmission

lines, and measurements and in superconductivity.

Dr. Rodrigue was an elected member of MTT-S AdCom from 1970 to 1979. He served as MTT-S President in 1976. He is a Fellow IEEE and has served on the IEEE Board of Directors, Executive Committee, Technical Activities, United States Activities, and Publications Boards. He was IEEE Vice President of Publication Activities in 1982 and 1983. He was chairman of the International Microwave Symposium Steering Committees in 1974 and again in 1993.

Georgia Tech Electrical Engineering seniors elected Dr. Rodrigue the Outstanding Teacher in Electrical Engineering in 1971 and in 1979. He received the Georgia Tech Outstanding Teacher Award in 1972. In 1984 he received the IEEE Region 3 Outstanding Engineering Educator Award. In 1984 he also received one of the IEEE Centennial Medals, and in 1985 the MTT-S Distinguished Service Award.

He and his wife, Mary, have been married for 40 years and have six children and four grandchildren.

1995 Distinguished Service Award
Dr. Reinhard K. Knerr

The Distinguished Service award is presented to honor an individual who has given outstanding service over a period of years for the benefit and advancement of MTT-S.

This year's honoree is **Dr. Reinhard H. Knerr,** AT&T Bell Laboratories. He has served MTT-S in a significant number of important positions over a period of many years.

The citation for the Distinguished Service Award reads: *"For His Outstanding and Dedicated Service to the Society."*

Dr. Reinhard H. Knerr received his Cand. Ing. degree in 1960 from Technical University of Aachen, Germany, Dipl. Ing. degree in 1962 from École Nationale Supérieure d'Hydraulique, d'Electronique de Toulouse, France, MSEE degree in 1964 from Lehigh University and Ph.D. EE in 1968 from Lehigh University. His dissertation was on electromagnetic propagation in nonreciprocal, gyrotropic materials.

Dr Knerr's honors include: 1961-62 German Government Scholarship to study in Toulouse, 1962-1963 Baldwin Scholar at Lehigh University, and 1964 NATO Scholar at Lehigh University studying plasma oscillations in thin silver films.

Dr. Knerr has been a Member of the Technical Staff of AT&T Bell Laboratories since 1968, where he has developed microwave ferrite devices, and solid state low noise and power amplifiers. He has held various management positions and has introduced microwave and lightwave products into manufacture in several AT&T factories in the U.S. and Europe. He is presently involved in the development of high reliability lightwave components for submarine cable applications.

Dr. Knerr's MTT-S activities include: Fellow IEEE; MTT-S President, 1986; *MTT-S Transactions* Editor, 1980-1982; Distinguished Microwave Lecturer, 1988-1989; Awards Chairman, 1992-1994; AdCom Member, 1978-1986; Member of IEEE delegation to USSR, 1979; Co-Chairman of Technical Committee on MICs (MTT-6), 1976; Chairman of Technical Committee on MICs, 1977-1978; Member of Technical Committee on Microwave Ferrites (MTT- 13); Assistant Chairman for MTT-S Technical Committees, 1978; MTT-S Guest Editor, 1978; *Transactions* Business Editor, 1979; Member of Editorial Board for *Transactions* on MTT since 1974; Member Publications Evaluation Committee, 1980-1982; Chairman, Publications Evaluation Committee, 1983; Representative and Founding Member of the *Journal of Lightwave Technology*, 1977-1978; Co-Representative to Lightwave Technology Council, 1983; Liaison Representative to New Jersey Coast, MTT/ED/QEA Chapter, 1983-1988; Liaison to Benelux MTT/AP Chapter, 1985-1994; Liaison to French MTT Chapter, 1989-1994; Representative to TAB, 1986; Intersocietal Relations/Planning Activity Chairman, 1985; AdCom Advisory Committee Member, 1991-1992; Long Range Planning Committee Chairman, 1985; Past Presidents' Council Chairman, 1993-1994.

His Accredited Standards Committees activities include: X3T9—Management Committee for X3T9.2 (SCSI); X3T9.3 (Fibre Channel); X3T9.5 (Fiber Distributed Data Interface, FDDI); AT&T Voting Member (Principal) since 1985; X3T9.5—FDDI; AT&T Principal Member since 1978, involved in the total evolution of the FDDI Standard; and X3T9.3 Fibre Channel; Alternate Voting Member since 1989.

1995 Microwave Prize
Dr. Frank Olyslager, Dr. Daniël De Zutter, and Krist Blomme

The Microwave Prize is awarded annually to the author or authors of a paper, published in the *IEEE Transactions on MTT* or any other IEEE publication, which is judged to be the most significant contribution in the field of interest of the Society in the calendar

year preceding that in which the selection is made.

The 1995 Microwave Prize is awarded to **Dr. Frank Olyslager, Dr. Daniël De Zutter,** and **Krist Blomme** for their paper, "Rigorous Analysis of the Propagation Characteristics of General Lossless and Lossy Multiconductor Transmission Lines in Multilayered Media." Dr. Frank Olyslager was born in Wilrijk, Belgium, on November 24, 1966. He received the electrical engineering degree from the University of Ghent, Belgium, in 1989. From 1989 until 1993 he was a Research Assistant of the National Fund for Scientific Research of Belgium. In 1993 he obtained a Ph.D. degree from the Laboratory of Electromagnetism and Acoustics (LEA) of the University of Ghent with a thesis entitled "Electromagnetic Modelling of Electric and Dielectric Waveguides in Layered Media."

At present he is a Postdoctoral Researcher of the National Fund for Scientific Research of Belgium in the Department of Information Technology (the former LEA) of the University of Ghent. His research concerns the use of integral equation techniques to solve Maxwell's equations numerically. His activities focus on the electromagnetic wave propagation along high frequency electrical and optical interconnections in multilayered isotropic and bianisotropic media, on the singularity of electromagnetic fields at edges and tips, and on the study of Green's dyadics in bianisotropic media. He is also investigating the construction of transmission line models for general waveguide structure and electromagnetic compatibility problems on printed circuit boards and microwave circuits.

His personal interests also include gravitational wave propagation.

He is author or co-author of more than 20 papers in international journals and of 15 papers in conference proceedings. He is also co-author of the book *Electromagnetic and Circuit Modelling of Multiconductor Lines* published by Clarendon Press in 1993 in the Oxford Engineering Science Series. In 1994 he became laureate of the Royal Academy of Sciences, Literature and Fine Arts of Belgium.

Dr. Daniël De Zutter was born in Eeklo, Belgium, on November 8, 1953. He received a degree in electrical engineering from the University of Ghent, Belgium, in 1976. From 1976 to 1984 he was a research and teaching assistant in the Laboratory of Electromagnetism and Acoustics (now the Department of Information Technology) at the same university. In 1981 he obtained a Ph.D. degree (dissertation: "Scattering and Radiation by Moving Objects and Sources"), and he completed a thesis in 1984 titled "Electromagnetic Field and Force Calculations in the Presence of Moving Conductors and Moving Sources" leading to a degree equivalent to the French Aggrégation or the German Habilitation. He is now a professor at the Department of Information Technology, University of Ghent, and Research Director of the National Fund for Scientific Research of Belgium.

Most of his earlier scientific work (under the supervision of Jean Van Bladel) dealt with the electrodynamics of moving media, with emphasis on the Doppler effect and on Lorentz forces. His research now focuses on all aspects of circuit and electromagnetic modelling of high-speed and high-frequency interconnections, on electromagnetic compatibility and electromagnetic interference topics and on indoor propagation. As author or co-author he has contributed to about 60 international journal papers and 70 papers in conference proceedings. He co-authored the book *Electromagnetic and Circuit Modelling of Multiconductor Lines*, published by Clarendon Press in 1993 in the Oxford Engineering Science Series. In 1990 he was elected as a member of the Electromagnetics Society.

Krist Blomme was born in Eelko, Belgium, on October 17, 1968. He received the electrical engineering degree from the University of Ghent, Belgium, in 1991.

At present, Mr. Blomme is a Research Assistant of the National Fund for Scientific Research of Belgium in the Department of Information Technology of the University of Ghent. He is working towards the Ph.D. degree in electrical engineering. During his licentiate thesis he studied polygonal waveguides embedded in layered media. In the first part of his Ph.D. research he investigated the incorporation of via holes, finite conductor thickness and air bridges in spectral Green's functions for layered media. At present he is studying the use of wavelets and related functions in the Method of Moments.

He is author or co-author of three papers in international journals and of six papers in conference proceedings.

1995 Pioneer Award
William C. Brown

The Pioneer Award recognizes contributions which have had major impact on our field and have stood the test of time. The basis for the nomination is an archival paper in the field of interest of MTT-S, published at least 20 years prior to the year of the award, i.e., it recognizes important technical contributions that have had a continuing impact on the practice of microwave engineering, for a period exceeding two decades.

The award consists of a plaque and a check for $1,000. The 1995 recipient is **W. C. Brown.** His citation reads *"For Pioneering Work on Crossed Field Amplifiers or Platinotrons."*

William C. Brown received the BSEE from Iowa State University in 1937 and the MSEE from M.I.T. in 1941. He is a Life Fellow of the IEEE.

He joined the Raytheon Co. in 1940, and became involved in making improvements on the design of magnetrons used in all World War II microwave radar. However, magnetrons are oscillators and were not suitable for the next generation of radars that needed an efficient, high powered and broadband amplifier. In 1952 he made a major contribution in fulfilling that need by converting the magnetron oscillator into a broadband amplifier. This device, variously referred to as the "platinotron," "Amplitron" or simply as the "CFA" (for crossed-field amplifier), found immediate military and civil applications, including Navy Aegis radar, Hawk and Patriot Missile Systems, commercial air route surveillance radar, and high data rate communications system in the Apollo lander that sent televised images from the moon to Earth.

Mr. Brown then proposed that the CFA be developed into a super power amplifier and the resulting DOD contract produced a CFA that generated 425 kW of continuous power with an efficiency of 76 percent at the frequency of 3 GHz. One of the proposed applications of this much power was the efficient wireless transmission of large amounts of power from one point to another. The public was first alerted to this application by the nationally televised demonstration in 1964 of a tethered microwave powered helicopter at Raytheon's Spencer Laboratory.

Mr. Brown retired from Raytheon in 1984 and has since been active as a consultant and as a spokesperson for wireless power transmission. Under the sponsorship of IBM and Northeastern University he made a series of four videotaped lectures on its technology and applications. He has published more than 70 papers and has 50 issued patents in the areas of microwave tube technology and wireless power transmission.

1995 Microwave Application Award
Dr. Cheng P. Wen

The Microwave Application Award is presented aperiodically to individuals for outstanding application of microwave theory and techniques. Eligibility requirements are creation of a new device, component, or technique, novel use of components, or both. The award consists of a plaque, certificate, and a $1000 check.

The 1995 recipient of the award is **Dr. Cheng P. Wen.** The award citation reads: *"For the Invention and Development of the Co-Planar Waveguide and for the Application of the Waveguide to Various Microwave Structures."*

Dr. Cheng P. Wen received his BS, MS and Ph.D. degrees in Electrical Engineering in 1956, 1957, and 1963, respectively, all from the University of Michigan, Ann Arbor, Michigan. From 1955 to 1963, he was employed by the University of Michigan Electron Physics Laboratory as a research assistant. During this period, he worked on traveling-wave amplifiers, leading to his dissertation in "Noise Propagation in Two-Dimensional Electron Streams."

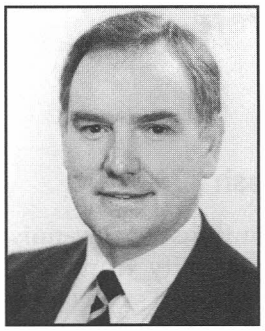
In 1963, he joined the Microwave Research Laboratory of the RCA Laboratories (David Sarnof Research Center), Princeton, New Jersey, where he conducted research on ultra low noise traveling-wave amplifiers, gas lasers, microwave acoustics, ferromagnetic semiconductors, microwave magnetics in integrated circuits and millimeter-wave avalanche diodes. His accomplishments included the demonstration of the lowest noise traveling-wave amplifier, the construction of the first surface acoustic wave coder/decoder, the operation of an electronic laser color switch, the development of coplanar waveguide (an alternate integrated circuit transmission medium), and the development of high power mm-wave IMPATT devices. He was a recipient of the RCA Laboratory Outstanding Achievement Awards in 1964, 1969 and 1973.

Dr. Wen joined Rockwell International Corporation in 1974 and established a microwave device research activity at the Science Center, Thousand Oaks, California. Later, he transferred to the Rockwell Electrons Division to develop manufacturing technology for discrete microwave devices.

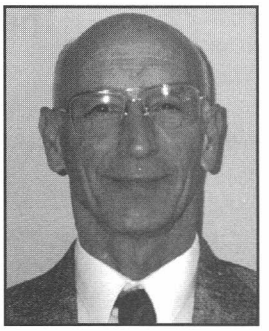
In 1982, Dr. Wen joined Hughes Aircraft Company in Torrance, California. He has provided leadership to technical teams to develop solid-state devices/components and to transition technology from research and development to manufacturing. Accomplishments include development of an ultra-high power millimeter-wave IMPATT diode (25-watt pulsed power output at W-band frequencies) and demonstration of a Gamma-radiation hard, superlattice long-wavelength infrared detector with built-in intrinsic event discrimination capability. He is now leading a project team to engage in the development of a coplanar waveguide based, dielectric coated, flip-chip monolithic microwave integrated circuit technology and is in charge of establishing magnetoresistance position sensor chip manufacturing at Hughes Microelectronics Division for automotive applications. He held a part-time teaching position under a Hughes microwave engineering program at California State University, Northridge, in the 1980s.

Dr. Wen has published over 30 technical papers on microwave solid-state devices and circuits, lasers, acoustic devices, traveling wave amplifiers and infrared detectors, has been awarded 27 U.S. patents, and is a Senior Member of IEEE and a member of the American Physical Society, Sigma Xi, Eta Kappa Nu and Tau Beta Pi.

1995 IEEE Fellow Awards



Lionel E. Davis



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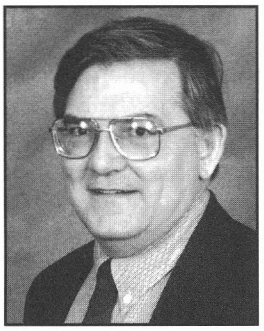

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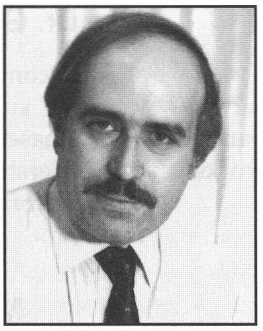
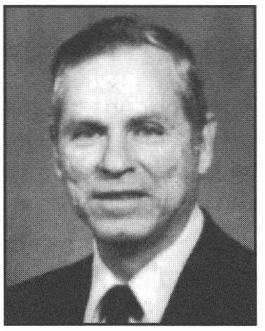
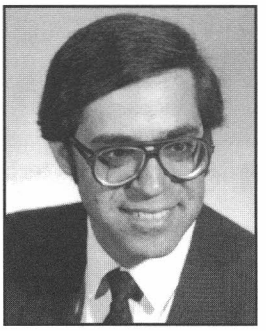


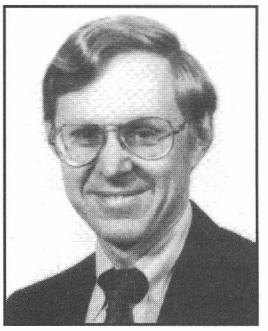
John A. Pierro



Richard A. Sparks



Barry E. Spielman



Peter W. Staecker

Twelve MTT-S members who were evaluated by our Society were elected to the grade of Fellow effective January 1,1995. The grade of Fellow is conferred in recognition of unusual professional distinction. It is awarded at the initiative of the IEEE Board of Directors after a rigorous nomination and evaluation process. Individuals receiving this distinction have demonstrated extraordinary contributions to one or more fields of electrical engineering, electronics, computer engineering and related sciences. This grade is not conferred automatically on nomination; only a fraction of those nominated are honored by elevation to the grade of Fellow IEEE.

Jerry C. Aukland

For leadership in the research and development of multi-gigahertz transistor and device technology.

Dr. John B. Davies

For contributions to computer-aided engineering of optical and microwave devices, and the advancement of finite element methods for electromagnetic field analysis.

Dr. Lionel E. Davis

For contributions to the development of novel circuit configurations using nonreciprocal media.

Dr. Robert L. Eisenhart

For contributions to the modeling, design, and measurement of microwave circuits and antennas.

Dr. Lawrence E. Larsen

For pioneering the application of microwaves to therapeutic and diagnostic medical devices.

Mr. John A. Pierro

For contributions to solid-state microwave low noise amplifiers, and integrated circuit developments.

Dr. Peter A. Rizzi

For contributions to microwave education, and the innovative design of microwave filters and ferrite components.

Dr. Klaus Schuenemann

For contributions to the analysis, modeling, and design of active and passive microwave components.

Mr. Richard A. Sparks

For leadership in the development, application, and manufacture of solid-state microwave devices for missile and radar systems.

Dr. Barry E. Spielman

For leadership in research and teaching in the microwave and millimeter-wave integrated circuits area.

Dr. Peter W. Staecker

For leadership and contributions to the design and development of microwave and millimeter-wave devices and circuits.

Mr. Britton T. Vincent, Jr.

For contributions to the development of solid-state phased-array radar systems and hybrid microwave integrated circuits.

The following, new Fellows are also MTT members but were evaluated by other IEEE Societies:

Mr. Renato G. Bosisio

For contributions to microwave instrumentation, computer-aided measurements, and microwave power applications.

Dr. John R. Brauer

For contributions to finite element analysis of electromagnetic devices.

Dr. Christopher T.M. Chang

For contributions to the development of GaAs high-speed digital circuits.

Dr. George Costache

For leadership in the application of the finite element method to the predictions of crosstalk on printed circuit boards.

Dr. Jacques J. Gavan

For contributions to the solution of cosite electromagnetic interference problems in communication systems and to electromagnetic compatibility education.

Dr. Gota Kano

For contribution to research, development, and industrialization of GaAs devices, particularly UHF FET integrated circuits and lasers for consumer applications.

Dr. Linda P. B. Katehi

For contributions to phased array packaging and high-frequency characterization of novel feeding networks for printed antennas and arrays.

Dr. Adalbert Konrad

For contributions to eddy current field computation by finite element methods.

Dr. Friedrich Landstorfer

For contributions to antenna theory.

Dr. Raymond J. Luebbers

For contributions to computational electromagnetics.

Mr. Umesh K. Mishra

For contributions to low-noise high-electron mobility transistors (HEMTs) and compound semiconductor device technology.

Dr. Gary K. Montress

For contributions to the development of surface acquisition wave (SAW) based frequency sources, and for leadership in their application to high performance military radar systems.

Mr. Koji Nihei

For contributions to thin film technology and printhead development.

Dr. Ronald J. Pogorzelski

For contributions to the techniques of analytical and computational electromagnetics.

Mr. Helmut E. Schrank

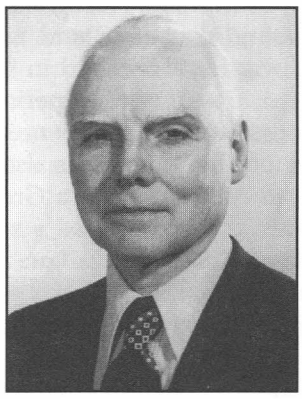
For contributions to antenna design and practice.

First Announcement & Call for Papers

- COMSIG-95
  Communications & Signal Processing Symposium
  16 November 1995
- AP/MTTS-95
  Antennas and Propagation & Microwave Theory & Techniques Symposium
  17 November 1995
- LEOS/EDS-95
  Lasers and Electro-Optics & Electronic Devices Symposium
  17 November 1995

Venue: University of Pretoria

The History of the Crossed-field Amplifier



by William C. Brown
MPT Systems

I was inspired to write this article for the Newsletter because of the delightful account two years ago in the Fall Newsletter of 1993 by Dr. C. Lester Hogan, Pioneer Award recipient for his "Pioneering the Application of Ferrites to Microwave Devices." My account of the pioneering activity on the crossed-field amplifier will be different, as expected. But there is one thing that we would agree upon, I'm sure, and that is that our efforts succeeded in large part because of the resources available to us in the form of established laboratories staffed with expert personnel upon whom we depended for advice and carrying out our concepts. In my case, it was the Magnetron Development Laboratory of the Raytheon Company and its personnel. After the initial breakthrough in converting the magnetron oscillator into a broadband amplifier, their support and original contributions were invaluable.

The reader will find this an account of one microwave tube activity leading to another, and the article is laid out with subtitles that reflect this chronological progression. There was not always smooth sailing, and there were even times when I used personal resources in the form of a small but well equipped machine shop and electronic test equipment in my home to splice successive developments together. There were other times when an unexpected development in an apparently unrelated area provided support for this progression of developments; for example, Sputnik supported the development of the super power Amplitron.

The main body of this paper minimizes the details of the technology involved. If a reader is interested in more technology detail he is referred to early papers, both authored by me[1,2] and papers or reports by Dombroswski, Skowron ankd Ruden.[8,9,13] Vol. 2, of Okress, Crossed-field Microwave Devices,[7] available in most engineering libraries, is also recommended.

How technical achievements happen has always been of interest to me, as it is to many others. What is the inside story of the device under discussion? To the outside observer at that time, reading the ad on the back cover of the August 1, 1957, issue of *Electronics*, the device we are discussing was an overnight success. The ad is reproduced as Figure 1. That issue of *Electronics* also contained an article entitled "Platinotron Increases Search Radar Range." But notice that the device in the ad is not referred to as the platinotron or the crossed-field amplifier but as the "Amplitron." What is

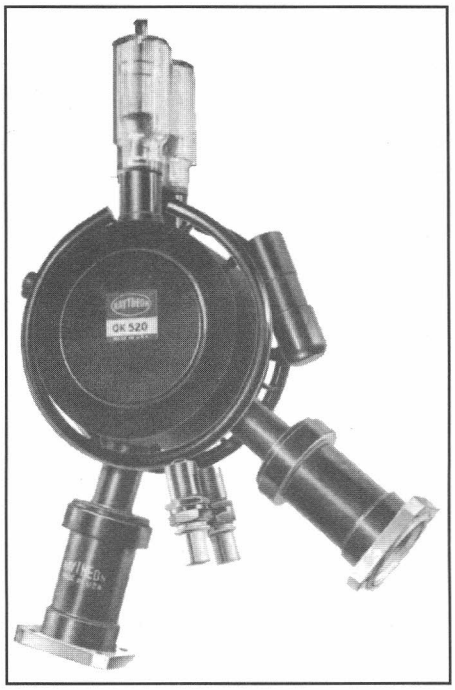


Figure 1. Raytheon advertisement in the August 1, 1957, issue of the magazine Electronics *describing the features of the platinotron but referring to it as the Amplitron. Explanation of this confusion is given in text.*

the inside story on this confused nomenclature for the same device?

The explanation is this. When the device was invented, I recognized it as a broadband amplifier, and wanted some new term that ended in "tron," because during that time period the suffix "tron" was applied to nearly all electron tube devices. It was also fashionable to come up with a Greek or Latin prefix. So I consulted a scholar familiar with the Greek language and he suggested the Greek work "platino," whose meaning was consistent with the broad, plateau-like qualities of the tube. I therefore used the term platinotron for the device and used the term in the title of the archived journal article, "Description and Operating Characteristics of the Platinotron—A New Microwave Tube Device," published in 1957 in the Proceedings of the IRE.[2]

However, our manager of marketing at Raytheon believed that the term "Amplitron" would have better marketing appeal, and the term "platinotron" rapidly faded into the background. Unfortunately, the term "Amplitron" was trademarked, so when Raytheon's competitors entered the arena they outflanked the Amplitron term by referring to the device as the "crossed-field amplifier" and eventually Raytheon began to use the more generic term also. I have learned to live with this interchangeable nomenclature and I hope that the reader will understand when I refer to the same device as the platinotron, Amplitron, or crossed-field amplifier throughout this article.

However, it should be pointed out that the generic term crossed-field amplifier also includes the injected beam amplifier, while the device with which we are concerned is a reentrant beam device, another way of saying that in the platinotron or Amplitron the electron beam goes round and round, about a central cathode, as opposed to an electron beam that is injected into the structure. This was confusing at the time, because the injected beam amplifier had already been introduced.[3] However, with the passage of time, and rather quickly so, the reentrant beam crossed-field amplifier dominated the application market, so at this time the term crossed-field amplifier is assumed to be the reentrant beam device. But the accurate term to describe the device is platinotron or Amplitron.

Circumstances and Opportunities in 1952

Now, having explained the nomenclature confusion, we will examine the circumstances in 1952 that led to the invention of the platinotron. Magnetrons were the only microwave tubes used in microwave radar during World War II. However, they were oscillators, unsuited for the new advanced radars that were being developed after World War II and which needed high power broadband amplifiers. On the other hand, the microwave power amplifiers at that time were big, relatively inefficient, and had limited bandwidths with a 3 db drop in power and efficiency at the band edges. The time was opportune then for the conversion of the ordinary magnetron oscillator into a broadband amplifier which would still preserve the outstanding properties of the magnetron for high efficiency, very high peak power handling capability, simplicity of manufacture and relatively low cost, and small size and low mass.

These were the circumstances at that time and the opportunity to resolve the situation was open to everyone. I was in charge of the magnetron development laboratory at the Raytheon Company which had grown from a few engineers at the start of World War II into a laboratory a few short years after the war of over 400 people of whom nearly 100 were engineers. We were busily engaged in developing a second generation of magnetrons for radar and countermeasures with little time to explore the conversion of the magnetron oscillator into a broadband amplifier. However, it was apparent to me as manager of the laboratory, as well as to many others, that the magnetron oscillator was not suited for the future more sophisticated radars and could become obsolete.

From Magnetron to Platinotron

To understand what was involved in the conversion of the magnetron oscillator into a broadband amplifier, it is first necessary to take a brief look at the magnetron oscillator. As shown in Figure 2, which schematically compares the magnetron with the platinotron, the magnetron is basically a microwave circuit, consisting of cavities tied together with a two wire transmission line, that surrounds a cathode that emits electrons. There is a magnetic field parallel to the axis of the structure. To operate the device a DC voltage is applied between the cathode and the microwave circuit. As the DC voltage is increased, electrons leave the cathode and interact with the magnetic field to circle the cathode. As

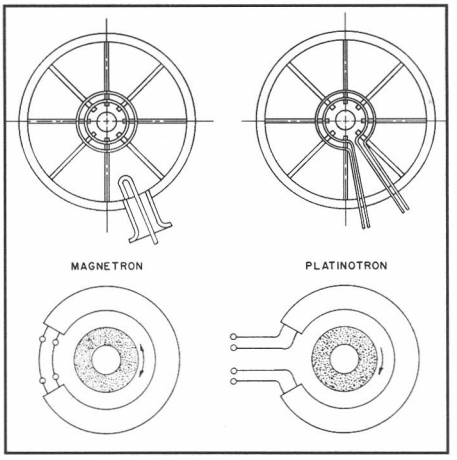


Figure 2. The basic structural difference between the magnetron oscillator and the platinotron is that the magnetron has a reentrant circuit and the platinotron does not. The circuit itself has the properties of a broad band-pass filter. The magnetron is operated at the bottom end of the pass band while the platinotron is operated well up into the pass band where the phase shift with frequency is low and the characteristic impedance can easily be matched to the external input and output circuits.

the voltage is increased further, the angular velocity of the electrons becomes equal to that of an rf wave travelling along the microwave network. When that occurs there is a spontaneous interaction between the circuit and the electrons, and spokes of space charge are formed which induce microwave power into the slow wave circuit.[4] These spokes, which are nearly identical in the magnetron and platinotron, are shown in the platinotron of Figure 3a.

In retrospect it is difficult to understand why the magnetron was not earlier converted into a broadband amplifier. It was well recognized that the microwave circuit of the magnetron, in its form at the end of World War II, was basically a transmission line loaded with a succession of resonant cavities. This loading made the overall circuit appear as a bandpass filter of considerable bandwidth, with a characteristic impedance ranging from infinite at the band edges to a characteristic impedance in the middle that could be easily matched to that of an external waveguide or coaxial line. However, the magnetron evolved from its original brilliant inception in England in such a manner that it was universally designed with a reentrant circuit, and operated at the lower end of the pass band, which made it a highly resonant device. It had only one output terminal, loosely coupled to the resonant circuit with a loop as shown in Figure 2.[5,4]

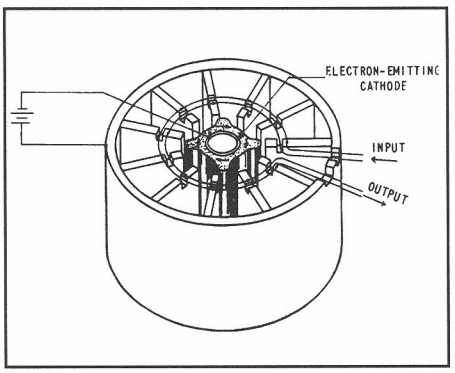


Figure 3a. Schematic showing the interaction of the space charge spokes with the circuit of the QK 403. The phase shift around the whole network is 540 degrees or 540/11 or 49 degrees for each network section. However, the two wires of the transmission line loaded by the cavities is connected to the vanes of the cavities in such a way as to introduce 180 degrees phase shift to be added or subtracted to the 49 degrees. If the 180 degrees is subtracted, –131 degrees is obtained. So the direction of the electric field on the vane tips as observed by spokes of charge travelling in a direction opposite to that of the circuit wave repeats itself every 360/131 or 2.7 cavities, or about 11/2.7 or 4 times around the 11 cavity circuit. This "backward" wave is therefore in synchronism with 4 spokes of space charge. So there is gain between input and output but the spokes are travelling from output to input.

It was therefore quite obvious to anyone that understood the basic circuit of the magnetron, that if the reentrant circuit of the magnetron were cut, two output connections made to the cutoff ends, as shown in Figure 2, and the resulting device operated in a frequency region near the middle of the pass band, that broadband amplifier performance might be exhibited.

On the other hand, there was no stampede of individuals to see what would happen if this simple mechanical conversion were made. The emphasis at the time was on linear beam devices such as the klystron and the travelling wave tube. Further, no one could predict, if the attempt were made and the device did exhibit broadband gain, whether it would be a saturated or linear amplifier, and whether it would oscillate or not with the drive signal removed. Not to hold the reader in suspense, it turned out that the successful device was a saturated amplifier whose output depended primarily upon DC power input to the device rather than rf drive, and that it would oscillate if the drive signal were removed. Furthermore, it turned out to have a limited gain of no more than 20 db and in most applications in which it was used, the gain was about 10 db. This was really not the description of an amplifier device at that time period. Nevertheless, the platinotron device quickly dominated the application market where high microwave power and wide bandwidth were simultaneously needed.

Moreover, in 1950, Warnecke, et al., had published an article describing the injected beam crossed-field amplifier tube, which operated well as an amplifier despite its deficiencies in terms of efficiency and power handling capability.[3] This had the impact of further reducing interest in the conversion of the magnetron oscillator into an amplifier.

Early Conversion Attempts and Breakthrough in 1952

I had worked in principle with the simple modification of the magnetron as shown in Figure 2 several years before 1952. But I did not anticipate useful results with a small number of network sections (corresponding to a small number of cavities). Working with others in the laboratory, we constructed and tested tubes with a large number of network sections, typically 60 to 80. These tubes would oscillate but we did not get them to amplify or lock onto the input signal.

At this point in the history of the device we note that "desperation was the mother of invention." In that mode of thinking, I decided to try the simplest kind of structure as shown in Figure 3b. There were only 11 network sections. Also the conventional vane and strap network was designed to have the highest possible impedance. I also decided to do all the testing myself to pick up any nuances of opera-

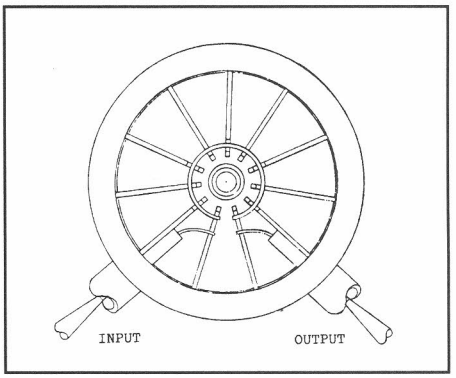


Figure 3b. The plan view to approximate full physical scale of the first successful platinotron, the QK 403.

Master Calendar—MTTS Sp

1995

Name	Date/Location	Involvement	
• 1st International Workshop on Transmission Line Matrix (TLM) Modeling Theory and Applications	1-3 August Victoria, BC Canada	Technical Co-Sponsor	Dr. Wolfgang Hoefer Chair in RF Engineering P.O. Box 3055 Victoria, BC Canada V8W 3P6 Tel.: 604-721-6030; Fax: 604-721-6052 e-mail: whoefer@ece.uvic.ca
• Cornell University Conference on Advanced Concepts in High Speed Semiconductor Devices and Circuits	7-9 August Ithaca, NY USA	Technical Co-Sponsor	Dr. Umesh Mishra UCSB Dept. of Electrical Engineering Santa Barbara, CA 93106 Tel.: (805) 893-3586; Fax: (805) 893-8714
• RF Optoelectronics Summer Topical Meeting	9-11 August Keystone, CO USA	Co-sponsor	D. Charles Cox MIT Lincoln Laboratory P.O. Box 73 Lexington, MA 02173 (617) 863-2500
• European Microwave Conference	4-7 September Bologna Italy	Cooperate	Ms. Gillian Shinar Nexus Information Technology Warwick House Swanley, Kent BR8 8HY United Kingdom Tel.: +44 1322 660070; Fax: +44 1322 661257
• 4th Topical Meeting on Electrical Performance of Electronic Packaging	1-4 October Portland, OR USA	Sponsor	Dr. Paul Baltes Engineering Professional Development University of Arizona Box 9 Harvill Building, Room 235 Second and Olive Streets Tucson, AZ 85721 Tel.: (602) 621-3054; Fax: (602) 621-1443 e-mail: baltes@bigdog.engr.arizona.edu
• Asia-Pacific Microwave Conference	10-13 October Taejon, Korea	Cooperate	Prof. Noh-Hoon Myung Dept of EE KAIST 373-1 Kusong-dong, Yusong-gu Taejon 305-701, Korea Tel.: 82 42 869 5417; Fax: 82 42 869 8010 e-mail: nhmyung@eekaist.kaist.ac.kr
• Microwaves and RF '95	10-12 October London UK	Technical Co-sponsor	Ms. Gillian Shinar Nexus Information Technology Warwick House Swanley, Kent BR8 8HY United Kingdom Tel.: +44 1322 660070; Fax: +44 1322 661257
• Int'l Symposium on Signals, Systems and Electronics	25-27 October San Francisco USA	Co-Sponsor	Prof. Ming C. Wu UCLA, EE Dept. 405 Hilgard Avenue Los Angeles, CA 90024-1594 Tel.: (310) 825-6859; Fax: (310) 825-6954 e-mail: wu@icsl.icla.edu
• GaAs IC Symposium	29 Oct.-1 Nov. San Diego, CA USA	Co-sponsor	Dr. George Bechtel Stategies Unlimited 201 San Antonio Circle, Suite 205 Mountain View, CA 94040 Tel.: (414) 941-3828; Fax: (414) 941-5120
• International Topical Meeting on Nomadic Microwave Technologies and Techniques for Mobile Communications and Detection	16-18 November Arachon France	Technical Co-sponsor	Dr. Robert Adde Institut D'Electronic Fondamentale Bat. 220 91405 Orsay cedex, France Tel.: +33(1) 69 41 78 50; Fax: +33(1) 60 19 25 93 e-mail: adde@ief-paris-sud.fr
• 3rd Int'l Workshop on High Perf. Electron Devices for Microwave and Optoelectronic Applications (EDMO)	27 November King's College London London, UK	Continued Cooperate	Dr. Terry Oxley "Tremont," Back Lane Halam, Newark Notts NG22 8AG England Tel.: +44 636 815510; Fax: +44 636 815865

S Sponsored Conferences[1]

1995 (continued)

Name	Date/Location	Involvement	
• Int'l Semiconductor Device Research Symposium	5-8 December Charlottesville, VA USA	Co-Sponsor	Dr. Elias Towe Dept. of Electrical Engineering Thornton Hall University of Virginia Charlottesville, VA 22903 Tel.: (804) 924-6078; Fax: (804) 924-8818
• Space Technology and Applications International Forum (STAIF-96)	7-11 January Albuquerque, NM USA	Cooperate	Prof. Mohamed S. El-Genk Institute for Space and Nuclear Power Studies University of New Mexico Albuquerque, NM 87131-1341 Tel.: (505) 277-5442; Fax: (505) 277-2814 e-mail: mgenk@unm.edu
• 5th International Conference on Satellite Systems for Mobile	15-17 April London	Cooperate	Mr. Terry Oxley "Tremont" Back Lane, Halam, Newark Notts NG22 8AG England Tel.: 44 636 815510; Fax: 44 636 815865
• MTT-S International Microwave Symposium	17-21 June San Francisco, CA USA	Sponsor	Dr. E. James Crescenzi Watkins-Johnson Co. 3333 Hillview Ave. Palo Alto, CA 94304-1204 Tel.: (415) 813-2506; Fax: (415) 813-2402 e-mail: j.crescenzi@ieee.org

1996

• Microwave and MM-Wave Monolithic Symposium	17-18 June San Francisco, CA USA	Sponsor	Dr. Mahesh Kumar Unisys Corp. 365 Lakeview Road, M/S F8 Great Neck, NY 11020-1696 Tel.: (516) 574-3295; Fax: (516) 574-1244
• IEEE International Symposium on Phase Array Systems & Technology	15-17 October Boston, MA USA	Technical Co-Sponsor	Dr. Eli Brookner Raytheon Company Equipment Division 528 Boston Post Road Sudbury, MA 01776 USA Tel.: (508) 440-5636
• International Topical Meeting on Optical Microwave Interactions	3-5 December Kyoto Japan	Technical Co-sponsor	Prof. Tsukasa Yoneyama Tohoku University Research Institute of Electronic Communications Katahiracho 2 Come 1-1 Sendai 980, Japan

Notes:
[1]Meetings listed are those that have been officially sponsored by MTT-S (i.e., AdCom approved). There are many other microwave related meetings (chapter sponsored, commercial, etc.) that are not listed.

MTT-S Continuously Sponsored Conferences

- MTT-S International Microwave Symposium (IMS)
  Annual (Sponsor)
- IEEE Microwave & Millimeter-Wave Monolithic Circuits Symposium (MMWMC)
  Annual (Co-Sponsor)
- Automatic RF Techniques Group (ARFTG)
  Semi-annual (Affiliated)
- European Microwave Conference (EuMC)
  Annual (Cooperate)
- Asia Pacific Microwave Conference (APMC)
  Annual (Cooperate)
- MIOP
  Biennial—1993, etc. (Cooperate)
- MIKON
  Biennial—1994, etc. (Cooperate)
- Combined Optical and Microwave Earth and Atmospheric Sensing
  Biennial (1993, etc.) (with GRSS-S, LEO-S)
- International Microwave Conference/Brazil (SMBO)
  Biennial—1993, etc. (Cooperate; Co-Sponsor 1995)
- IEEE GaAs IC Symposium
  Annual (Co-Sponsor)
- IEEE Conference on the Computation of Electromagnetic Fields
  Biennial—1992, etc. (Cooperate)
- European GaAs Applications Symposium
  Biennial—1992, etc. (Cooperate)
- Topical Meeting on Electrical Performance of Electronic Packaging
  Annual (Sponsor)
- 19th International Conference on Infrared and Millimeter Waves
  Annual (Cooperate)
- Microwaves in Medicine
  Triennial—1993, etc. (Cooperate)
- National Radio Science Meeting
  Annual (Cooperate) (with International Union of Radio Science)
- Int'l Workshop on High Perf. Electron Devices for Microwave and Optoeletronic Applications (EDMO)
  Annual (Cooperate) (with UKRI MTT/AP/Leo Joint Chapter and King's College London)
- Cornell University Conference on Advanced Concepts in High Speed Semiconductor Devices and Circuits
  Biennial (Technical Co-sponsor) (Sponsored by the IEEE Electron Device Society)

tion that might lead to better insight into successfully converting the magnetron oscillator into a broadband amplifier.

A tube, designated the QK 403, was constructed and placed on test. Because of my managerial responsibilities in the daytime, I performed the testing in the evening. I started to test it as an oscillator with loads and movable reflection at both ends. After some initial adjustments of operating conditions, I was pleased to observe a great difference in the power flow from the two terminals which would reverse with a reversal of magnetic field . This was very encouraging because it indicated directional gain. It was late in the evening, however, so I turned the equipment off and went home.

The next evening I sought to check my findings of the previous evening before proceeding with the amplifier experiments and was startled to find that I could not reproduce the results. There followed several evenings of intensive activity in checking every conceivable change that could have occurred in the testing. I began to think that the performance that I had witnessed earlier was an illusion.

Finally, as a last resort, I had the cover machined from the tube and found to my relief that one of the vane tips had melted. Apparently, the vane tips, quite fragile because of my desire to keep the impedance high, had melted just at the time I had turned off the source of power for the evening.

A second tube was hastily constructed and on December 18, 1952, I was able to repeat the previous observations and to go on to obtain much more test data on the directional properties of the device. However, I lacked a drive source to demonstrate it as an amplifier. By February of 1953, I had obtained a drive source and had achieved a gain of 9 db over a frequency range of 3780 to 3850 MHz. The peak power output was 24 kW and the efficiency was 40 percent. This data, based upon data in my Raytheon engineering notebook, is shown in Figure 4.

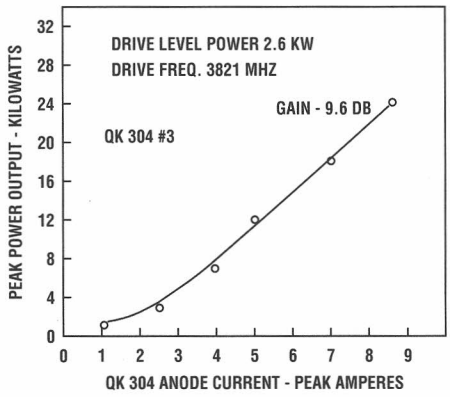


Figure 4. Early data obtained from the QK 403 #4 which was operated as an amplifier and showed directional gain. If the magnetic field were reversed to send the electron stream in a different direction around the cathode, the input and the output of the tube were reversed.

Although it was not clearly evident at the time, it was later established that the tube was operating with the phase shift from input to output of 540 degrees, corresponding to 49 degrees phase shift for each of the 11 network sections. The tube operated with four spokes of space charge in the backward wave mode as further explained in Figure 3a.

The author preserved the original QK 403 on which the initial measurements were made and turned it over to the MTT-S historical collection in a ceremony at Raytheon in 1987. See Figure 5. A closeup view of the tube is shown in Figure 6.

Initial Nonacceptance and the Army Signal Corps to the Rescue

I concluded from the data shown in Figure 4, and from the simplicity of the structure, that the principles involved in the construction and operation of the QK 403 were what we had been looking for and that the achievement would be recognized as very important for the future of crossed-field devices and for systems in need of a broadband amplifier. However, there was no immediate consensus among my peers within the microwave community that this was so. Certainly the specific tube that had demonstrated these principles could not be plugged into an existing socket, nor could it be expected that a new equipment could be designed around it.

It is quite possible that the activity might have ended in frustration had it not been for Beverly Kumpfer and Ross Kilgore of the Army Signal Corp who perceived that the prin-

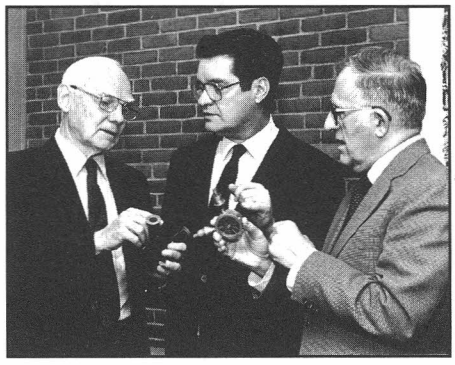


Figure 5. William Brown and Joseph Hilton, representing the Raytheon Company, make presentation of the QK 403 #3 to Ted Saad for the MTT-S historical archives in March 1987. This tube was the first platinotron to indicate directional gain, but it was operated as an oscillator. One of the vanes melted while it was being tested.

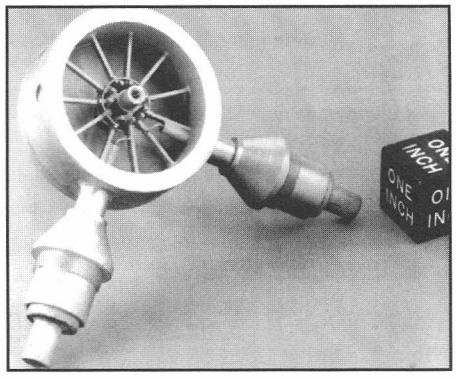


Figure 6. Close-up view of the first platinotron, the QK 403 #3, to indicate directional gain. Cover has been removed to show the circuit.

ciples exhibited by this device were worth pursuing further. However, they also needed the support of their peers. So at the Electron Tube Research Conference held in Ottawa, Canada, in June of 1953, a caucus of several important experts was assembled. After hearing the facts and discussing the matter, their consensus was to recommend support for its further development. So a contract was let by the Signal Corps in August of 1953 to Raytheon to further study and explore the concept. This was indeed a fast contract negotiation.

Although the purpose of the contract was to further develop the concept, it was agreed, if possible, that the output product of the study should meet some application need. Therefore, with the help of John Skowron on the Raytheon staff of engineers, I designed the tube as a potential replacement for the L-Band 5J26 magnetron that had become a workhorse for many radar applications but whose limitations for newer systems was becoming evident. This strategy also allowed a kind of one-on-one comparison by making the tubes as identical as possible except for breaking the reentrant circuit and matching two output ports to the internal circuit. For example, we used the 5J26 cathode in the tube to eliminate the cathode as a variable.

The new tube, the QK 434, was frequency and voltage scaled directly from the QK 403 (Figure 6), using well known scaling laws for the magnetron. The result was the tube shown in Figure 7, where it is compared with the QK 403. In Figure 7, the cover from the QK 434 has been removed showing the internal structure. One innovation made, basically to keep the impedance of the microwave circuit high to interact better with the rotating spokes of space charge, was to make the inductive portion of the circuit from small diameter tubing. An additional advantage of this approach was the direct removal of heat from that portion of the microwave circuit that faced the cathode and received the bombarding electrons that generated heat.

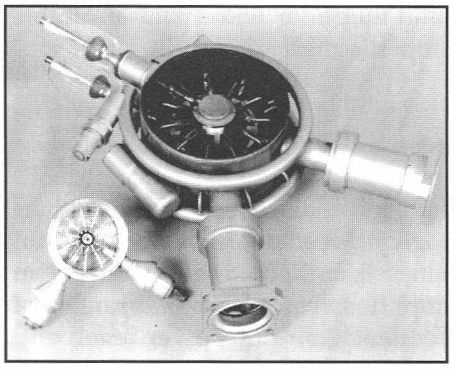


Figure 7. The QK 434, frequency and power scaled directly from the QK 403, with which it is compared in the photograph, and developed within one year in the 1953 to 1954 time frame under contract to the Army Signal Corps, was an immediate success. The QK 434 exhibited stable gains as high as 16 db, peak power output levels ranging from a few hundred kilowatts to 3 MW, average power of 1500 watts, and power added efficiencies ranging from 60% for normal power ranges to 76% for high-power, low-gain operation. This tube and its performance is described in detail in the paper documented in the September 1957 issue of the Proceedings of the IRE.

Immediate Success of the QK 434 Platinotron and Broad Application

The new tube, the QK 434 was an immediate success. After we demonstrated it as both an amplifier and highly stabilized oscillator (the stabilotron principle) in a special classified symposium at the Army's Hexagon in Fort Monmouth in 1954, as shown in Figure 8, it was clear to all observers that the magnetron oscillator had been converted into a broad-

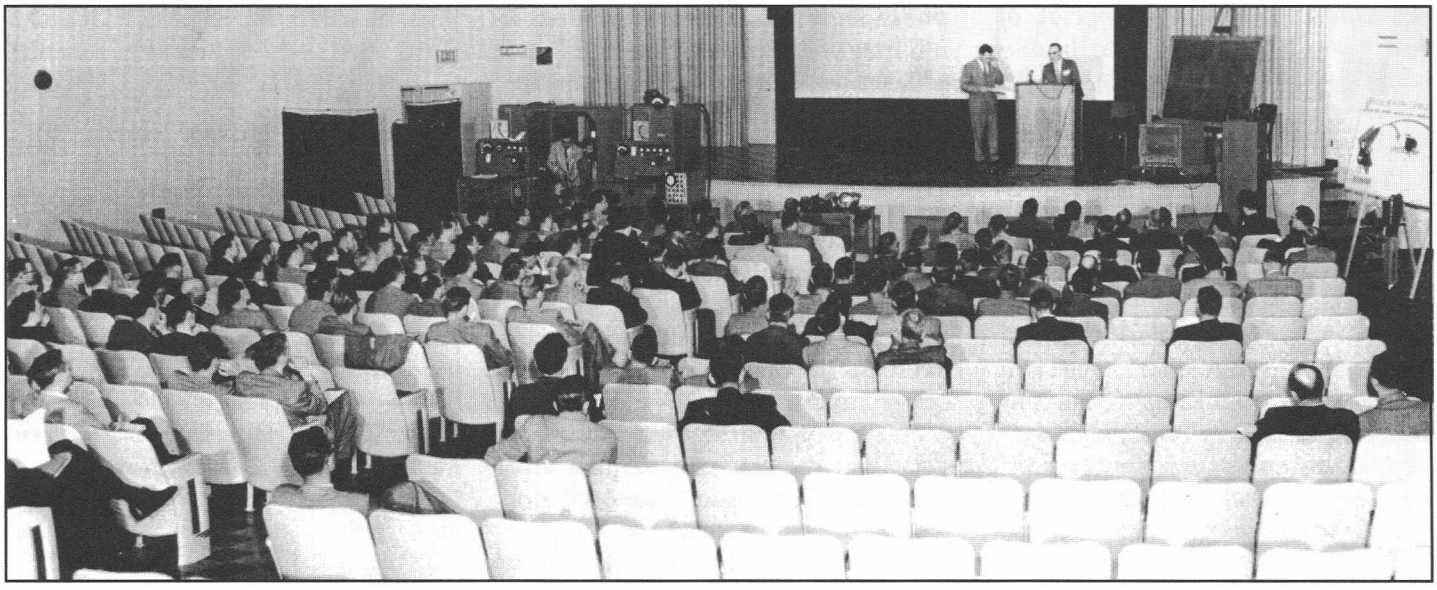


Figure 8. The QK 434, exhibited in both its amplifier and Stabilotron (oscillator) format, was the subject of a special classified symposium at the Army Electronics Development Laboratories in Fort Monmouth, NJ, in 1955. Beverly Kumpfer of the Army's Laboratories and William Brown of Raytheon are at the podium.

band amplifier with many desirable properties.

One of the reasons that the crossed-field amplifier principle was accepted so readily was the outstanding performance of the QK 434, thoroughly documented by the data obtained from operating the tube as an amplifier over very broad ranges of frequency, output power level, and load.[6] This documentation was in the form of photographs that showed the nearly theoretical spectra for a 5 microsecond pulse for hundreds of data points in which frequency, operating power level, and rf load were varied. Figure 9, for example, shows the data as a function of all positions of a 2.5 VSWR mismatch placed in the microwave waveguide load. In all of this data in which all operating parameters were examined over wide ranges, no anomalous regions of double spectra were found, as would have been the case for the 5J26 magnetron. Much of this data was transferred to the original published paper on the platinotron.[2]

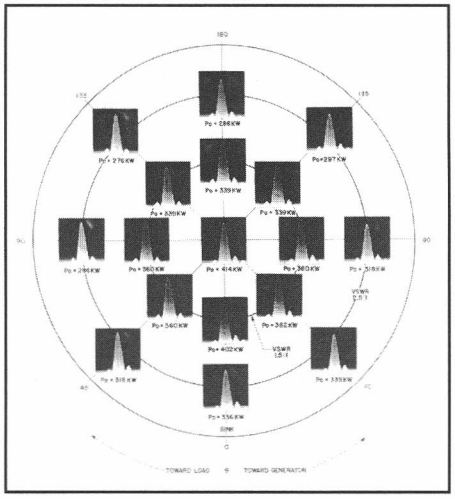


Figure 9. An example of the thorough testing of the KQ 434 as an amplifier working into a wide variation of resistive and reactive loads, as determined by placing obstacles in the output transmission line to create various magnitudes of reflection and changing their position along the transmission line. No anomalies of performance were found, as were the findings when frequency, and output power level, were varied over wide ranges.

The first application of the crossed-field amplifier was in the search radar in the Hawk Missile System. But here it was used as a highly stabilized oscillator, called the "Stabilotron."[1,7] The Stabilotron application provides an opportunity to discuss a fundamental property of the platinotron, directional gain. With no power applied, the tube is transparent to microwaves in the pass band where it operates. A signal applied at either terminal flows to the other end, unimpeded except for a small insertion loss caused by the slight resistive losses in the microwave circuit, usually a small fraction of a db. But if power is applied to the tube and it is amplifying the signal, amplification occurs in one direction but not the other, depending upon the direction of the magnetic field. If any power is reflected from the load at the output terminal of the platinotron it passes back through the tube with little interaction with the spokes of space charge and arrives at the input end with very little attenuation.

This behavior suggests that if, in addition to a reflection at the output, a complete reflection is placed at the input, the tube will behave as an oscillator and the frequency will be determined by the well known need that the "around the loop phase shift" must be some integral multiple of 2π radians. Now if, instead of a simple short at the input, the input is terminated with a highly resonant cavity in shunt with an rf load, then there will be no or very little reflection at frequencies removed from the resonant cavity, while at the resonant frequency of the cavity there will be almost total reflection. In addition the phase of the reflection from the cavity will vary rapidly with frequency, and the round the loop phase requirement will be met only at or very near the resonant frequency of the cavity. The result is an oscillator source that is extremely stable. The person responsible for the stabilotron principle is Earl Shelton.

How well this works in comparison with the 5J26 magnetron, of the same power level and frequency as the QK 434, when a very long pulse of very poor shape is applied is shown in Figure 10. It is of interest that the Hawk Missile System after forty years still uses this arrangement.

However, all of the subsequent applications of the platinotron, alias "Amplitron" and "crossed-field amplifier," were as amplifiers. And there were many applications, as shown in

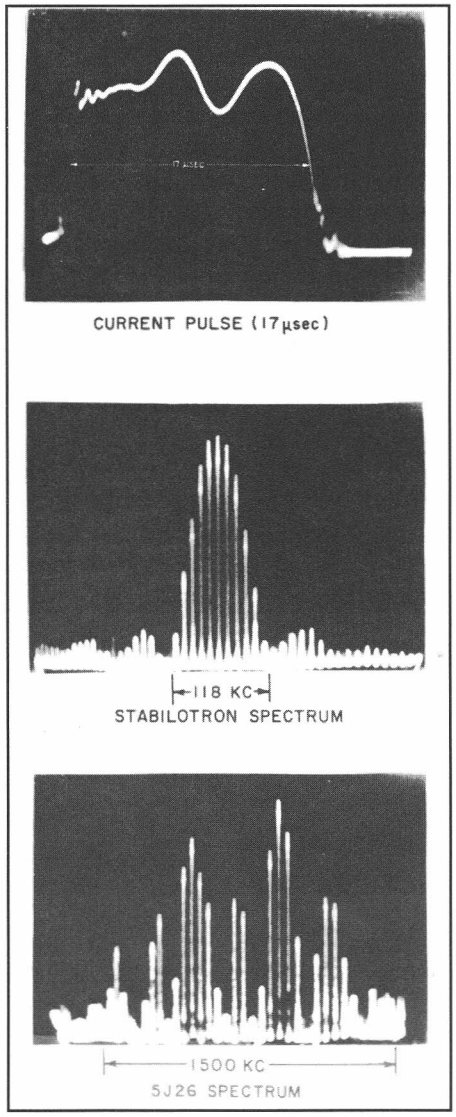


Figure 10. The remarkable contrast between the performance of the conventional L-Band 5J26 magnetron and the platinotron operated as a Stabilotron is shown above when a 17 microsecond pulse with a poor current shape was applied to both. Stabilotron has almost a theoretical spectrum for a pulse of that duration while that from the 5J26 magnetron was spread out over 1500 MHz.

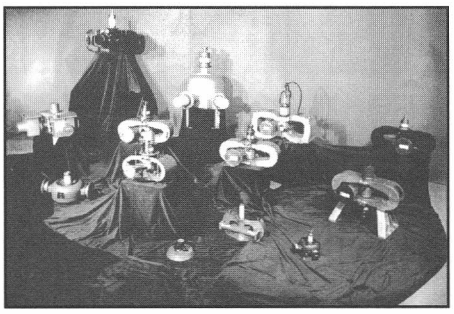


Figure 11. A partial collection of the many crossed-field amplifiers, also known as Amplitrons or platinotrons, that were designed and constructed at the Raytheon Company.

Figure 11 which shows a collection of some of the tubes designed by the Raytheon engineers. A major reason why the platinotron principle could be so rapidly applied to many different tubes for many different applications was the trained staff of magnetron tube engineers at Raytheon. Because of the similarity of the mechanical design and basic operating principles of the magnetron and the crossed-field amplifier, it was comparatively easy for them to adapt their skills as tube engineers to the crossed-field amplifier.

One particularly outstanding tube development that was to play a vital role in leading to a super power Amplitron was the QK 622. This S-Band tube (3 GHz) tube pioneered the direct coupling of the two waveguide ports to the internal microwave network. This 3 megawatt peak power output tube broke new ground in efficiency and average power output, producing 15 kilowatts of average power at an efficiency of 80%.[10] The other development that supported the logic of proposing a super power tube that would produce hundreds of kilowatts of continuous power at high efficiency is discussed in the next topic.

Achieving Continuous (CW) Operation of the Crossed-field Amplifier

Several potential application areas for the platinotron, including communications, CW radar, and microwave processing depend upon CW or continuous operation of the tube. But CW operation of the first generation of platinotrons was not possible, or at least not practical. There was a basic reason for this. At the low power operating levels of the early platinotrons, where CW operation might be achieved, there was excessive leakage of electrons from the cathode-anode interaction area to the magnetic pole pieces of the tube that were at ground or anode potential. This leakage greatly reduces the efficiency and the pole pieces are heated up by the electrons they collect. I believed that this difficulty could be eliminated by placing the pole pieces at cathode potential, which would then repel the axial flow of the electrons and allow efficient operation at lower power output levels.

Getting the Heat Out

But with this problem corrected, what would be the upper power output limit of the device? The upper limit would be determined by the amount of heat that was generated by the electrons that bombarded the microwave circuit and how well that heat could be removed. The amount of heat generated would depend upon the efficiency with which the DC power input was converted into microwave power; the amount of heat that could be removed would depend upon the heat removal process. For heat removal, I recalled a technique to absorb very high heat flux densities by forcing water at high velocity through small diameter channels. I had witnessed this technique many years ago while a student employee at the research center of the Radio Corporation of America in Camden, New Jersey.

I decided to combine this heat removal technique with the negative pole piece principle in the design of a tube at X-Band where the total area of the cooling surface of the slow wave circuit would be about 1 square centimeter. The tube, the QK 680, that resulted represented a thrust into new performance territory.[11] The tube operated with efficiencies as high as 59% at a CW power level of 5000 watts over a frequency range of 9900 to 10,300 MHz. It was the highest powered CW tube of any type at X-Band when it was developed in 1959. The dissipation densities at the tips of the vanes in the tube were judged to be in excess of 10 kW/cm^2.

The 400 KW CW Super Power Amplitron and Sputnik

By combining this high power dissipation density achievement in the QK 680 with the 80% efficiency performance observed in the QK 622, we were in a position to propose a super power tube at a frequency of 3 GHz that would operate at the continuous power output level of 400 kilowatts, an unprecedented level. But the development of such a tube would require advanced construction facilities, a very large DC power supply and other advanced test facilities.

Ordinarily, an unsolicited proposal to develop such a super power tube would receive little response from the government. By coincidence, however, an unexpected international event took place that caused the government to respond with an action favorable to such proposals. The event was Sputnik, and the response was DARPA, the Defense Advanced Research Projects Agency. DARPA was looking for leap frog advances in technology. Raytheon, a leading innovator of new electronic technology, responded to DARPA with a system proposal called RAMP, acronym for Raytheon Airborne Microwave Platform. The proposed super power Amplitron was a key component of this proposed system in which a high power microwave beam formed on the ground was focused upon a helicopter platform

operating ten miles above the Earth to supply that helicopter with power to stay on station and to perform communication and surveillance functions. The proposed system received some study money but the super power Amplitron portion of the proposal was fully funded. Over six million dollars was funded for the 400 kilowatt CW Amplitron development and a companion super power 50 megawatt pulsed Amplitron. As its contribution to the program, the Raytheon Company built the super power development laboratory. I was placed in charge of the Super Power Programs which included not only the super power Amplitron tube developments, but also the applications of super power that included Industrial Microwave Processing of materials and early development of wireless power transmission systems.

The development of the 400 kilowatt CW Amplitron, shown in Figure 12, was successful. Over 425 kilowatts of continuous power output was generated at an efficiency of 76%, and the tube had a full efficiency bandwidth of 8%. One important development was the use of a water cooled pure platinum cathode which supplied the current by a secondary emission process based upon a percentage of electrons in the interaction area returning to and bombarding the cathode and releasing secondaries. Very long cathode life could be expected.

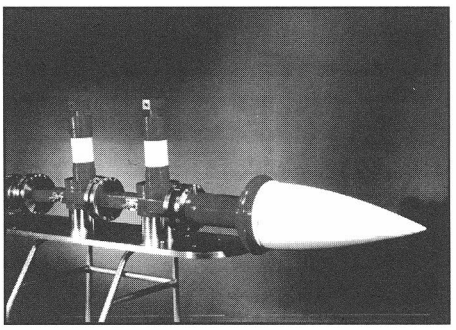


Figure 12. This two stage "super power" Amplitron, shown without permanent magnets, generated 425 kW of CW power output with a power added efficiency of 76%. The gain was 9 db and the bandwidth was 5% at a mean frequency of 3 GHz. The tube featured a water-cooled secondary-emitting platinum-metal cathode. Such a high power level motivated interest in wireless power transmission for several different applications.

The super power tube development needed the efforts of many people. The engineers involved in a major way were John Skowron, George MacMaster, Bill Zettler, Roy Mims, Kenneth Dudley, and Larry Nichols.

In retrospect the super power program may be regarded as an anomaly that does not often occur in peace time. Although the resulting tubes represented a large step forward in technology, they were not needed in the same urgent sense as were the magnetrons during World War II or the crossed-field amplifiers for sophisticated radar after World War II, and the program soon slipped into eclipse.

But the super power Amplitron program was a key element in initiating work on wireless power transmission.

Application of the Platinotron Principle to Low Power Tubes for Communication Use; Application to the NASA Apollo Program

A number of activities and events led to the use of the Amplitron or crossed-field amplifier for all high data rate transmission from the Apollo landing spacecraft on the moon to the Earth. An early consideration was the author's interest in applying the platinotron principle to the low power amplifier and "local oscillator" kind of application. In large part this interest was motivated by the author's desire to form a company of his own and further apply the platinotron principle. The start up logistics in terms of test equipment and fabrication equipment would be minimized for low power devices.

This desire to form a company was no idle desire. The author had a machine shop for many years and had used it on some of the Raytheon projects. And in the late 1950s he purchased additional tools, test equipment, all raw material such as oxygen-free copper that would be needed, vacuum exhaust equipment, and constructed a small scale hydrogen brazing furnace. With this he fabricated at home an X-Band low power platinotron that successfully operated at an anode voltage of 300 volts, a range then quite acceptable for local oscillator tubes.

With this achievement I was about to form the new company when Sputnik intervened and the unlikely proposal that we had made to the Department of Defense to build a super power Amplitron was funded. Because of my heavy involvement and interest in this proposal I opted to remain with the Raytheon Company and became the head of a new Operations devoted to the generation of super microwave power and its applications.

However, I incorporated the progress that I had made on low power tubes into our various development efforts in the new laboratory. Eventually the low power effort led to a proposal to use the crossed-field amplifier in the transmitter in the LEM or lunar excursion module in the Apollo program. The communication frequency was in the S-Band portion of the spectrum. The power output was 24 watts, several times what solid state amplifiers had reliably achieved at that time. As I recall the drive level to the crossed-field amplifier was about 1.5 watts. Two of the crossed-field amplifiers were cascaded (the input of the second tube connected to the output of the first tube). Should the cathode of one of the tubes fail (the most likely failure mode) the tube that failed would still be transparent, either to the input drive power or to the output power of its companion tube. A pho-

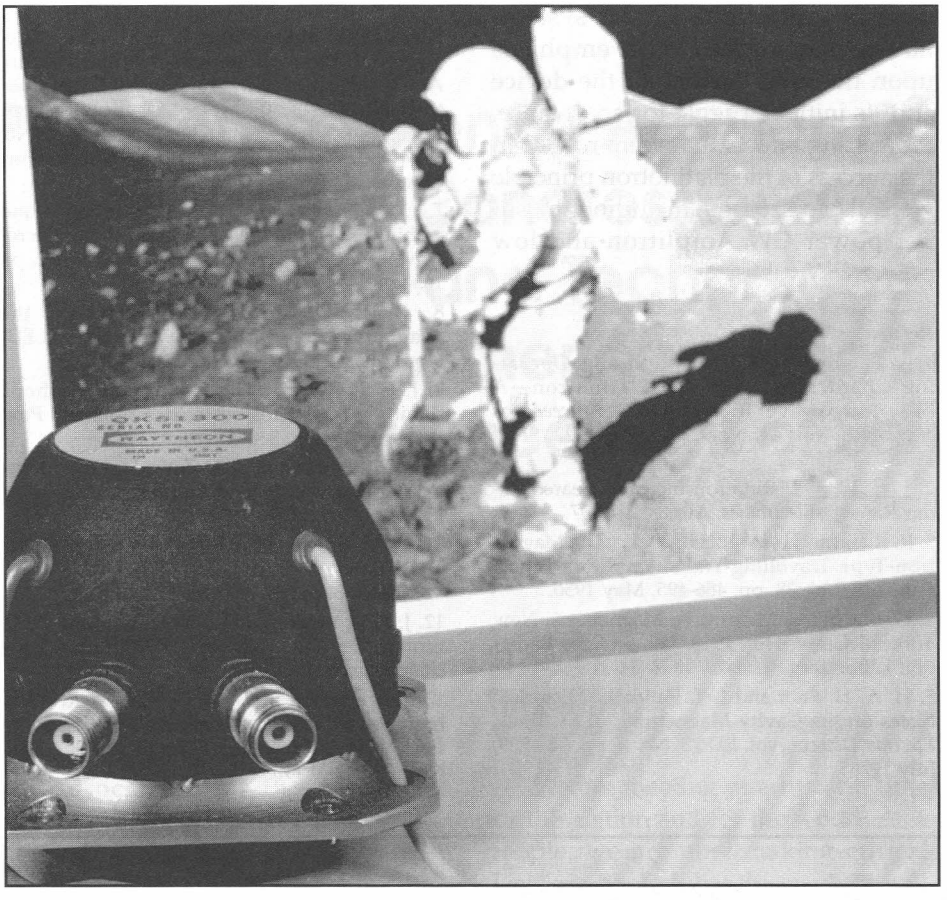


Figure 13. The S-Band QKS 1300 Amplitron was used for all high data rate transmission from the lunar excursion module to Earth during the NASA Apollo program. It provided 17 db gain and a power output of 25 W.

tograph of the tube, the QKS 1300, is shown in Figure 13. Mr. Wesley Teich was the principal engineer for this tube.

This application in the Apollo program was a success and all of the high data rate communication, including video, between the LEM and Earth came down through the crossed-field amplfier.

Although successfully used in the Apollo program it was discovered that the average life of the many tubes that were tested in the development program prior to use in the LEM was only 1000 hours. Failure was caused by bombarding electrons stripping the cathode coating from the cathode. We did not realize then that this stripping would not have occurred with a carburized thoriated tungsten cathode like the one used in the ordinary microwave oven magnetron. If we had, the crossed-field amplifier with a long life carburized thoriated tungsten cathode might have had a substantial role in communication systems.

Note on Attempt to Develop High Gain Crossed-field Amplifiers

The major shortcoming of the crossed-field amplifier was low gain, so their use in a broadband frequency application had to be supported by another lower power crossed-field amplifier and then a high gain travelling wave tube. In some cases the travelling wave tube drove the final crossed-field amplifier directly.

George MacMaster of Raytheon developed a high gain crossed-field amplifier by incorporating a slow wave structure into the cathode that matched the slow wave structure in the anode. He called this a "circuited-cathode crossed-field amplifier." The low level drive signal was then fed into the cathode circuit as well as the anode circuit. With this arrangement power gains as high as 30 db were obtained. MacMaster also observed lower noise in the cathode-circuited tube.

However, the tube was mechanically quite complicated and it was introduced after most radar designs had been frozen and gone to production. There was not an urgent need for such a tube. In addition, microwave tube development as a business was declining, making it difficult to support programs like that of MacMaster's.

MacMaster's work is of importance for several reasons. First, there may be a revival of interest in microwave application areas where a crossed-field amplifier would be a logical choice if it had a gain approaching 30 db. Secondly, the device presents a challenge to analyze its principle of operation; and in analyzing it better insight into CFA operation in general may be obtained. Finally, it is possible that the noise level may be lower in this version of the CFA.

Future Outlook for the Crossed-field Amplifier

It has been over forty years since the introduction of the platinotron principle which converted the ordinary magnetron oscillator into a broadband amplifier. Crossed-field amplifiers are still being widely applied and used, and will continue to be for many years until the systems in which they are used become obsolete by technological advances. An example of this is the proposed use of the global positioning system to take over the surveillance of all aircraft, thus obsoleting all radar systems for that purpose.

Their future use in wireless power transmission is questionable. Ironically, by an odd reversal of direction of technology, the ordinary magnetron oscillator like that used in the micro-

wave oven can be converted with external circuitry into a high gain (30 db and more), phase-locked amplifier, and combined with small sections of slotted waveguide antenna to become modules in an electronically steerable phased array for the purposes of wireless power transmission. Such amplifiers are narrow band, but wireless power transmission will use only one frequency so broad bandwidth is not needed.

However, the future is never completely predictable, and the crossed-field amplifier, or more specifically the reentrant beam variety, may be around for a long time to come.

Conclusion

The conversion of the ordinary magnetron oscillator into a broadband amplifier that has had many applications in sophisticated radar systems has been reviewed with emphasis upon the early history of the device and its initial struggle for acceptance. Pioneering efforts that were rooted in the success of the platinotron principle were also discussed, including the super power CW Amplitron and low power CW tubes.

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The Pioneer Award

The 1995 IEEE MTT-S Pioneer Award was awarded at the 1995 MTT-S International Microwave Conference to William C. Brown "for his Pioneering Work on Crossed-field Amplifiers or Platinotrons."

Eligibility of Mr. Brown for this award was his "publication in an archival journal of a contribution which has made a major, lasting contribution in the field of interest of MTT-S at least 20 years prior to the year of the award."

To be more specific, the publication was in the Proceedings of the IRE in 1957, five years before the combining of the IRE with the AIEE to form the IEEE in 1962. The publication was entitled "Description and Operating Characteristics of the Platinotron—A New Microwave Tube Device."

In the nearly 40 years that have elapsed since that time, the "platinotron," also know as the "Amplitron" under a Raytheon trademarked name, and more simply as the "crossed-field amplifier," established itself firmly in nearly all major radar systems, including the FAA's Air Route Surveillance Radar, Navy's Aegis radar, and the radars used in the Hawk and Patriot Missile Systems. It has been estimated that over this period of time, tube sales alone from Raytheon and other companies have amounted to between one and two billion dollars, and the radar systems in which they were used to many times that.

In addition to its successful application to radars, it was successfully used in all high data rate transmission, including television, of all communication from the lunar lander during NASA's successful landings on the moon. Perhaps more importantly the successful development of a "super power Amplitron" that produced over 400 kilowatts of continuous power at 3 GHZ or 10 centimeters motivated the application of microwave technology to wireless power transmission that has made notable technological progress but still awaits maturing into successful applications.

Bill Brown has written for this *Newsletter* "The History of the Crossed-field Amplifier" which describes the circumstances under which the device was invented, the short time period of not realizing its importance and of non-acceptance, and then with the support of the Army Signal Corps sudden acceptance and immediate application. Its emergence came at a most opportune moment when radar technology after World War II demanded a much more sophisticated device than the magnetron oscillator which had been the backbone of all radar during World War II.

President's Science Advisor, John H. Gibbons, Decries Congressional Handling of Science and Technology Budget in Speech to American Association for the Advancement of Science

Leaders of over 96 science and engineering societies (including IEEE) gathered in Washington on June 26th at a meeting sponsored by the American Association for the Advancement of Science (AAAS) to discuss planned congressional cuts to the federal research and development budget and how the science and technology community should respond to this new environment. An analysis prepared by AAAS for participants showed that Federal investment in non-defense R&D would decline by 34.4 percent in constant dollars (adjusted for inflation) by the year 2002 under current congressional budget balancing plans. The normally apolitical AAAS has also taken the rare step of issuing a position statement urging Congress to "exercise great caution in making changes of this magnitude and consequence for the nation's vital research enterprise."

Presidential Science Advisor John Gibbons spoke to the gathered assembly to provide the Clinton Administration's perspective on Congress' handling of the S&T budget and insight into the President's plans. The full text of Gibbon's prepared remarks are appended:

Remarks by John H. Gibbons, Assistant to the President for Science and Technology to AAAS Forum "Unity Under Adversity"

"The First Rule of Tinkering'

We are meeting at a historic time for this nation and for the world. As a people, we are now making critical decisions about what this country will be in the 2lst century. We are doing no less than deciding our future as a self-governing society.

Do we have the discipline not to empty the treasury and borrow from our descendants for near-term gains, as we did during the spendthrift '80s? Do we have the commitment to invest in the future even as we consume and enjoy the fruits made possible by those who came before us? Do we have the ability to form alliances for the future national interest, and more effectively engage in the coming global economy?

These are not the headlines in the *Washington Post* or the *New York Times*. But they are the issues underlying whether we will have health care for all Americans; whether our elderly receive basic social services and dignity in their old age; whether our children receive an adequate education that prepares them for jobs in the future; whether we protect or despoil our environment; whether we mount a strong national defense that keeps our country safe in a time of highly complex conflict.

These were the issues that defined the last Congressional election, and also the previous election that brought President Clinton to the White House. They will continue to be a part of the national dialogue for years to come.

These issues merit and command the attention of the American people; but the noise level is very high. What I fear is that the state of science and technology—with its long-term payoff—will be lost in the immediacy of the high-stakes, high-decibel debate.

As the President's science advisor, it has been my job over the last three years to make sure that the nation maintains its commitment to long-term investments in science and technology, even as we work through a period of great change. We have been fortunate that the President and Vice President themselves share a deep conviction that our future depends on continuing to support science and technology—our economic gains, our national security, and our quality of life, all depend on it.

But the pace of change ushered in last November has made securing the future of science and technology investments immensely more difficult. How can we advocate for science funding, when deep cuts for hospitals, schools, police, and housing are on the block, too? Why should we maintain

a portfolio of solid R&D investments, when it may well mean cuts to school lunch programs, environmental protection, anti-terrorist activities?

These questions are difficult enough given the Administration's continuing commitment to cut the deficit momentum, a deficit we inherited from past Administrations; they approach the impossible in the face of the Congressional juggernaut to bring the deficit to zero by 2002. Under these conditions, how do we convince the American people that preserving S&T funding is equally important in terms of providing a more secure and robust future?

Crumbling Bipartisan Support

Fifty years ago this week, in his office at the Carnegie Institution on 16th Street, Vannevar Bush was putting the finishing touches on a document that he was to send to another President—President Truman. Released to the public on July 19, 1945, it was an instant hit. It was hailed across the nation and by both political parties as a landmark statement of why the government should support science and technology. It became a statement of national consensus about the kind of future we wanted, and how support of science would enable us to get there.

The publication of "Science, the Endless Frontier" marked the beginning of what have been 50 years of strong, bipartisan support for science, technology, and higher education. Yet today, after a half century of resounding success, this long-standing support is in jeopardy.

The House and Senate are now talking about cuts that would wipe out a third of our civilian science and technology investments over the next four years. The Congress would slash and even abandon broad areas of research that are vital in understanding how the global environment works and how to build our economy. Under these projected cuts, we would sink far below other industrialized nations in the percentage of our gross domestic product invested in research and development.

We also know that the government ought to be doing a better job of assessing risk so that we can make sure that all regulations make sense, and are based on sound analysis. But you need information to make such analyses, and some in Congress are trying to decimate the data collection and analyses, both scientific and socioeconomic, that make risk assessment possible. What we could well end up with is lawyers arguing the points of the law while nothing gets done. After all, wetlands don't change because someone in Washington decides to change the definition of a wetland. Recent attempts by reactionaries in Congress to define away the majority of our wetlands by imposing pseudoscientific condltions make a mockery of good sclence, rational analysis, and thoughtful stewardship.

Proposals to eliminate the National Biological Service and slash global change research rest on the same know-nothing stance. Some in Congress seem to believe that what we don't know won't hurt us. But we all lose by failing to understand the world in which we live.

We in the Clinton Administration believe that, in looking for savings, Congress is not paying appropriate attention to protecting key investments that are at least as important in providing for the future as debt reduction. The leaders of the 2lst century will be those nations that excel in education, science and technology. They will be the nations able to take advantage of new opportunities. They will be the nations that can respond to environmental, economic, military challenges.

The 2lst century will severely test human knowledge. We will need to feed and improve the living standards of a burgeoning population. We will need to find replacements for fossil fuels—and be prepared to adjust to global climate change. Such changes come upon us slowly, but the capability to deal with them also requires long-term investments that enable the change to be accommodated.

This Administration agrees wholeheartedly that we need to balance the budget. But there are right ways and wrong ways to do so. There are ways that will make us stronger and ways that will leave us weaker. We must be very wary of those who argue that long-term issues such as global environmental change are best ignored. On these and other decisions we make today, we will be judged by our children and grandchildren.

Two Cultures—and a Second Look

Essentially, we are being presented with two very different views of governance for the 21st century. Many members of Congress are acting upon the general impression that government is inevitably intrusive and wasteful. This Administration disagrees. We believe that government can be a force for good in the life of the nation—that government can help create a more perfect union—and we will stand by that conviction no less fervently than did the Founding Fathers.

It will be easy today to leave this room having heard all the speakers talk about the importance of science and technology, and to believe that this apparently-shared commitment to the value of science will carry us into the next century. But while we share many common goals, the Administration and Congress differ greatly on how to achieve them—and the way we obtain the goals has everything to do with what kind of system you end up with in the end.

After 12 years of talking about fiscal constraints while we let government grow and tripled the national debt with a hemorrhage of overspending, this Administration from its outset has been making the hard decisions

that need to be made. For the first time since the Truman Administration, the annual budget deficit has dropped for three years running. In fact, if not for the interest on the multi-trillion dollar debt run up during the Reagan and Bush years, the federal government would be running a surplus right now.

Where the Administration is using a scalpel to trim programs, leaving them more effective, the Congress would use a meat ax that cleaves out bone and muscle along with fat. While the Administration believes in building partnership pipelines to enable and speed the flow of research from the laboratory bench to the marketplace, the Congress would build ditches that divert the flow only to the lucky or the rich. And while this Administration supports basic research as the wellspring of the future, the Congress would poison the wells that might interfere with its political agenda—in environment, sociology, behavior, and other areas of research.

Many members of Congress think that they know what they are doing—they are balancing the budget. But they don't seem to realize what they are undoing in the process. It can take 100 years to grow a tree, but it only takes a few minutes to chop it down. As a recent Science editorial by Rich Nicholson put it: "The United States has created a fantastic system for simultaneously producing new knowledge and new talent. It is a system that will be very easy to tear down, yet slow and difficult, if not impossible, to rebuild."

There is an alternative to tearing down the system. We can use the commitment to balance the budget as an opportunity to examine the rationale and functions of the full range of science and technology programs. The world for which Vannevar Bush wrote 50 years ago no longer exists. We are entering a new era. We need to take a fresh look at how we pursue and use new knowledge.

The Clinton Administration's vision for science and technology is expressed in the report "Science in the National Interest," released last August. Among the goals established in that report were maintaining leadership across the frontiers of scientific knowledge, enhancing connections between fundamental research and national goals, and producing the finest scientists and engineers for the 21st century. We continue to refine this vision in regional meetings across the country; recently such a meeting was hosted by Florida A&M.

Achieving these goals requires adequate resources, which is why funding for science has been protected in the Administration's plan to balance the budget. As the President announced earlier this month, we have proposed adding $2.5 billion a year to the NIH budget by 2002. We have proposed adding $500 million a year to NSF's budget by 2002. Also by 2002, NASA's basic research, including Mission to Planet Earth, would go up by $500 million a year.

It is very difficult to achieve even these modest increases in today's budget climate. For the past two and a half years this Administration has been engaged in a "zero sum game" in terms of spending—a far cry from the inflation-plus numbers that obtained in the free-spending Reagan and Bush years.

Aldo Leopold's first rule of tinkering is to keep all the cogs and wheels. And the "tinkering" that has allowed us to maintain this level of investment keeps the cogs and wheels. In our approach to preparing ourselves for a post-Cold-War world, a world in which we have fewer discretionary fiscal resources, we've been working away at getting more for less: President Clinton chairs the National Science and Technology Council that draws on the expertise of the agencies to capitalize on synergies and eliminate duplication, inefficiency, and miscommunication. Rather than agency integration, the Congressional approach is agency elimination—and without saving a dime more than our reorganizational efforts. We've been increasing productivity—Congress would simply cut programs. And we've diversified, maintaining a balanced portfolio of direct investments though public-private partnerships and indirect investments such as R&D tax credits and streamlined regulation. Congress would draw the line by only supporting basic research and disengaging from assisting in precompetitive technology development—even when it promises enormous public benefits. At the same time, our competitors abroad are stacking the deck through their own public-private cooperation.

Government support for applied research and development is nothing new. In 1842 Congress appropriated $30,000 for Samuel Morse to build a telegraph line from Washington to Baltimore to demonstrate the feasibility of the new technology Morse had developed. Since then the government has continued to make far-sighted investments in agriculture, aviation, electronics, medicine, energy, space—investments that have made us world leaders in these areas.

But in recent decades the world has changed in ways that have changed the government's responsibilities for technology development. Today we live in a world increasingly dominated by the advancement of knowledge. Individual firms in highly competitive markets cannot capture much of the return to new fundamental knowledge. Knowledge therefore becomes in part a public good, and the only way to ensure adequate investment in a public good is through public involvement.

It's ironic to me that the Congress would be taking steps now to retrench from such investments. In recent years, companies have been cutting back on generic and long-range research, in part because of intense competition from abroad. If Congress now cuts federal support to basic research, and removes itself entirely from applied R&D, the gap between the generators of new scientific knowledge, and the people in a position to apply that knowledge, will widen.

It is a perilous time to be decimating the government's investments in technology. The Critical Technologies Report that our office recently released concluded that the United States is ahead or tied with Europe and Japan in all 27 areas of technology examined. But our leads are small and shrinking—often very rapidly. Our competitors are aided hand-in-glove by their governments. If we want to maintain leadership—or even parity—we cannot stand still.

The proposals being made by Congress reflect an inadequate picture of the world. The Congress assumes that basic research can be neatly separated from applied research and development. That's just plain wrong. In today's society, where science and technology so thoroughly permeate our lives, these sharp distinctions can no longer be made. Science and technology are like a huge tapestry, with the threads intermingling in a single pattern. Start pulling a thread here or a thread there, and you might not notice it on a tapestry of this size. But pull out a third of the threads and you'll be left with a mass of tangled yarn.

This month's *Physics Today* provides an elegant example. In an effort to compensate for the flaw in the Hubble Telescope's primary mirror, workers at the Space Telescope Science Institute developed a large collection of image-processing software. The software acts to help spot faint stars in blurry images. It turns out that finding that faint star is a lot like finding microcalcifications—faint spots in a blurry mammogram image that can signal breast cancer. Current mammography images only show microcalcifications 250 microns large or larger; the new techniques developed for use with the Hubble can yield resolution down to 50 microns. With resolution like that, many more cases of breast cancer can be detected, and detected early enough for successful treatment.

When Dan Goldin testified before Congress on the need to support imaging science at NASA, he didn't promise Congress a breast cancer treatment in return for their funding. He couldn't have known—none of us could—what benefits this new technology might spawn.

Toward the Future

How do we make sure that these kinds of breakthroughs keep happening, and that they bear fruit across the R&D spectrum for all Americans? Luckily, in protecting research and development as vital investments in our future, the science and technology communities are not alone. In a recent editorial, the New York Times wrote:

> "Cutting the science budget will save a few billion dollars a year in a $6 trillion economy. Knocking out innovative research can lead to stagnant productivity and growth. By that calculation, the House plan is an irresponsible gamble."

And this from the *Washington Post*:

> "It's necessary to balance the federal budget, just as it is necessary to enforce corporate efficiency. But it's also necessary to accomplish those things in ways that do not jeopardize the country's future standard of living."

This kind of support from the media is invaluable. But I want to emphasize that the primary responsibility for making the case to Congress and the American people belongs to the science and technology community. We are the ones who are most familiar with both the potential and the limitations of science and technology. As C. P. Snow once wrote, "Scientists have the future in their bones." It is our obligation to convey that sense of the future to others.

If we are to reverse the substantial momentum that lies behind proposed cuts in science and technology, we need to engage many different communities: the R&D community, the industrial community, the education community—ultimately the entire American populace, because they are the ones who will suffer the most from these changes.

But none of us will get a full meal if we continue to fight each other for table scraps. Rather, we need to present the best case for our future as a nation—not our future as a high-energy physicist, or a biosystematist, or an immunologist. And we have to do this in the most effective manner we can. We need to capture the nation's attention. If we can do that, the facts will speak for themselves.

This is an anxious time, because change generates anxiety. In his *Prison Notebooks*, Antonio Gramsci writes that:

"Crisis consists precisely in the fact that the old is dying and the new cannot be born; in this interregnum a great variety of morbid symptoms appears."

We are in just such an interregnum—the vision that was Vannevar Bush's wanes, and a new vision has not yet firmly rooted in the minds and hearts of the people. Yet the American public recognizes that change is inevitable. The President and Vice President were elected because of their commitment to change. We now have a Congress that has made a similar vow.

For all the differences between the Administration and Congress, there are many convictions we share. For both, science is a most powerful agent for change in our society. In the end, that is why we must continue to support research, even as we move to balance the budget. Science and technology will not only enable us to stop digging deeper into the hole of deficit spending; they will enable us to climb out of the hole we have dug.

The Clinton Administration wants to work with Congress. An endless string of vetoes will damage the country as well as the government. The

leaders of Congress are hard-working advocates for change; their convictions and their tenacity are admirable. But every member of Congress needs to understand the enormity of the changes that are being proposed, and the impact those changes would have on the American public.

I have been faulted in recent weeks for introducing a partisan note in the debate on science and technology funding. The science advisor to the President has always been apolitical, I've been told, a cheerleader for science who left the world of politics behind and worked for the overall good of the community.

That's fine if you're a science advisor with an expanding budget. If your job is to hand out money, then it's very easy to be on good terms with everybody. I do not have that luxury.

It is not a pleasant task to go before the Congress and tell them they're making a big mistake—that they are compromising the nation's future for the sake of ideology. It isn't easy to tell good friends on the Hill—on both sides of the aisle and in both chambers—that the bipartisan support for R&D that we've built up over the past 200 years is gravely threatened.

It is not a pleasant task to come before the nation's leaders in science and technology—and you're sitting in front of me this morning—and deliver an unpalatable message that you would just as soon not hear. It isn't easy to urge you to take time from your work in science and education to become more active participants in the national debate over the role of government support for science and technology...not as lobbyists for your particular area of science, but for the whole enterprise of science and technology.

But this is my job, and if I must, I will use the harsh rhetoric that focuses attention on science and technology issues. I do not want to be the science advisor on whose watch our future foundered for lack of commitment to the very things that made us great. The President does not want to be remembered as the President who ceded world leadership to other countries—in science, in technology, in economic growth and productivity—because he could not be heard above the howl of the budget-cutting frenzy and the din of debate over other national issues.

If that means that I am partisan, so be it. But the partisanship is for science—to provide and preserve our nation's future. [It's easier to gin up the enthusiasm for this task after you become a grandfather!] And I urge you to be partisans with me—partisans for the future—or that future is a bleak one indeed.

You have a very special role to play—you understand the issues, and you are educators. You must help us convey this message to the nation, and especially to its leaders.

With persistence and good faith, we can find areas of agreement and build on those areas. As John F. Kennedy said, "Let us not seek the Republican answer or the Democratic answer, but the right answer. Let us not seek to fix the blame for the past. Let us accept our own responsibility for the future."

AICN Workshop Promotes Self-Marketing Skills

The IEEE's Los Angeles and Southern California Consultants' Networks hosted the third national workshop for the Alliance of IEEE Consultants Networks (AICN) on June 3 in Anaheim. The expanded workshop, which drew 155 attendees, included dual-track sessions for experienced consultants and those engineers beginning or considering a consulting career.

The prime emphasis for this year's workshop was on self-marketing. Experts introduced the topics and, along with panels of consultants from the Institute's national networks, shared their techniques. Panelists discussed liability, tax considerations, and other specialized independent contracting issues.

For more information about a proposed workshop to be held in Boston this fall, contact William Anderson at the Washington Office at (202) 785-0017, ext. 330 (phone); or w.anderson@ieee.org (e-mail).

IEEE-USA Submits Testimony on Air Safety

On April 16, E. David Hinkley, chair of IEEE-USA's Aerospace R&D Policy Committee, submitted testimony for a hearing of the House Science Technology Subcommittee on research and acquisition management in the Federal Aviation Administration (FAA). He argued that the growth in air travel threatens to overwhelm the presently inadequate air-traffic control system, which has not kept pace with available navigation, communications and flight surveillance technology.

Hinkley expressed IEEE-USA's support for modernization of the nation's air-traffic control system and the FAA's R&D programs. He described the division's recent position on air-traffic control safety, which favors accelerating the use of the satellite-based Global Positioning System and adopting a digital link between aircraft and ground controllers.

For more information or a copy of IEEE-USA's position, contact Jim Anton in Washington at (202) 785-0017, ext. 320 (phone); (202) 785-0835 (fax); or j.anton@ieee.org (e-mail).

Microwaves

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The main purpose of this communication is to emphasize how the word *microwaves* has been introduced for the first time in the scientific and technical terminology. This term has been commonly used to indicate those electromagnetic waves with wavelengths ranging from 1 mm to 1 m. The corresponding frequency range is 300 MHz up to 300 GHz for l-mm-wavelength waves, which are the highest frequencies used in telecommunications. The previous limits have been arbitrarily defined: in practice they constitute an attempt to define the microwave frequency range as that located between the frequencies of the electromagnetic waves employed for radio and television broadcasting and those of infrared rays.

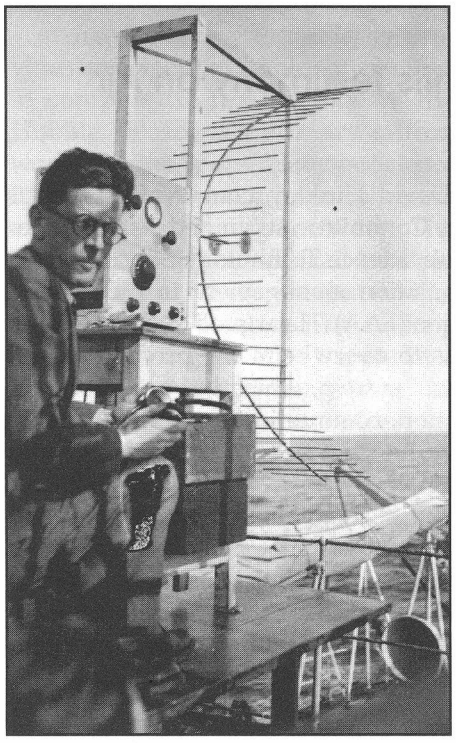

Figure 1. Nello Carrara during a transmission experiment in 1931.

The steadily improving technology of such range of frequency has characterized the development of telecommunications since the beginning of the World War II. The demand for more and more high frequencies in telecommunications was originated from various well known reasons, for the sake of brevity not discussed here, and has attracted the attention of researchers toward this field. Guglielmo Marconi (Bologna 1874, Rome 1937), in the decade from 1919 to 1931, was the first scientist to drive the attention of researchers to this range of frequency. The first radio wave broadcasting experiments with microwaves were realized in 1931, by Marconi (at $\lambda \cong 50$ cm) through the Tigullio Gulf in Liguria (Italy), and by Clavier (at $\lambda \cong 17.6$ cm) across the Channel. Later on, in April 1932, Marconi realized the first microwave terrestrial link between Villa Mondragone (Monteporzio Catone, Rome, Italy) and the Vatican State.

The same period of time was characterized by the first theoretical studies on microwave propagation and the first experiments involving devices to generate and detect them. In this context, the term microwaves as it is understood today, was introduced first by the Italian physicist Nello Carrara (Florence 1900, Florence 1993) in the period when he was with the R.I.E.C. (*Regio Istituto Elettrotecnico e delle Comunicazioni* [Royal institute for electrical techniques and communications]) of the Italian Navy in Leghorn. The Institute was previously founded by Giancarlo Vallauri in 1916. There worked the first Italian group of researchers in the fields of microwave engineering and radar techniques. The R.I.E.C. maintained a prominent position in this field for a long time.

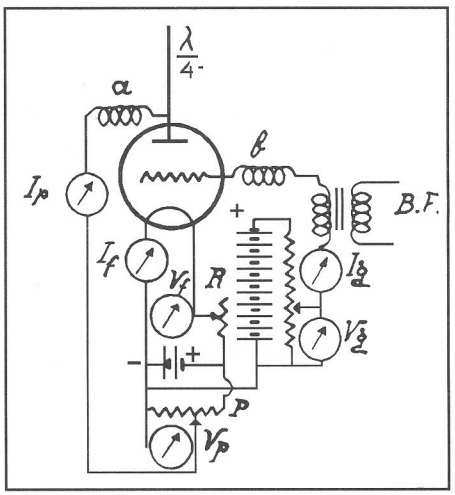

Figure 2. Schematic diagram of the device employed by N. Carrara in 1932 for detecting microwaves.[1,4]

In a paper dated March 1932, published in the first issue of the

Italian journal *Alta Frequenza*[1] (the journal was founded in the same year thanks to the work of G. Vallauri), N. Carrara reminded that *un triodo, ad elettrodi cilindrici, con tensione di placca nulla o negativa e con tensione di griglia fortemente positiva, puó emettere onde elettromagnetiche di frequenza elevatissima (microonde)** ("a triode with cylindrical electrodes, with a low anode potential and a highly positive grid potential, is capable of generating electromagnetic waves of a very high frequency (microwaves)," from Ref. [4]) and explicitly related the term *microwaves* with electromagnetic waves with frequency of the same order as 10^9 Hz.

Incidentally, it is worth emphasizing that in the same period, many other terms were used to denote the range of frequency now referred to as microwaves. Among others, it is worth mentioning the terms *micro–rays* and *quasi optical waves* introduced by Clavier and Karplus, respectively.

The term *microwaves* was later on used again by Carrara in some other works published both in Italian (see for example Ref. [2] and [3]) and in English [4]. In particular, the publishing of the paper "The detection of microwaves" in the *Proceedings of the Institute of Radio Engineers* (I.R.E.) [4] (the original manuscript was received by the Institute April 2, 1932) definitely made the term microwaves enter in the commonly adopted scientific and technical terminology.

References
[1] N. Carrara, "La rivelazione delle microonde [The detection of microwaves]," *Alta Frequenza*, vol. I, N. 1, pp. 7-11, March 1932.
[2] N. Carrara, "Systema a doppia modulazione per radiocomunicazioni duplex con microonde [A double modulation system for duplex microwave radiocommunications]," *Alta Frequenza*, vol. I, n. 2, pp. 189-201, June 1932.
[3] N. Carrara, "Le onde cortissime e il loro impiego nelle radiocomunicazioni [Very-short waves and their applications in radiocommunications]," *Rend. A.E.I.*, vol. 5, pp. 299-307, September 1932.

*The etymology of the Italian word microonde (microwaves) is due to the combination of the word *micro-* (from the Greek xxxxx, small) and the word *-onde* (from the Latin *undae)*, which corresponds to the English term *waves*.

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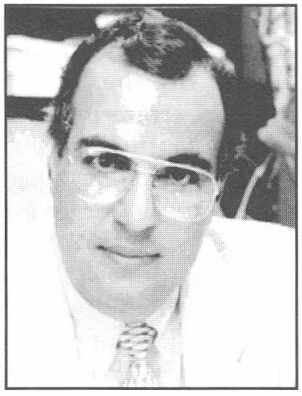

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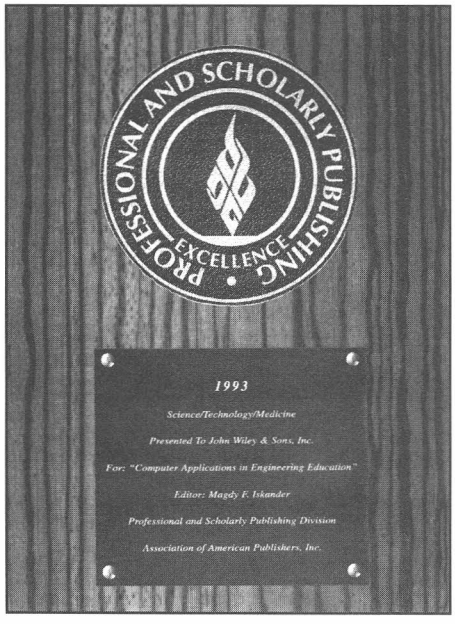
The CAEME Center for Multimedia Education and Technology is pleased to announce the availability of the *CAEME Software Book,* Vol. II, which contains 16 software packages on nine disks and also includes a CD-ROM for electromagnetics. The CD-ROM includes the 15 software packages published in the *CAEME Software Book,* Vol. I, the 16 software packages published in Vol. II, and four multimedia lessons in electromagnetics. Volume I also includes two video tapes, a two-hour tape illustrating experimental demonstrations and a 12-minute video showing results of numerical simulations of several basic electromagnetic phenomena. Tables I and 2 provide the two lists of the software published in Volumes I and II, respectively. A list of the multimedia lessons included in the CD-ROM published with Vol. II is given in Table 3. It may be also worth mentioning that the Vol. II software book is over 900 pages and contains a description of the solution procedures used in developing the software, instructions on how to use the software, and graphical illustrations (in color) of the results of some of the solved examples. You may obtain a copy of the CD-ROM on electromagnetics by contacting the CAEME Center at the above address. The price of the CAEME software is as follows:



- Individual copies of Vol. I of the software book including the CD-ROM on electromagnetics are $150.00. You may also request the two VHS videos with this purchase at no additional charge.
- Individual copies of Vol. II of the software book including the CD-ROM on electromagnetics are $200.00 plus shipping/handling ($15 in the U.S.; $30 outside the U.S.).
- University site licenses may be obtained through a membership fee of $500.00. This fee is for each Volume I and II. Volume II also has a shipping/handling charge of $15 in the U.S. and $30 outside the U.S. These prices were set by the CAEME Policy Board and are based on covering the production expenses of these products and also on helping CAEME be active, productive, and self-supporting in the future. Universities which already have Vol. I of the software book need only purchase Vol. II, although the CD-ROM will include both the Vol. I and Vol. II software and the multimedia lessons.

We are also pleased to announce the availability of a second CD-ROM that includes all the software distributed so far in the journal, *Computer Applications in Engineering Education (CAE),* published by John Wiley & Sons. As you may remember, the *CAE* journal includes a software package with each issue, and Wiley in collaboration with the CAEME Center, decided to publish this promotional CD-ROM that may be obtained free of charge with new subscriptions to the *CAE* journal. The annual U.S. subscription rate for individuals is $75, for institutions $220, and $36 for students and members of ASEE. A list of the software packages and video clips included on the *CAE* CD-ROM is given in Table 4. To make sure that you receivc the free CD-ROM with your

Table 1. List of the software packages included in the CAEME Software Book, *Vol. 1.*

Software Package	Principal Investigator	Institution
Fields and Operators	M. Lapidus	Lascaux Graphics
Elements of Engineering Electromagnetics	N. N. Rao	University of Illinois
ElectroCard and SilverHammer: Teaching Fundamentals of Electromagnetics	R. Cole	University of California, Davis
MacEM	K. E. Lonngren	University of Iowa
Electromagnetic Waves—A Video Tutor Graphics Package	W. L. Stutzman	Virginia Tech
Electromagnetic Software for Solving Static and Dynamic 2D Field Problems on a Personal Computer	J. Lebaric	Rose-Hulman Institute of Technology
Experimental Demonstrations for Teaching Electromagnetic Fields and Energy	M. Zahn	Massachusetts Institute of Technology
Nuline Transmission Line Analysis Program	F. M. Tesche	Tesche Associates
Polylines: A Multiconductor Transmission Line Simulator	L. Carin	Polytechnic University of New York
Mapping of Vector Fields Inside Waveguides	A Elsherbeni	University of Mississippi
Analysis of Waveguides Using the Conjugate Gradient Method	T. K. Sarkar	Syracuse University
Computer-Aided Instruction for Linear Antenna Array Theory and Design	S. J. Blank	New York Institute of Technology
An Interactive Graphics Tool for Displaying Three-Dimensional Equations	J. McKeeman	Virginia Tech
Mininec	R. W. Adler	Naval Postgraduate School
Computer Electromagnetics—Sottware for an Introductory Course	M. F. Iskander	University of Utah
Simulation of Electromagnetic Phenomena Using a Finite Difference-Time Domain Technique	R. T. Shin	Massachusetts Institute of Technology

Table 2. List of the software packages included in the CAEME Software Book, *Vol. II.*

Software Package	Principal Investigator	Institution
Modeling Radiated Fields from Moving Charge Distributions	R. Cole	University of California, Davis
MacFields	W. Tabbara	Supelec, France
Lorentz Force	M. F. Iskander	University of Utah
EMAG: A 2-D Electrostatic and Magnetostatic Solver in MATLABTM	J. Lebaric	Rose-Hulman Institute of Technology
Sinusoidal Steady-State Analysis of Transmission Lines	M. F. Iskander	University of Utah
Particle Simulation of Plasmas	C. K. Birdsall	University of California, Berkeley
Interactive Analysis of Antenna Arrays	A. Elsherbeni	University of Mississippi
Interactive Antenna Pattern Visualization	A. Elsherbeni	University of Mississippi
Antenna Pattern Visualization Using Personal Computers	A. J. Gasiewski	Georgia Institute of Technology
Learning About Antenna Patterns Using 3D Computer Graphics	S. Chakrabarti	University of Kansas
Reflector Antenna Analysis Software	Y Rahmat-Samii	University of California, Los Angeles
Array	J. Romeu	Polytechnic University of Catalunya, Spain
Electromagnetic Wave Propagation	T.-W. Kao	Loyola Marymount University
Integral Equation Solution of EM Problems	C. M. Butler	Clemson University
EM Fields Inside Waveguides and Cavities	A. Elsherbeni	University of Mississippi
General Electromagnetic Model for the Analysis of Complex Systems (GEMACS)	E. L. Coffey	Rome Air Development Center

subscription, you may want to contact CAEME at the above address for your subscription.

We truly hope that members of the IEEE will continue to support the *CAE* journal, not only through subscriptions but also by submitting papers describing new software development and also the use of software and multimedia modules in education. As you may know, the *CAE* journal is published in color, contains free software with each issue, and has received the 1993 Award of Excellence in professional and scholarly publishing in the area of science/technology/medicine. A copy of the award received by the *CAE* journal is shown in Figure 1.

Furthermore, the CAEME Center has been developing software for science and math education. The Center received grants from the State of Utah Centers of Excellence Program and the State of Utah Higher Education Technology Initiative to develop CD-ROMs for calculus, physics, and biology. So far, the Center has developed the *Calculus Castle* CD-ROM and a CD-ROM for the *Physics Museum.*

Table 3. List of the four multimedia lessons included in the CD-ROM on electromagnetics.

- Electrostatic charges and Lorentz force
- Dielectric and conductive media
- Electromagnetic plane waves
- Tic-tac-toe review game in electromagnetics

The *Calculus Castle* is an interactive multimedia CD-ROM tutorial for IBM-based computers. Students are allowed to wander within the rooms of the castle and select a topic of interest. Topics include area under curves, polar functions, limits and continuity, particle motion, rules of differentiation, vectors, a game room, and a tic-tac-toe review game. You may obtain copies of the *Calculus Castle* CD-ROM for $75 from the CAEME Center.

The *Physics Museum* CD-ROM is a Windows-based application and presents multimedia tutorials and interactive laboratory demonstrations of the concepts of physics. These experiments are comfortably arranged in a virtual-reality museum that promotes the learning of physics in a highly motivating environment. Presents available topics in the museum include electrostatics; optical libers, refraction, and dispersion; vectors and coordinate systems; and a drill and practice game, "Frantic Physics," which includes questions on mechanics, electricity and magnetism, optics, and sound. The *Physics Museum* will be available for both Macintosh and Windows in late 1995

We are pleased with the progress the CAEME Center has made and certainly hope that the Center's contributions to education will continue to grow and be productive and beneficial for many years. We are grateful to the Division of Undergraduate Education (DUE) at NSF, IEEE and its participating societies—including AP-S, MTT-S, and EMC-S—and to our corporate sponsors—including Andrew Corporation, Hewlett-Packard, Hughes Aircraft, Lockheed, Motorola, and Texas Instruments—for their financial support, technical contributions, efforts, and support. The more recent grants from the State of Utah Centers of Excellence Program and the Higher Education Technology Initiative are also wholeheartedly appreciated.

We will describe the new joint venture with Hewlett-Packard which resulted in establishing the Conceptual Learning of Science (CoLoS) USA project in a future article. Until then, we look forward to hearing from you and learning of your comments and suggestions.

Table 4. List of the software packages and the two video clips included in the promotional CD-ROM available with the CAE *journal.*

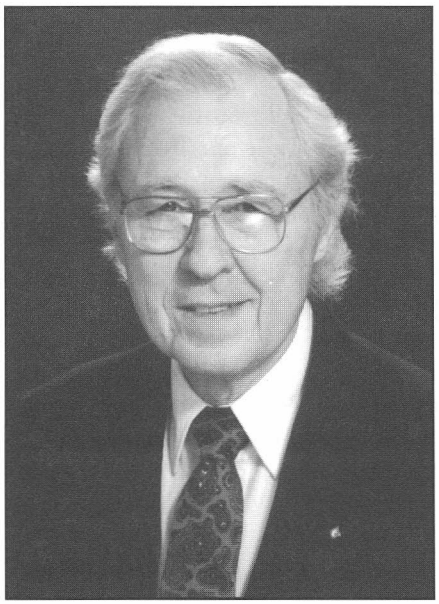
A. Software:

- Interactive Computer Modules for Chemical Engineering
- Antenna Arrays
- 2D Finite Difference-Time Domain Solver
- FATPAK II—Elastic Analysis of Frames and Trusses
- EES—Engineering Equation Solver for Thermodynamics
- SEDIF—For Design and Analysis of Passive and Active Filters
- ARRAYS—For Analysis and Synthesis of Antenna Arrays
- TEACON—Software for Computer-Aided Teaching of Process Control
- CART—3D Animated Graphical Simulation of Mobile Robot
- WGC—Visualization of EM Fields in Waveguides and Cavities
- SIGNALS—Software for One-Dimensional Signal Processing
- CIG—Simulation of the Effects of Caloric Imperfection in Compressible Flow
- DishPat and FeedPat—For Calculating Radiation Patterns and Aperture Fields of Dish Antennas

B. Video:

- Simulation of Some Concepts in Electromagnetics (12 minutes)
- About CAEME (7 minutes)

In Memoriam: William J. Getsinger



William James Getsinger died on June 5, 1995, at his home in Bozman, Maryland. He died of non-Hodgkin's lymphoma, from which he had suffered for ten years.

Bill was born in Waterbury, Connecticut, January 24, 1924. During World War II he was a Flight Radio Operator with the Air Transport Command of the US Army Air Force. After the war he attended the University of Connecticut, where he received the Bachelor of Science degree in Electrical Engineering in 1949. He later attended Stanford University, where he received the Master of Science degree in Electrical Engineering in 1959 and the degree of Engineer in 1961.

Bill Getsinger had a long and distinguished career. His influence on the evolution of microwave theory and techniques is profound. Many diverse and concrete examples of his fundamental contributions can be cited. His papers provide a legacy of insight and practical information. He served on the *MTT Transactions* Editorial Board and twice as Guest Editor of *Special Issues*.

He was particularly influential in the formative days of Computer-Aided Design in the late 1960s, through the MTT Technical Committee which he served as Chairman. His role as Guest Editor of the *Special Issue of the Transactions on Computer-Oriented Microwave Practices* in 1969 went far beyond that expected of a typical guest editor. He personally nurtured the submissions of emerging invited contributors and was particularly influential in bringing novel design concepts into the microwave area. This followed the memorable and lively "Computer-aided Design of Microwave Networks," an informal but seminal Evening Session, which he organized and moderated, at the then G-MTT Symposium in Detroit, Michigan, in May 1968.

He was the founding Chairman from 1968 to 1970 of the Technical Committee on Computer-Oriented Microwave Practices, now known as MTT-1. Bill also lectured on "Field Analysis and Circuit Simulation" (1969), organizing and moderating various conference sessions and panels, and serving on committees, all relating to microwave CAD. He was thus a true visionary in the microwave CAD area, laying a solid path for new contributors to present their work. He also introduced to the *Transactions* the new department of "Computer Program Descriptions."

In 1950 Bill began work as a microwave design engineer at Technicraft Laboratories in Thomaston, Connecticut. In 1952 he moved to the Westinghouse Electric Corporation, Air Arm, where he designed airborne radar waveguide packages. From 1957 to 1962 he was a research engineer at Stanford Research Institute (SRI), working on the theory and design of microwave components (filters, stripline couplers, parametric amplifiers) and antennas. He was a member of the outstanding team headed by Seymour B. Cohn. From 1962 to 1969 he was at MIT Lincoln Laboratory, where he conducted research and development of microwave components (filters, low-noise amplifiers) and CAD of parametric amplifiers. He directed the development of GCP, one of the first interactive microwave circuit analysis programs.

In 1969 he joined COMSAT Laboratories. From 1969 to 1981 he was Manager of the Low-Noise Receiver Department. He conceived and directed the design and development of microstrip-based C-Band low-noise parametric amplifiers for earth terminals, electrically-cooled FET X-band low-noise amplifiers for earth terminals, and a computer program and computer-directed test-set for nonlinear microwave amplifier characterization. He also participated in COMSAT proposal evaluations, design reviews and contract monitoring in the areas of low-noise amplifiers, receivers and solid-state power amplifiers (IS-6, COMSTAR, ITALSAT, ALSACOM, etc.).

During the period 1974 to 1978 he was Project Manager at COMSAT Laboratories for 19 and 28.6 GHz solid-state (IMPATT) beacons orbited on four Bell Laboratories COMSTAR communication satellites. He directed the design, development, manufacturing and testing of solid-state source, multipliers and multi-stage IMPATT amplifiers. He invented a passive device to correct IMPATT amplifier signal distortion caused by phase nonlinearity.

From 1981 to 1983 he worked as Senior Scientist at COMSAT Laboratories on characterization of microstrip, finline and slotline by the spectral domain method. He contributed the first meaningful measurements and publication on the apparent characteristic impedance of microstrip. Bill's contribution used fundamental physical principles to explain these phenomena rather than mathematical abstraction.

Bill became a consultant in 1983. From 1984 to 1990 he developed formulations, algorithms, software for approximation functions for high-Q filters, as used for channelizing filters in satellite communications, spiral inductors on microstrip, and various discontinuities in stripline, microstrip and coplanar waveguide. He consulted for EEsof from 1987 to 1992, analyzing and programming passive microwave components. His models were included in the Libra catalog and are in current use by thousands of microwave design engineers worldwide. He also lectured on transmission lines for Besser Associates and Johns Hopkins University.

Bill's publications span the years 1960 to 1995. His work on "Coupled Rectangular Bars Between Parallel Plates" (1962) is a standard reference for filter designers. It was particularly important for the design of bandpass microwave interdigital filters. For the first time results were available accurately relating physical dimensions to electrical parameters. Filters using such rectangular bars were soon in production by some companies.

His "Prototypes for Use in Broadbanding Reflection Amplifiers" (1963) not only presented tables of prototype element values but archived a very practical procedure for designing wideband negative-resistance amplifiers through these tables. Bill's results were included by G. L. Matthaei, L. Young and E. M. T Jones in their own classic book, "Microwave Filters, Impedance Matching Networks and Coupling Structures," published by McGraw-Hill. "The Packaged and Mounted Diode as a Microwave Circuit" (1966) provided important theoretically sound microwave-consistent insights. It is a classic in the field.

The first closed-form theoretically based microstrip dispersion model, avoiding costly numerical analysis, was presented in "Microstrip Dispersion Model" (1973). Bills' work on microstrip dispersion is considered by practitioners as elegant, practical and technically complete. The "End-effects in Quasi-TEM Transmission Lines" (1993) deals with microstrip and coplanar lines and again exemplifies his physical insight. Useful applications are in the development of CAD equivalent circuits for vias in microstrip lines, coplanar short circuits and right-angle bends.

Bill joined the IRE in 1948. He became a Fellow of the IEEE in 1980. He was awarded the Microwave Career Award in 1995 "For a career of meritorious achievement and outstanding contributions to field of microwave theory and techniques." This is the Society's highest recognition. Most microwave circuits designed today have made use of one or another model whose ancestry can be traced to Bill.

Bill and his wife, Doreen Catterall Getsinger, moved to Maryland's eastern shore in 1986. He was a member of the Third Haven Friends Meeting in Easton. A very moving memorial service was held there on June 9, 1995. Many family members, friends and former professional colleagues, principally from COMSAT Laboratories, attended and paid tribute to Bill's memory. He is survived by his wife Doreen, children John Robert, Margaret, Jennifer and Valerie, sister Betsy Getsinger Donlon, as well as five grandchildren.

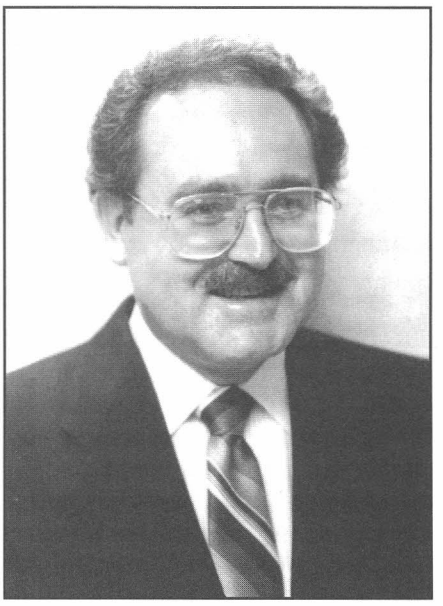
I have known of Bill's work for 30 years and known him personally for 28. Our paths crossed at important moments in my life, both personal and professional. It seems no coincidence that we became coauthors for the first time on his last paper, which will appear in 1995. During many an afternoon stroll our discussions ranged easily from very personal events to mathematically abstract concepts we were struggling with. By far, I believe, Bill will be remembered for the deep respect he displayed to his colleagues and friends, his unique intuitive style and for his singularly open mind.

—John Bandler
June 1995

Memorial donations may be sent to:

American Friends Service Committee
Middle Atlantic Region
4806 York Road
Baltimore, MD 21212.

In Memoriam: Mario A. Maury, Jr. 1936-1995



Mario A. Maury, Jr., Vice President of the MTT-S Administrative Committee and President of Maury Microwave Corporation, died unexpectedly March 30, 1995. His passing is a great loss to the microwave industry, the MTT and Instruments and Measurements (IMS) Societies, the Automatic RF Techniques Group, and to the many of us who knew him well. He labored on behalf of the microwave industry and these societies throughout his later life and left a long list of worthy accomplishments. He was a sincere friend to most of us whom he met, and contributed to the growth and advancement of many people within these societies. He was an organizer and doer. We missed his enthusiastic encounters at the Orlando International Microwave Symposium and Exhibits.

Mario emigrated from Cuba in 1944 with his electrical engineer father and brother Marc. They eventually settled in California, where Mario completed high school and attended Mt. San Antonio College and the California State University at Los Angeles, majoring in electrical engineering. In 1957, Mario Sr. and his sons, Mario Jr. and Marc, founded Maury Microwave Corporation in Mountclair, California. The company, now located in Ontario, California, attained a reputation for high quality design and manufacture of coaxial and waveguide products for the commercial, industrial, and military/aerospace RF and microwave industry. Mario Sr. died in 1964, and the brothers took the reins and continued to make the company grow, Mario Jr. becoming President, CEO and Chairman.

In addition, Mario was a talented microwave engineer and contributed to the design of many coaxial and waveguide components for the product line. He is credited with the design of the first mode-free coaxial connector to operate to 40 GHz, an improved millimeter wave waveguide flange, and several innovations in the design of coaxial standards used to calibrate microwave instruments. He presented and published a number of papers on components, measurements, and measurement and calibration issues. Users of microwave network analyzers were often surprised to open calibration kits from major suppliers and find that Maury Microwave devices were used as critical components.

In the mid-seventies, Mario turned more attention outside the company and became active in the IMS and ARFTG and in issues concerning the microwave industry. He was a personal friend of presidents and industrial leaders in the measurements and standards field and with them recognized the need for the microwave industry to better support our national standards organization, then the National Bureau of Standards. With some of these leaders he cofounded the group to Promote National Microwave Standards (PNMS) and personally solicited and obtained the support of the MTT-S AdCom. With this support the group met frequently, formulating statements of need and presenting these statements to Congress to gain better mission and financial support for the NBS. Although the group was less than successful, their efforts cemented a good, mutually supportive relationship between the NBS and the microwave industry. Mario also served on the IEC Subcommittee on Coaxial Connector Design, the IEEE committees on coaxial connectors and waveguide flanges, and the National Conference of Standards Laboratories RF and Microwave Metrology subcommittee, among others.

In 1980 Mario was elected President of the ARFTG and was preeminent in reorganizing that organization from a loose group into a society, creating several functional committees to more effectively carry out the group's historical activities and new activities such as budgets, nominations, service and best paper awards and exhibits. For his exemplary service, Mario was awarded the ARFTG Distinguished Service Award in 1983 and later was elected an Honorary Life Member and honored with the ARFTG Automated Measurement Career Award for his many contributions to microwave measurements.

Mario first served the MTT Society as chairman of several subcommittees including Publicity and Public Relations, the MTT-12 Technical Committee and liaison to PNMS and ARFTG. In 1986 he was elected a voting member of the MTT-S AdCom. Later he served as chairman of the two major AdCom committees,

Meetings and Symposia and Membership. In each of these committees he again created new functional committees to better conduct business and brought motivated, enthusiastic new faces into the AdCom. Many of these new faces are now elected members of AdCom.

In the M&S Committee he introduced subcommittees on Domestic Conferences, International Conferences, Symposium Operation/Manual, Symposium Accounting and Audit, and University Exhibiting. In the Membership Committee he introduced subcommittees on International Chapter Liaison, Chapter Officers Handbook, Chapter Communications, Student Membership Development and Special Technical Articles. In September last year, Mario was elected Vice President of the MTT-S Administrative Committee. Had he lived to be president, he may have taken the AdCom to another higher level of performance.

In November last year, Mario was diagnosed with stomach cancer. After surgery he was believed to be free of the disease. After several months of limited recovery, in early March he was found to have cancer in other organs including the liver. In most of the last months he believed he was recovering and presented a positive face to his friends. That is the way most of us will remember him.

Mario is survived by his wife Janet; a son, Mario A. Maury III; three daughters—Donna Maury and Beth Sargert, both of Alta Loma, and Michelle Maury of Upland; two brothers, Marc A. Maury of Claremont and Richard A. Maury of Alta Loma; and a grandson, Brandon Sargert.

—George Oltman

In Memoriam: Frank Reggia Fellow, IEEE 1921-1995

Frank Reggia went to be with the Lord March 13, 1995. He leaves behind Betty, his wife of 51 years, in Roanoake VA, and sons Daniel of Gaithersburg, MD, and James, a physician in Columbia, MD, as well as their wives and his grandchildren. Frank is best known for his invention of the ferrite phase shifter in conjunction with Ed Spencer—the Reggia-Spencer Phase Shifter—1957. This phase shifter was the basic building block that made practical electronically controlled phased array antennas possible.

In the earliest part of Frank's career, he was a radio operator on board the *USS Astoria* when it was bombed in Pearl Harbor. He was one of the first casualties of WWII. After the war he went to work for the National Bureau of Standards in the radio (microwave) division. When part of the radio division of the bureau was made into Diamond Ordnance Fuze Labs in 1953, he was part of it. Frank made all of his contributions to microwaves and spent the rest of his career at DOFL and its subsequent renamed organizations, retiring in 1977.

He published over 45 papers, was awarded 20 patents, and earned the honor grade of Fellow of the IEEE. He was sought after as a lecturer in Europe and Japan to share his knowledge of ferrite devices in important applications. He was very active in the local (Washington) chapter of the Professional Group on Microwave Theory and Techniques, contributing to the leadership in its early days and later encouraging younger leaders. This chapter has been very active and strong since its inception in 1956, due in large part to the spirit of enthusiasm and standards of performance Frank instilled in it. He was also active on section and national committees contributing to awards committees and the International Microwave Symposia.

Frank was a generous and caring man. When one of the young ladies at work was almost killed in an auto accident, he created and campaigned for a fund at DOFL to pay her $40k hospital bill. He had great empathy for her, much like his own struggle in recovering from the wounds he suffered in WWII. Frank's name is forever etched on our technology, in every phased array radar.

I knew him for many years as an office mate and good friend. He got me active in the local chapter of the MTT. For many years we had an ongoing competition as to who could do it better, diodes switches or ferrites. I think we both won.

—Bob Garver
Fellow

— Call for Papers —

IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES

Special Issue on Automated Circuit Design Using Electromagnetic Simulators

Recent advances in microwave CAD technology, the availability of powerful workstations and massively parallel systems, suggest the feasibility of interfacing electromagnetic (EM) simulations into optimization systems or CAD frameworks for direct application of powerful optimizers. With fast, robust, commercial EM simulators increasingly available, microwave engineers are already pushing the frontiers beyond traditional uses of EM simulators. The new thrust is to integrate EM simulations directly into the linear/nonlinear circuit design process in a manner transparent to the designer. This Special Issue, to be published in August 1997, addresses the evolution of this novel art and exciting new directions of research and development. Expectations of using EM simulations as effective tools in an automated design environment have been raised, based on the considerable and excellent work currently in progress. This emerging design technology is expected to be a cornerstone of future integrated CAD systems. Novel theoretical contributions as well as practical applications and software implementational aspects are encouraged. Topics of particular interest include but are not limited to:

- Design with tolerances and yield-driven design using EM simulators
- Implementable adjoint parameter sensitivity computations
- Automatic layout optimization with EM validation
- Techniques for capturing and automating parameterization of 2D and 3D geometries
- Novel parameterized geometrical model primitives
- Scalable models for optimization
- Space Mapping optimization
- Quasi-global modeling of EM simulated subcircuits and devices
- Parameter extraction methodologies for companion modeling
- Novel techniques for numerical, geometrical and EM decomposition
- Optimization strategies for complex and irregular shapes
- Active device physical/EM simulation and optimization
- Use of supercomputers, massively parallel and heterogeneous workstations
- Novel software architectures for EM optimization environments
- Use of data bases and automated table look-up for EM simulations
- Multidimensional response approximation and effective interpolation techniques
- Exploitation of meshing, simulation accuracy and simulation speed
- Techniques for inverse electromagnetic problems
- Visualization for automated EM design
- Mixed analytical, empirical and numerical EM simulation and optimization
- Merging of linear/nonlinear circuit theoretic and field-theoretic simulations
- Asymptotic waveform techniques applied to EM simulations
- Optimization techniques for chip compaction
- Optimization in the frequency, time and mixed domains
- Applications: filters, multiplexers, antennas, waveguides, MMICs, interconnects, etc.

Authors should submit five copies of their paper describing original work by June 3, 1996, to the Guest Editor:

Dr. John W. Bandler
Optimization Systems Associates Inc.
P.O. Box 8083, Dundas, Ontario
Canada L9H 5E7
Tel: 905 628 8228
Fax: 905 628 8225
e-mail: j.bandler@ieee.org

IEEE

MTTS ®

CALL FOR PAPERS

The 1996 IEEE-MTT-S International Microwave Symposium week will be held in San Francisco, California, June 16-21. Contributed papers are solicited describing original work in the microwave field. Topics and technical areas of interest appropriate for the Symposium are listed below, but any paper concerned with the utilization and application of microwave theory and techniques will be considered.

- Biological Effects and Medical Applications
- Passive Components
- Acoustic and Surface Wave Components
- Signal Generation, Frequency Conversion and Control Circuits
- Filters and Multiplexers
- Ferrite Components
- Guided Waves and Propagation Characteristics
- Transistor Power Amplification
- Nonlinear Modeling and Analysis
- Measurement Theory and Techniques
- High Power Sources and Control
- Phased Arrays
- Low Noise and Special Function Amplifiers
- Manufacturing, Production and Packaging
- Advances in Hybrid Technology
- Millimeter and Submillimeter Wave Technology
- EM Analytical and Numerical Techniques
- Field Theory
- Monolithic Technology
- CAD Procedures, Techniques and Modeling
- Microwave and Communications Systems
- Active and Quasi-Optic Arrays
- Lightwave Technology and Techniques
- Superconductivity Technology
- Digital Microwave Circuits
- Vehicular Technology
- Wireless Technology

Please indicate your preference for full length (20 minutes), short (10 minutes) or the interactive forum presentation. Full length papers should report significant contributions, advancements or applications of microwave technology. Short papers typically report specific authors to present theoretical or experimental material in poster format, display hardware, perform demonstrations, and conduct discussions in an informal manner with interested colleagues.

Paper Evaluation Criteria and Submission Information

The papers submitted for the International Microwave Symposium are reviewed by subcommittees of the Technical Program Committee. The criteria used for judging is scoring based upon equal weighting of the following four factors:

1. **Originality:** a) Technical, b) Application, or c) Commercial Significance - Discussion should point out the contribution in one of these three areas.
2. **Quantitative content** - Explicit summary with adequate supporting data.
3. **Quality** - Value of contribution clearly defined with sufficient references to previous work.
4. **Interest to MTT-S membership** - Why should this conference or a particular subcommittee support the work?

The introduction should include a clear indication as to what is original and why the author believes it is important to the microwave community. The clarity with which the summary presents its information will be used to judge the ability of the author to communicate to the conference attendees.

Paper submission requirements are as follows:

1. **Sixteen (16) copies of a 30-50 word abstract** on a single sheet. This sheet should indicate the title and author(s) of the paper, and their affiliation(s).
2. **Fifteen (15) copies of a 500-1000 word summary** with supporting illustrations. The title of the paper and author's name(s) should be on the front page of each copy.
3. A separate sheet with the complete mailing address (with FAX number & E-mail address, if applicable) of the author, a statement indicating the author's preference of **full length, short, or interactive forum** presentation, and a prioritized list of up to three topic areas appropriate for reviewing and sponsoring the paper.
4. A statement signed by all authors, indicating that the same or similar material has not been submitted to any other publication, and will not be until disposition is determined by MTT.
5. For publicity, one page with a title of less than 85 characters (including spaces and punctuation), and author/affiliation information of less than 100 characters.

NOTE: Authors are cautioned to obtain all required company and government clearances prior to submittal. A statement signed by author(s) stating that such clearances have been obtained must accompany the final manuscript of accepted papers to be published in the Symposium Digest.

Mail submissions to: **MTT-S Symposium 1996**
c/o LRW Associates
1218 Balfour Drive
Arnold, MD 21012, USA

Authors will be notified of the status of their submissions by February 15, 1996. Authors of accepted papers will receive copyright release forms and instructions for publication and presentation.

Final manuscripts for publication in the Symposium Digest will be required by March 15, 1996. In addition to camera-ready copy, authors of accepted papers will be asked to provide their material in electronic format. Instructions will be included in the kits sent to authors.

Proposals for Panels and Workshops

Panel and workshop proposal abstracts giving technical descriptions and names of proposers must arrive by September 1, 1995 to be considered. Sponsorship of an MTT Technical Committee is generally required for panels and workshops. Send proposals to Paul Khanna, (408) 970-3108 or FAX (408) 970-2594.

For **more information** see http://www.ieee.org/mtt/imscall.html

Deadline: 12/1/95 for receipt of papers. (Sorry, no FAX or E-mail)

— Call for Papers —

International Journal of Microwave and Millimeter-Wave Computer-Aided Engineering

Special Issue on Optimization-Oriented Microwave CAD

Microwave engineers have been using optimization techniques in computer-aided engineering for some three decades. A general purpose commercial CAD system for RF and microwaves is no longer regarded as complete without optimization capabilities. The role of optimization in modeling and design is taken for granted. This special issue will focus on the current state of the art and promote important topics for the future. We believe that in the next century integrated CAD systems will directly link geometry, layout, physical, electromagnetic and process simulations, with performance, yield, cost, system specifications and testability in a manner transparent to the designer. Thus, we plan to address yield-driven and cost-driven optimization (statistical design centering, design with tolerances, etc.) methodologies that are crucial not only for massively manufactured circuits but also for improving the probability of first-pass success in designs for small volume production. The effective application of powerful workstations and massively parallel systems are emphasized. Papers treating software engineering, implementational and practical applications aspects are encouraged.

Suitable topics for this special issue include:

- Yield-driven design methodologies and design with tolerances
- Physically-based statistical device modeling and parameter extraction
- Parameter sensitivity computations for efficient gradient optimizers
- Automated layout optimization
- Use of supercomputers, massively parallel and heterogeneous workstations
- Optimization techniques for nonlinear circuits
- Software architectures for optimization-oriented design
- Automated design using electromagnetic simulators
- Process-oriented optimization
- Optimization techniques for diagnosis and testing
- Data bases, multidimensional approximations and automated table look-up for optimization
- Optimization for "inverse" electromagnetic problems
- Verification of solution uniqueness
- Visualization for optimization problems
- Approaches to global optimization: simulated annealing, genetic algorithms, etc.
- Neural network approaches
- Expert systems
- Optimization for discrete problems
- Design of experiments approaches

This special issue will appear in late 1996. Authors wishing to have their contribution considered for this issue should submit five copies before March 1, 1996, to the Guest Editor:

Dr. John W. Bandler
Simulation Optimization Systems Research Laboratory
Dept. Electrical and Computer
Engineering
McMaster University
Hamilton, Ontario
Canada L8S 4L7
Tel: 905 525 9140, Extension 24818
Fax: 905 523 4407
e-mail: j.bandler@ieee.org

43rd International Field Emission Symposium

July 14-19, 1996 • Moscow, Russia

Call for Papers

The event is organized by the Institute of Theoretical and Experimental Physics (Moscow) and Association "Ultramicroscopy in Science and Technology" (Moscow). The co-chairmen of the Symposium are Prof. R. Bakhtizin and Prof. A. Suvorov. This Symposium in Moscow will be the 43rd meeting in its series that started in 1952, organized by the late Professor Erwin W. Muller, inventor of field emission microscopy, field ion microscopy and atom probe.

The Symposium is the most comprehensive one in this field and the scope of the meeting covers a variety of microscopy, including field emission and field ion microscopy, scanning tunneling microscopy and spectroscopy as well as atom probe microanalysis.

The Symposium will be organized in the form of plenary and section sessions as well as several workshops. The main topics are as follows:

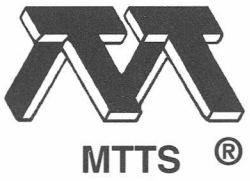
- Theory of field electron and field ion emission
- Field electron microscopy and spectroscopy
- Field ion microscopy and atom probe analysis of materials and interfaces
- Field ionization mass-spectrometry
- Scanning tunneling microscopy and spectroscopy
- Vacuum microelectronics
- Electron, ion and liquid-metal sources

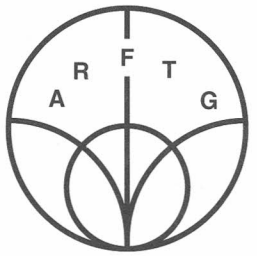
The deadline for submission of abstracts (1 page in two copies) is March 31, 1996. Time for presentation: plenary session—40 min; section session—20 min.

The language of the Symposium is English.

The address of the Organizing Committee of the Symposium is:

Professor Alexander L. Suvorov, IFES'96
Institute of Theoretical and Experimental Physics
Association "Ultramicroscopy in Science and Technology"
B. Cheremuskhinskaya 25, Moscow 117259, Russia
Tel.: (095)1259691, (095)1253439; fax: (095)1253439
e-mail: suvorov@cl.itep.ru or umst@cl.itep.ru





Automatic RF Techniques Group

Call for Papers

Fall 1995 Conference

The Automatic RF Techniques Group will hold its 46th Conference in the Phoenix-Scottsdale area on November 30 and December 1, 1995. The conference theme will be:

Testing for Wireless Applications

The expansion of the market for wireless is continuing at an explosive rate; however, the competitive nature of this market is putting tremendous downward pressure on both costs and development cycle time. Equipment manufacturers are in the unique situation of having to reduce test time and costs while maintaining a high level of performance and reliability demanded by their quasi-consumer customer base. Papers are solicited relating to test requirements, methods and techniques, test equipment design, performance results and environmental considerations, leading to lower overall testing costs, reduced test time and high confidence levels. This includes on-wafer as well as fixture characterization techniques. Load-pull characterization for power, gain and efficiency, as well as for linearity and stability, is of interest. Derivation of novel figures-of-merit and analysis or correlation of large signal RF to DC test parameters are of concern.

Papers are also invited in other areas of automated microwave and RF testing including calibration issues, MMIC related measurements, and other topics of interest to the RF/microwave community.

Presentations should be informal, 20 minute talks using viewgraphs or 35mm slides. Authors are requested to submit two copies each of a one-page abstract and a 500 to 1000 word summary, including illustrations, to allow evaluation with regard to the interests of the attendees and for advance publicity. This submittal should be made to the Technical Program Chair no later than August 28, 1995. Final deadline for full, camera-ready papers is October 5, 1995. Additional information can be obtained from the Conference chair noted below. Manufacturers interested in setting up an exhibit should contact the Exhibits Chair for information and application forms.

Conference Chair:
Mr. William E. Pastori
Maury Microwave Corp.
2900 Inland Empire Blvd
Ontario, CA 91764
Tel: (909)987-4715
Fax: (909)987-1112

Technical Program Chairs:
Dr. Mike Golio & Dr. Dave Halchin
Motorola, MS EL-609
2100 East Elliot Road
Tempe, AZ 85284
Tel: (602)413-5947
Fax: (602)431-4453
e-mail: m.golio@ieee.org

Exhibits Chair:
Mr. Michael Fennelly
ATN Microwave
11 Executive Park Drive
Billerica, MA 01821
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1996 IEEE MICROWAVE AND MILLIMETER-WAVE MONOLITHIC CIRCUITS SYMPOSIUM

San Francisco, CA — June 17-18, 1996

First Call For Papers

The 1996 IEEE Microwave and Millimeter-Wave Circuits Symposium will be held in San Francisco on Monday, June 17 and Tuesday, June 18, 1996. The Symposium is held annually in conjunction with the IEEE MTT-S International Microwave Symposium (IMS).

Papers are solicited describing original work on monolithic circuits for RF, microwave, or millimeter-wave applications. The following subject areas are particularly appropriate:

- New RF, microwave, mixed signal or millimeter-wave chip or chipset designs.
- System applications of monolithic circuits, such as in wireless, satellite, military, automotive, or optical fiber systems.
- Innovative high-frequency device and circuit concepts for Si, GaAs, InP, SiGe, SOI, SiC, or other semiconductor technologies.
- Components and subsystem design and design methodology.
- Multi-chip module microwave packaging.
- Production techniques including cost reduction, cycle time reduction, design for manufacturability, design for testability.
- Back-end fabrication technology including packaging, testing, and reliability qualification.

High-frequency monolithic technology is the foundation of many exciting new commercial and military systems. This international conference is an ideal opportunity to present your latest results and compare them with progress made by others throughout the industry.

Authors are required to submit 20 copies of a 500-1000 word summary which includes a 30-50 word abstract and the complete mailing address of the author(s). **The summary should not exceed four pages of text and figures; only the first four pages of longer summaries will be reviewed.** Authors should clearly explain what has been achieved, how the results were accomplished, and how this effort compares with other work in the field. The paper summary and abstract must be in English and be received before December 1, 1995. Late submissions will not be considered. Submissions should be sent to:

Louis Liu
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Arnold, Maryland 21012 USA
Telephone: (410) 647-1591

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CALL FOR PAPERS

IEEE International Symposium on Phased Array Systems and Technology

Revolutionary Developments in Phased Arrays

15-18 October 1996
Boston, Massachusetts

During the past two decades, phased array systems have taken major steps forward with the development of many major radar and communication systems. Due to several recent technology advances such as MMIC, photonics, and digital beam forming, phased array systems are progressing rapidly. Current and future developments for ground-based, sea-based, airborne, and space-based phased array radar and communication systems will be discussed at this international symposium.

Authors are requested to submit a summary of the paper of not less than 1000 words in double-spaced format.

Topics:

- conventional phased arrays
- active (MMIC) arrays
- adaptive arrays
- limited field-of-view arrays
- multiple-beam arrays
- digital beam forming
- optical beam forming and signal distribution
- diode, ferrite, and optical phase shifters
- time/power/scan management and scheduling
- system design/tradeoffs/optimization/analysis
- radiating element design
- array measurement and calibration
- element failure detection and correction
- array error analysis/accuracy
- conformal arrays
- wideband arrays
- multiple band arrays
- diode grid scanning arrays
- millimeter wave arrays
- neural network beamforming
- applications: ERIEYE, Iridium, GBR, Globalstar, COBRA, ASAP, Teledesic, Phalcon, ACTS, wireless communications

The cover page should include the title, name of the authors, address, telephone and fax numbers, and organization.

Send three copies to :

Dr. Robert Mailloux,
Technical Program Chair
IEEE Phased Arrays Symposium
Rome Laboratory / ER
31 Grenier Street
Hanscom AFB, MA 01731-3010 USA

617-377-3710 telephone
617-377-5040 fax.

The deadline for receipt of summary papers is 04 December 1995. Authors of accepted papers will be notified by 19 February 1996 and will receive forms and instructions for publication and presentation at that time.

Completed camera ready papers, limited to six pages including text, tables, and figures, will be required not later that 20 May 1996. If applicable, government approval for publication as an unclassified paper is necessary at this time.

In addition to formal presentations, there will be poster presentations. Authors who believe their papers are better suited to a poster format are requested to so note on their summaries. This format provides authors the opportunity to display their paper and related equipment or visual aids and to discuss their information with the conference participants.

Both oral presentation and poster presentation papers will be published in the proceedings.

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Images from the 1995 MTT-S Symposium

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