APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY (ACES)

NEWSLETTER

Vol. 9 No. 1 March 1994

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ACES NEWSLETTER AND JOURNAL COPY INFORMATION

Issue	Copy Deadline
March	January 25
July	May 25
November	September 25

For further information on the ***ACES JOURNAL,*** contact Prof. Duncan Baker at the above address.

For the ***ACES NEWSLETTER*** send copy to Ray Perez in the following formats:

1. A hardcopy.
2. Camera ready hardcopy of any figures.
3. If possible also send text on a floppy disk. We can read any version of MICROSOFT-WORD and ASCII files on both IBM and Macintosh disks. On IBM disks we can also read WORDPERFECT and WORDSTAR files. If any software other than MICROSOFT WORD has been used on Macintosh Disks, contact the Managing Editor, Richard W. Adler **BEFORE** submitting a diskette. If it is not possible to send a Macintosh disk then the hardcopy should be in Courier font only for scanning purposes.

NEWSLETTER ARTICLES AND VOLUNTEERS WELCOME

The ACES Newsletter is always looking for articles, letters, and short communications of interest to ACES members. All individuals are encouraged to write, suggest, or solicit articles either on a one-time or continuing basis. Please contact a Newsletter Editor.

AUTHORSHIP AND BERNE COPYRIGHT CONVENTION

The opinions, statements and facts contained in this Newsletter are solely the opinions of the authors and/or sources identified with each article. Articles with no author can be attributed to the editors or to the committee head in the case of committee reports. The United States recently became part of the Berne Copyright Convention. Under the Berne Convention, the copyright for an article in this newsletter is legally held by the author(s) of the article since no explicit copyright notice appears in the newsletter.

OUTGOING EDITOR'S COMMENTS

I feel it an honor to have served as ***ACES Newsletter*** Editor since 1989, and it has been a gratifying and educational experience. Over the past four or five years I have seen ACES become more active and better organized. The effort and energy put forth by the team of ACES publications volunteers have been an inspiration to me over the years, particularly those I have worked most closely with: namely the previous and current Editor's-in-Chief Dave Stein and Perry Wheless, the Adlers, and Ray Perez who I'm sure will do an excellent job as your new Newsletter Editor. New ways to improve the Newsletter are already being implemented (see The Practical CEMist department beginning this issue). I wish them the best of luck. See you in Monterey. -- Paul Elliot

OFFICER'S REPORTS

PRESIDENT'S COMMENTS

As I write this column, the temperature outside is struggling to get up to 10 below zero, after reaching 25 below during the night. It's chilly in Bloomington this January 19, but you are now reading this in March, perhaps in Monterey, where it is considerably warmer, and where we are celebrating our tenth conference.

Tenth anniversaries, of course, are milestones in any organization's life, and serve as good opportunities to review the life and times of that organization, and to answer the questions, "Who are we?" "Where have we been?", and "Where are we going?" So it is with ACES. I am aided considerably in this regard by reprinting the article in the IEEE Antennas and Propagation Magazine of February 1991. Duncan Baker used this same article in an email mass-mailing to inform a number of NEC users about ACES, and I am reprinting Duncan's copy (since it's already in my computer). Some of you saw the original, while this is novel for others.

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IEEE ANTENNAS AND PROPAGATION MAGAZINE, FEBRUARY 1991, pp. 18-19

The Applied Computational Electromagnetics Society

The Officers and Directors of ACES, Inc.

Abstract

This paper briefly describes a relatively new and unique professional society -- the Applied Computational Electromagnetics Society (ACES) -- which provides a forum for issues relevant to numerical modeling in applied electromagnetics. The primary focus of ACES is on computational techniques, electromagnetics modeling software, and applications. Included in this paper is a description of the ACES annual symposium, publications, code user groups, benchmark problem solution workshops, short courses, software demonstrations, and other activities which serve the professional community.

1. Introduction and Background

During the past several years, computer modeling and numerical methods have matured as problem-solving tools in real-world electromagnetics applications. Consequently, the need for an application forum, of sufficient scope to include all modeling techniques and commonly-used codes, became readily apparent. There was further consensus that both a regular meeting (with published proceedings) and an additional publication were appropriate. To these ends, ACES was organized in 1986. Now formally chartered and incorporated as a non-profit organization, ACES is an international, interdisciplinary, professional society, with a wide range of activities and services. The interdisciplinary scope of ACES is pivotal to maintaining a "cross-pollination" between the high-frequency and low-frequency applications.

ACES activities and services have expanded to include canonical problem solution workshops (to "benchmark" the performance of codes and techniques) and code user groups, in addition to the newsletter, the journal, and the annual symposia. Furthermore, a Software Exchange Committee, and a Software Performance Standards Committee, provide a means to exchange information about electromagnetic computational codes and their performance in real-world applications. At the symposia, short courses and software demonstrations are offered. The ACES Journal is administered by an international editorial board, which presently represents nine nations.

2. General Scope of ACES Activities

Among other things, ACES activities relate to these areas:

1. Validation of codes and techniques.

2. Performance analysis of codes and techniques.

3. Computational studies of basic physics.

4. New computational techniques, or new applications for existing computational techniques or codes.

5. "Tricks of the trade" in selecting and applying codes and techniques.

6. New codes, algorithms, code enhancements, and code fixes.

7. Input/output issues. This normally involves innovations in input (such as input geometry standardization, automatic mesh generation, or computer-aided design) or in output, input/output data base management, output interpretation, or other input/output issues.

8. Computer hardware issues. Vector and parallel computational techniques and implementation are of particular interest.

Applications of interest include, but are not limited to antennas (and their electromagnetic environments), radar cross section, shielding, electro-magnetic pulse (EMP), electromagnetic interference (EMI), electromagnetic compatibility (EMC), microwave components, fibre optics, electromagnetic wave propagation, non-destructive evaluation, eddy currents, and inverse scattering.

Interests include frequency-domain and time-domain techniques, from integral-equation formulations to diffraction theories and physical optics.

3. Code User Groups

To provide needed links between developers and users of electromagnetics modeling codes and techniques, ACES is forming several code user groups. The following benefits to code developers and to code users are envisioned:

1. Distribution of developer communications (letters, bug reports, and upgrades) to the user group members so as to provide the developer with a single point of contact for as many users as possible.

2. Collection and evaluation of user feedback, with subsequent forwarding to the developer. This includes the compilation of user comments, as well as the verification of bug reports. User-proposed "work-arounds" and code modifications can be handled similarly.

3. Periodic surveys of users, to determine the major actual applications of the code, with a survey report sent to the developer.

4. Assistance to inexperienced code users via publication of tutorials, user guidelines, and typical problems with solutions -- and also via increased access to experienced users.

Some of these benefits to users are contingent upon the cooperation of the respective code developers, whereas other benefits can be provided independently. However, in the interest of serving developers and users alike, ACES is seeking full cooperation from the developers, who are also being encouraged to maintain existing user-support arrangements for nonmembers of ACES.

4. Benchmark Problem Solution Workshops

An essential code and model validation task is the testing of the codes and computational models against benchmark problems, which themselves require careful selection. This task is already underway, with the publication of the "ACES Collection of Canonical Problems--Set 1" in the Spring of 1990. With this set of problems, ACES offers the computational electromagnetics community a set of tools which can be used to help validate models and the codes which execute those models. With frequencies ranging from 900 Hz to 10 GHz, the problems in Set 1 include not only perfectly conducting bodies, but also penetrable bodies. Transient as well as sinusoidal steady-state waveforms are represented in Set 1, and the applications include radar cross section, non-destructive evaluation, and inverse scattering.

ACES will be publishing future collections of benchmark problems, and will be convening international workshops at which problem solutions will be presented. Whenever possible, ACES will sponsor these workshops jointly with other groups of computational electromagneticists. To that end, ACES is collaborating with the TEAM (Testing Electromagnetic Analysis Methods) Workshop, to sponsor joint ACES/TEAM international workshops for solving canonical problems in computational electromagnetics. The first such joint workshop was held in October 1990, in Toronto. At that meeting, solutions to problems in both the TEAM collection and the ACES collection were presented, so that we could draw upon the expertise within both groups.

A parallel effort of the Software Performance Standards Committee is the development of code performance standards. Also under development are procedures and protocols for the validation and performance analysis of codes and computational models. Performance assessments will be based on user-community feedback, and these assessments will be updated periodically as codes are modified, models are refined, and more test cases are investigated. This committee is collaborating with the AP-S EM Modeling Software Committee in the sharing of information, and in the participation of ACES members in the AP-S activity.

5. The ACES Newsletter

Several types of articles or columns appear in the ACES Newsletter, including the following:

1, Modeling Information.

* Writeups of EM computer modeling attempts -- successful and unsuccessful -- which can save time and effort for others
* Hints, shortcuts, observations, ideas, or tips for EM modeling
* Tutorial articles which give an introduction/overview of various modeling topics from an applications viewpoint, covering material likely to help the modeler do more accurate, efficient, and reliable modeling
* New needs in EM modeling

2. Code Information

* New, or newly-available codes. These may be supplemented with listings of short codes and/or sample input/output
* Code bugs, limitations, and other problems discovered by users
* Code enhancements, improvements, and bug "fixes" or "work-arounds"
* New innovative applications of particular codes

3. Pandora's Box: an in-depth, "blue-ribbon" analysis of particular submitted computational electromagnetic problems

4. Computer graphics showing fields, currents, and other EM observable

5. Special features

6. Other articles of interest to ACES members

7. A cumulative bibliography of measured EM data (to support code validation efforts)

8. Correspondence

* Corrections/additions to previous ACES Newsletter articles

* Suggestions as to how ACES can facilitate computational EM technique development and state-of-the-art advances

* Letters to the Editor

9. News

* ACES news, and committee reports
* Code user group news
* Other news

6. The ACES Journal

The ACES Journal is devoted to the exchange of information in computational electromagnetics, to the advancement of the state of the art, and to the promotion of related technical activities. A primary objective of the information exchange is the elimination of the need to "reinvent the wheel" to solve a previously-solved computational problem in electrical engineering, physics, or related fields of study.

The ACES Journal welcomes original, previously unpublished papers, relating to applied computational electromagnetics. All papers are refereed.

A unique feature of the ACES Journal is the publication of unsuccessful efforts in applied computational electromagnetics. Publication of such material provides a means to discuss problem areas in electromagnetic modeling. Of course, material representing an unsuccessful application or negative result in computational electromagnetics is considered for publication only if a reasonable expectation of success (and a reasonable effort) are reflected.

7. Other ACES Activities and Services

A data base is evolving out of the various ACES activities. It consists of computational data to be used for code validation, performance analysis, and optimization, as well as information about particular codes and techniques. Each data set will be documented to include the code and machine used, input variables (including numerical grids, where possible), number of unknowns, basis and testing functions (where appropriate), a priori assumptions and simplifying approximations, computational method, and solution technique. Also included will be the code memory requirements, typical run times, and maximum number of unknowns. A primary objective of this data base is to establish a "baseline" for the capabilities and limitations of various codes for different applications, so as to provide the best possible user guidelines. In addition, the data base provides an informal peer-review mechanism for codes and computational techniques -- to facilitate a rapid transfer of useful knowledge into the mainstream of the numerical electromagnetics community.

A small software library is maintained by the Software Committee.

There are tentative plans for additional activity in artificial intelligence/expert systems and in computational electromagnetics education.

8. Membership and Subscriptions
(Information updated from ACES Newsletter Vol. 8 No. 3).

The $60.00 annual membership fee ($63.00 non-US surface mail) includes subscriptions to the Journal and the Newsletter. These fees are valid until 1 April, 1994, when all dues, except students, will be increased by $5.00. Further information regarding individual or institutional ACES memberships, the ACES publications and other ACES activities can be obtained from the ACES Executive Officer, Dr. Richard W. Adler, Naval Postgraduate School, ECE Department, Code EC/AB, 833 Dyer Rd, Monterey, CA 93943-5121, USA, telephone (408) 646-1111 or Fax (408) 649-0300. E-mail 554-1304@mcimail.com.

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ACES is determined to play a significant role in computational EM, but it is a role that can be played only by dedicated people. Our first ten years have been great and rewarding. How the next ten play out can only be shaped by you. If you have an idea for your own role, let me know. We're looking for you.

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THE APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY, INC.

NOTICE OF THE ANNUAL BUSINESS MEETING

Notice is hereby given that the annual business meeting of the Applied Computational Electromagnetics Society, Inc. will be held at Steinbeck Forum, Doubletree Hotel and Convention Center, Monterey, CA on Tuesday 22 March 1994 at 7:30 AM PST for purposes of:

1. Receiving the Financial Statement and auditors report for the year ending 31 December 1993.
2. Announcement of the Ballot Election of the Board of Directors.
3. Summary of the activities of incorporation.
4. Modifications to the Bylaws that have been approved by the Board of Directors at the June 1993 meeting in Ann Arbor, MI. The following is the portion of the Bylaws that will be considered for approval by the membership. It is from Article 7, Section 1 and allows the Board of Directors to appoint an officer of the corporation, which is not on the Board of Directors, as a member of the Executive Committee. The proposed changes are in bold italics.

ARTICLE 7. COMMITTEES

SECTION 1. EXECUTIVE COMMITTEE

The Board of Directors may, by a majority vote of Directors then in office, designate two (2) or more of its members (who may also be serving as officers of this corporation) and any other subordinate officers in the corporation to constitute on Executive Committee and delegate to such Committee any of the powers and authority of the Board in the management of the business and affairs of the corporation, except with respect to:

(a) The approval of any action which, under law or the provisions of these Bylaws, requires the approval of the members or of a majority of all of the members.

(b) The filling of vacancies on the Board or on any committee which has the authority of the Board.

(c) The fixing of compensation of the Directors for serving on the Board or on any committee.

(d) The amendment or repeal of Bylaws or the adoption of new Bylaws.

(e) The amendment or repeal of any resolution of the Board which by its express terms is not so amendable or repealable.

By order of the Board of Directors
Perry Wheless, Secretary

ANNUAL REPORT 1993

As required in the Bylaws of the Applied Computational Electromagnetics Society, Inc. a California Nonprofit Public Benefit Corporation, this report is provided to the members. (Additional information and an auditors report will be presented at the Annual Meeting and that same information will be included in the July Newsletter for the benefit of members who could not attend the Annual Meeting.

MEMBERSHIP REPORT

As of 31 December 1993, the paid-up membership totaled 486, with approximately 24% of those from non-U.S. countries. There were 16 students, 69 industrial (organizational) and 417 individual members. The total membership has decreased by 5% since 1 January 1993, but non-U.S. membership has decreased by 19%.

Perry Wheless, Secretary

ANNOUNCEMENT ON DUES INCREASE

In accordance with a 5-year financial plan adopted by the Board of Directors in July 1992, for the purpose of maintaining ACES as a financially solvent non-profit corporation, the annual membership dues will increase by $5, effective 1 April 1994, and will increase by an additional $5 each year.

MEMBERSHIP RATES EFFECTIVE 1 APRIL 1994

AREA	INDIVIDUAL SURFACE	INDIVIDUAL AIRMAIL	ORGANIZATIONAL (AIRMAIL ONLY)
US & CANADA	$65	$65	$115
MEXICO,CENTRAL & SOUTH AMERICA	$68	$70	$115
EUROPE FORMER USSR TURKEY SCANDINAVIA	$68	$78	$115
ASIA, AFRICA MID EAST, PAC RIM	$68	$85	$115

FINANCIAL REPORT

ASSETS		
BANK ACCOUNTS	**1 JAN 1993**	**31 DEC 1993**
MAIN CHECKING	1,802	24,711
EDITOR CHECKING	1,754	2,196
SECRETARY CHECKING	2,009	2,889
SAVINGS	296	304
CD #1	11,068	11,420
CD #2	11,068	11,420
TOTAL ASSETS	$27,998	$52,940

LIABILITIES:	0

NET WORTH 31 December 1993	$52,940

INCOME	
Conference	69,845
Publications	7,385
Membership	29,335
Software	2,650
Interest & misc.	8,068
TOTAL	117,238

EXPENSE	
Conference	35,082
Publications & Flyers	32,281
Software	438
Services (Legal, Taxes)	1,485
Postage	11,526
Supplies & misc.	11,547
TOTAL	92,359

NET INCREASE FOR 1993	$24,879

In 1991 and 1992 we incurred a net loss of $3898 and $5395, respectively. This year we have stemmed this trend and achieved a net increase. The net increase came from increased conference income while holding down conference and publication expenses.

James C. Logan
Treasurer

PERMANENT STANDING COMMITTEES OF ACES INC.

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COMMITTEE REPORTS

ACES PUBLICATIONS

A great deal has transpired since precisely 24 minutes past midnight GMT on 23 September 1993, when David Stein was promoted to Editor-in-Chief Emeritus status. Those of us left behind to carry on the good fight for ACES Publications miss David's leadership and contributions each day, but dividing his myriad activities between two successors (Duncan Baker is now the **ACES Journal** Editor-in-Chief) has made the load much more manageable. ACES Publications is blessed at this time with an imposing slate of Editors, each one eminent in the field of computational electromagnetics and committed to the success of ACES. The future of ACES Publications is particularly bright because our Editoral Board is so strong.

It is my privilege to announce two recent appointments. First, Adalbert Konrad was appointed in late October, 1993, to the newly created post of Associated Editor-in-Chief for the **ACES Journal**. Dr. Konrad brings valuable expertise and relationships in the low-frequency community, which will serve the **ACES Journal** particularly well as we reach out to this sizable body of CEM practitioners.

The second major appointment is that of Reinaldo (Ray) Perez to **ACES Newsletter** Editor-in-Chief as of 15 February 1994, succeeding Paul Elliot. On behalf of the ACES membership as well as ACES Publications, I congratulate Paul for a job well done for five years; his achievements and dedicated service with the **ACES Newsletter** have given us a solid foundation for the future. Ray Perez has been very active as Associate Editor for some time already, and is extremely well qualified for this important post; we are fortunate that Ray has accepted this appointment.

In early December, the ACES Executive Committee approved an increased Publications budget for 1994. This will allow publication of three **ACES Journal** issues in 1994 (vol. 9). With this vote of confidence comes the responsibility for Publications to demonstrate corresponding benefit to ACES from this expanded activity, and the resultant higher expenses of publication. **One way you can help right away is to lobby your local library to enter an Organizational Membership to ACES.** An aggressive library subscription campaign, in addition to the obvious wider dissemination of ACES materials, can give us a substantially broader financial base to help freeze (or maybe even roll back) individual membership rates in the future.

Toward a more efficient use of the annual page allocation for the **ACES Journal,** Duncan Baker has developed some style, font, and general camera-ready copy guidelines for authors, which are now being field-tested. Editors and prospective authors for the **ACES Journal** should read Duncan's letter, which appears separately in this Newsletter.

Mandatory excessive length page charges and voluntary page charges for papers in the **ACES Journal** will go into effect in 1994. To encourage authors to join ACES, the present intent is that mandatory page charges will apply to all pages in excess of twelve (12) for ACES members or in excess of eight (8) for non-members.

Duncan, Ray, and I freely welcome constructive criticism of the **ACES Journal** and/or **ACES Newsletter.** We invite and value your enthusiastic participation in the progressive evolution of ACES Publications!

W. Perry Wheless, Jr.
ACES Editor-in-Chief / Publications Chair
e-mail wwheless@ualvm.ua.edu

ACES JOURNAL

The March 1994 issue of the Journal was the first one which I have had the privilege of putting together as the new and untried Editor-in-Chief. Perry Wheless is the new Editor-in-Chief for ACES with overall responsibility for the ACES publications, while Adalbert Konrad is Associate Editor-in-Chief of the ACES Journal.

As Editor-in-Chief of the Journal I gratefully acknowledge the support and assistance of Perry Wheless, Adalbert Konrad and Dick Adler. Our sincere thanks to the Editorial Board of ACES for their support and encouragement during the transition phase while the new editors were finding their feet.

In recent times a number of colleagues have expressed their concern on the issue of double submissions to journals. These are papers which are either identical or, at best, very similar and which are submitted simultaneously to two journals. This is a practice which, to the best of my knowledge, is frowned upon by all editors, not only those of learned societies. Apart from the obvious consideration of copyright and its ramifications, there is also the ethical issue.

These matters were recently eloquently addressed by W. Ross Stone, Editor-in-Chief of the IEEE Antennas and Propagation Magazine. His editorial comments appear in the December 1993 issue of the Magazine. I would urge all our readers to try to obtain a copy of the editorial and to read it carefully. Others have also commented on the problem. Ross has graciously referred us to a similar editorial in IEEE Microwave and Guided Wave Letters (Vol. 3, No. 4, April 1993, p.94) and a letter from Gabriel Rebeiz which appeared in the February 1992 issue of the IEEE AP Magazine on p. 76. Double submission of articles is a matter which affects all of us.

Publication of an article in the unrefereed transactions or proceedings of a conference or symposium does not, in general, disqualify that article from later publication. A conference or symposium provides authors with an ideal opportunity to present their work and to discuss its merits with their peers. Normally a revised version of the work can be submitted to a refereed journal for possible publication. However, most journals expect the author to refer to the fact that the article was presented at a symposium, either in a covering letter, or by direct reference in the submitted article. The ACES Journal decries the practice of double submissions and requests all potential authors to refrain from this practice. If there is sufficient interest from readers, we will approach the IEEE for permission to reprint Ross Stone's editorial in a later issue of the ACES Newsletter.

While we are discussing professional ethics I would also like to raise the question of submission of papers to conferences and subsequent non-attendance (or 'no-show') of any of the authors of the paper. While there are frequently valid reasons for this, the organizers are often not advised that there will be no author to present the paper. This 'no-show' practice is unfortunately on the increase. It provides the offending author with a vehicle for publishing his work and earning some credits. The practice places the organizers of the conferences in the invidious position of indirectly having to pass the costs for such 'free' exposure on to the registered attendees of the conference, as well as having to carry some of the costs out of potential profits. From personal experience I know that these profits are usually carried over to the organizing committees of subsequent conferences in the same series, thus easing the task of organization. The reprehensible 'no-show' practice thus affects the entire professional community and is one which must be discouraged if various professionally organized conferences are to succeed and are to continue to make a meaningful contribution to the exchange of information.

Duncan Baker
Editor-in-Chief, ACES Journal

MODELING NOTES

[The following bug report was sent by Brian Beezley]

I recently discovered two bugs in the MININEC antenna-analysis algorithm.

The most serious bug yields incorrect patterns for antenna models with grounded wires. The error overstates gain at low elevation angles by as much as several dB. The problem occurs only for models with wires connected to imperfected ground. It does not affect models using perfect ground or models with ungrounded wires.

The error decreases as you add segments to grounded wires. Therefore, if you habitually test algorithm convergence by increasing segmentation density until results no longer change significantly, the problem won't affect your results. However, I doubt that most users check convergence for simple models. Since the bug affects models regardless of complexity, I believe that the error often goes unnoticed.

You can check any MININEC-based program for this bug by modeling a quarterwave monopole over imperfect ground and observing the response at zero degrees elevation. There should be no response at the horizon because direct radiation is cancelled by that reflected from ground. Uncorrected MININEC will show a significant response unless you use an unusually high number of segments. In contrast, the corrected algorithm has no response regardless of segmentation.

You can fix this bug in MININEC 3.13 by deleting lines 716, 717, and 733. After the change, lines 741 through 744 are no longer used and may be deleted as well. The original code erroneously uses perfect ground when calculating the field from pulses connected to imperfect ground. Perfect ground reinforces rather than cancels radiation near the horizon, so the grounded-pulse contribution corrupts the field summation calculated correctly for other pulses.

The second MININEC bug occurs only for sloping, grounded wires in the X = -Y plane. Since this geometry isn't common, you may never encounter the problem. The bug causes completely erroneous results which can be corrected only by moving the wires out of the plane. The error involves overzealous removal of redundant calculations. You can fix this bug by correcting two lines as follows:

```
239 IF CA (I1) = 0 AND CB (I1) =0  THEN 241
242 IF CA (J1) =0 AND CB (J1) =0  THEN 244
```

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ANTENNA COMPUTER-AIDED DESIGN IN WESTERN UKRAINE THE STORY OF A RESEARCH GROUP

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Introduction

In this brief article we attempt to give a retrospective view of our research in the field of computational electromagnetics that was performed at the Lvov Technical University (Lvov, Ukraine) from 1980 to 1993.

How this began

In 1979 Professor Anatoly F. Chaplin, noted Russian scientist in the field of antenna theory and electromagnetics, moved from Moscow Power Institute to the Lvov Polytechnic Institute (now Lvov Technical University). At the Institute, Professor Chaplin served as Chair of the Department of Radio Devices. As chair, one of Professor Chaplin's first accomplishments was to organize a small group of students and post-graduates to do research in applied computational electromagnetics, including antennas and microwave design. The authors of this article were charter members of this group.

The Institute's model ES-1020 was the first computer available to the group for research. The ES-1020 was an early Soviet equivalent of the IBM 360 computer series. Its CPU speed was approximately 3 times slower than an IBM PC XT. Consequently, our first research tasks were small, involving analysis of Yagi-Uda and other antenna arrays with small numbers of elements. To compensate for the slow CPU speed we developed computer programs with maximum efficiency, and closed expressions for integrations were found whenever possible. Additionally, adaptive algorithms, utilizing subroutines written in assembly language, etc.,were used for numerical integration

Later, we used the more powerful BESM-6 (the original Soviet model) and ES-1060 computers (the Soviet equivalent of the IBM 370 computer series). These computers were the property of another organization so we could use them only in the late evening and night hours. These more powerful computers made it possible to solve more difficult problems such as synthesis of the Yagi-Uda arrays and analysis and optimization of printed antenna arrays.

A new era (IBM PC)

In 1987 the Antennas and Microwaves CAD System Design Laboratory was organized in the Radio Engineering Department of the Lvov Polytechnic Institute. At that time, co-author Dr. M.Y. Mikhailov was appointed as Director of the Laboratory. The laboratory employed 10 full-time scientists, engineers, programmers, and technicians and several half-time post-graduates and students. In 1988, the Institute purchased two IBM PC XT computers. These computers were the first IBM PCs at the Institute.

In 1988 the Energy Space Corporation (Kaliningrad, Moscow region, Russia), the main corporation in the former USSR which designs and produces spacecrafts and satellites, awarded our Laboratory a 6-year contract for the design and development of methods, numerical algorithms and computer programs for computer-aided design of various types of antennas. The funding from the Energy Space Corporation made it possible for the Institute to buy an IBM PC AT 386/387 computer, which was the most powerful personal computer at the Institute at that time. In 1990 we bought a second 386/387. Since acquiring these PCs, we have performed all our calculations using these computers, and have designed our software packages for only IBM PCs running MS DOS.

The main research problems

In the field of computational electromagnetics our research program focused on:

- simulation and optimization of various wire antennas and dipole arrays (Yagi-Uda, Backfire antennas, Helical antennas, printed antenna arrays and some others);

– computer simulation of large reflector antennas.

The algorithms to analyze various wire antennas and arrays of wire dipoles used an integral equation approach and the method of moments. We used several sets of expansion functions and compared the efficiency of the numerical algorithms obtained.

The problem of antenna synthesis was solved by using a numerical optimization technique. We developed, used, and compared various optimization procedures. Several types of error functions were used, such as:

i) an accuracy of the achieved approximation of the radiation pattern to the required one;

ii) maximum antenna gain with additional requirements on antenna input impedance at the same time;

iii) minimum side-lobe level in the required angular range.

Printed Antenna Arrays. We considered one-dimensional arrays of printed dipoles over a multi-layer lossy dielectric substrate. It was designed as a strict electromagnetic model of the printed array using an integral equation technique. We used an original set of expansion functions. The Green's function for the multi-layer structure has a very specific form. Thus, it was not possible to obtain closed expressions for the calculations of the elements of a mutual impedance matrix. We used several original numerical methods to overcome these computational problems.

Optimization procedures were accelerated by the following approach. Initially, numerical approximations of the functions – mutual impedance vs lengths of dipoles and distance between them – was made. These approximations were then used for fast calculations of the current distributions along the dipoles.

Reflector Antennas. We considered the problem of a single and dual-reflector antenna simulation for the most general case. The main and auxiliary reflector surfaces (center-fed and offset) could have an arbitrary shape of any smooth surface, such as parabolic, spherical, elliptical, hyperbolic, plane, etc. The shape, type of the edge shape, position and orientation of the main and auxiliary reflectors could be separately set. The antenna may be excited by several types of feeds such as rectangular and circular waveguides and horns, dipole and measured data from a prototype feed. The position, orientation and excitation of the feed could also be set. The equivalent current method was used for the analysis. The main and auxiliary reflector surfaces are divided by triangles. There is constant approximation of the magnitude and linear approximation of the phase of the current inside each triangle. The blocking of a main reflector by an auxiliary one was taken into account by methods of ray optics. This approach made it possible to analyze the reflector antennas with a main reflector size up to 1000 wavelengths on an IBM PC 386/387.

The electromagnetic models and algorithms described above have been used in several original software packages, intended for engineering design of various types of antennas. The packages, written for the IBM PC have user-friendly graphical interfaces, and have been supplied to several customers in the former USSR. For more detailed information, as well as the programs, please contact the authors.

New days

During the last several years there have been many significant changes in the former USSR. The country is radically different from the country of three or four years ago. These changes have led to a critical reduction of funding for computational electromagnetics R&D. In 1993 only a few researchers are employed at the Laboratory, a typical situation now for many research groups in the Ukraine and Russia. In the summer of 1993, Professor A.F. Chaplin's untimely death increased the Laboratory's funding crisis, and in spite of the great efforts of Ukrainian and Russian researchers, there is little hope for the Laboratory's continued existence. At the end of 1993, both authors moved to the Aerospace Monitoring Center (Lvov, Ukraine) to continue research in computer-aided antenna design.

The Practical CEMist
- practical topics in communications -

Perry Wheless, K4CWW

With this issue, the *ACES Newsletter* begins a new department - **The Practical CEMist**. The idea of a regular column of this sort has been kicked around in ACES for some time now, and the decision was finally made to put the implied interest level to the litmus test. Response in the form of submitted articles, telephone calls and e-mail, new subscriptions, and so forth will be assessed on a yearly basis to determine ongoing acceptance and support for the concept. I am optimistic that a bright future lies ahead, but the success of the effort will depend on the *active participation* of ACES members who are concerned with practical aspects of communications.

Why **The Practical CEMist**? The state of the art in computational electromagnetics (CEM) is moving forward at high speed. The *ACES Journal* is one outlet among many for international, refereed papers describing work and accomplishments either at, or directed toward, cutting edge developments in the field. A major problem, however, is that the peer-review scientific CEM publications treat increasingly sophisticated topics in increasingly shorter formats as time goes along, so that the papers become progressively less readable and useful to CEM practitioners in their day-to-day work. The present alternative is acticles in the "hobby" magazines, mostly in the amateur radio community, which are more often than not at a scientific level so low as to be of dubious value to occupational users of CEM. The first objective of this new department, then, will be to seek out and provide articles which are intermediate in technical sophistication and with a heavy applications emphasis. An alternative description would be to say the the first objective will be to keep the practicing CEMist, who needs good modeler's notes and the like, well informed and entertained.

I would like to emphasize further why keeping readers informed does *not* mean impressing them with more news about state of the art theory. If you limit yourself to state of the art reading, you actually can fall behind because new papers are continually appearing on the horizon while the time required to digest all this new material becomes more monstrous both because of sheer quantity and increasing obscurity. Many CEMists want to maintain a clear idea of present techniques to the extent that they can understand the principle(s) in the next new advance, but also require practical information which they can adapt to their special jobs.

In recent years, CEM is becoming integrated more and more into communications system analysis and design. While CEM applied to antennas was an independent, self-sufficient field of study for several decades, the recent trend is to consider the antenna(s) as just one part of the end-to-end communications system. Reliable antenna analysis and design is now expected in a shorter time frame, and engineers generally are alloted less time to become familiar with code capabilities and limitations. This trend, again, reinforces the need for reference material of intermediate technical sophistication and with a practical emphais.

Many ACES members have an occupational or hobby interest (or both) in keeping abreast of the essential aspects of complete rf and microwave communications systems - including topics such as propagation, transmission lines, and impedance matching networks. The previous scope of the *ACES Newsletter* will enlarged somewhat, in this department, to include relevant topics.

The Practical CEMist will endeavor to fill the gap in other publications. A large number of ACES members have experience and special knowledge which will allow them to prepare excellent articles for this purpose, and I hope that they will eagerly respond to this opportunity to become contributing authors. The department will strive to become a reference for state of the art practice, versus pure theory, with a lot of 'how to use' information.

Some ACES members will doubtless have concerns that about the *ACES Newsletter* becoming a hobbyist magazine, but that is not the intent and such an identification is highly unlikely. **The Practical CEMist** will attempt to revive the modeler's notes and 'tricks of the trade' articles which were more plentiful in earlier years, in today's context. Because several thousand amateur radio operators are now experimenting with ELNEC, MININEC, and other wire antenna codes, we do hope to involve a substantial number from that sizable community of users with ACES over the next few years. However, we aspire to do so through articles which are clearly a cut above those available in the leading amateur radio magazines with respect to technical content and merit.

We will try to make **The Practical CEMist** useful, interesting and stimulating to you. The articles will all be oriented to the practical approach, but the fare will be varied as necessary to address the recognition that not all of you are interested in the same things. Computational electromagnetics and wireless communications are diverse. If you haven't seen an article that covers your special knowledge elsewhere, then probably no one has written it up. You should take advantage of that opportunity, and write it up yourself as a contribution to this department of the *ACES Newsletter*. If you are contemplating an article, you may find it useful to discuss your idea with me as you come to the point of preparing your manuscript, particularly because camera-ready copy is required.

I would like to thank Richard W. Adler, K3CXZ, for suggesting **The Practical CEMist** name. It clearly implies that CEM hints and kinks are the focus of interest, and that the articles should appeal to communications professionals as well as advanced radio amateurs. Also, I would like to thank Dick for contributing an article to this initial installment, which also includes a paper from Marc Tarplee on the CCD antenna. Several individuals have promised articles for the next issue, which should put us well underway.

Anyone interested in coordinating this column on a ongoing basis should contact me to discuss that possibility. I have initiated the effort for 1994, but have no territorial claims and would welcome the interest of anyone dedicated to the long-term success of the venture.

Until May 15, 1994, authors should submit articles to me at the following address:

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The e-mail address wwheless@ua1vm.ua.edu is vali now and will remain so after May 15. I look forward to receiving your articles!

Amateur radio operators attending the ACES '94 symposium in Monterey March 21-26, 1994, should check in on the 146.37/97 (PL 94.8 Hz) or 449.7/444.7 (PL 123 Hz) repeaters. You can override the PL requirement by entering '081' from your keypad, which kills PL for 30 seconds (and it continues off so long as transmission breaks are less than 30 seconds). Thanks to Rudy Anders, AA2HT, for his suggestion to publicize these frequencies for use by hams at the conference.

REFLECTIONS ON RUNNING NEC ON A PC

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Abstract **- The transition from running NEC-MOM on a mainframe computer to running on a 32-bit PC platform has not been smooth and easy. Eight years after the first attempts at NEC-PC, the pitfalls experienced in porting NEC in the beginning have been overcome, but the explosion in 80486 computer board designs has created new traps for the beginner as well as the veteran "PC CEMist". Recent experiences in installing NEC3-PC on five 486-PCs have shown that without intimate knowledge of the architecture of PC board design and a keen understanding of DOS memory managers, success may be more a matter of perseverance and experimentation with CONFIG.SYS files than of logic.**

I. Introduction

Our first attempt at porting NEC3 from an IBM System 370 mainframe to a PC was reported in the 1986 ACES Conference Proceedings[1]. The PC performance was 1/50th of the 370's. Three years later, in the 1989 conference[2], a 20MHz Compaq 386/387 PC only took 20 times as long as the 370. Today, we use 486-66 PCs with six times the performance of the '89 tests. The improvements in computational performance have elevated the PC to a level of preference over the mainframe. Our Signal Enhancement Lab at NPS is home to five different 486 NEC engines. We are forever upgrading our motherboards with doubler-chips and experimenting with the latest releases of DOS. That is, our lab technician tries out every DOS upgrade, particularly in an attempt to squeeze every last usable byte out of the basic 640KB of PC base memory.

I learned the hard lesson of sticking with a stable DOS once you have found one that meets the criteria of working on as many platforms as possible. Those who have suffered through the days of buggy DOS versions, starting with 3.0 and on to the disastrous DOS 4.X series of "upgrades" will appreciate the stroke of fantastically good luck I experienced during a business trip to Washington DC one spring. I was traveling with my "sewing machine" Compaq Portable III (a 286-12MHz orange plasma CGA-screened beast) and was cranking out antenna configurations on NEEDS 1.0 one evening during an April thunderstorm, when the power in the Holiday Inn surged two or three times and trashed the boot sector on the hard drive. Naturally, I did not have a DOS boot disk with me and was facing a long weekend in a hot, muggy hotel room (the DC folks don't seem to think it gets warm and humid until May 1st so they won't fire up their central A/C until then). I headed out into the streets of Bethesda, in search of a copy of DOS 3.X to restore my C:\ drive. The only thing I could find was a Compaq DOS 3.31 version and assumed that it would not hurt the Compaq sewing machine. During the next year, I replaced all copies of DOS 3.X on every PC I had access to, with copies of Compaq 3.31. No incompatibilities were observed, regardless of the manufacturer of the motherboards. I laughed with delight as the lab tech screamed and wailed when DOS 4.0 and 4.1 trashed hard drives on all types of PCs! I even resisted all attempts at the new DOS 5.0, with all of its magnificent memory managing power, and stuck to my tried-and-true Compaq-embellished DOS 3.31.

I finally gave in when the hard drives reached 256MB and DOS 3.31 could not handle the size, and allowed the "techies" to install 5.0 on my then new HP 486-33 Vectra in late 1991. This was the time when we began motherboard transplants on our 386 PCs to upgrade them to 486 status. The transition was not smooth. One shipment of 486 boards required almost one year of continuous bickering with the manufacturer to get memory and caching chips that would work. The problems ran from manuals that contained multiple errors in setup configurations to bios versions that were the wrong ones for the version of the board. Last week we pulled the last of those boards out of service in word processing. Their NEC performance has been pitiful. They barely matched the speed of the 386 boards they replaced! The hard disk drive replacement exercises have not been without major miseries. We have replaced early 330MB SCSI drives of a particular manufacturer up to 3 times within the first year of their life. One time we were sucked into acquiring a set of "hopped-up" boards that the supplier had "tweaked" for max performance. Several students used these screamers to complete large NEC models of aircraft antennas, and obtained better turn-around times than when they ran on the mainframe in the time-share mode. Once the chips started failing, we discovered that the supplier had vanished and the original board manufacturer, of course, refused to deal with us.

II. 32-BIT DOS-EXTENDERS & COMPILERS

Early PC 32-bit compilers were mentioned in the last newsletter[3]. We have recently upgraded some of our old FORTRAN compilers and note that the various DOS extenders, such as Ergo OS/386 and Phar Lap Tools, are being used by different compiler vendors, but loyalty to a particular extender is not noted. Lahey used to favor the Ergo extender but now supplies the Phar Lap version, as does Microsoft in their FORTRAN Powerstation. Microway, which had been supplying Phar Lap Tools, provides their own extender and Ergo's and still supports Phar Lap. All of these extenders allow brain-dead DOS to access memory above 1 MB for executable code use. This is known as the protected mode operation of the 80X86 Intel chips.

Memory managers, supplied as a part of a DOS, create access to upper memory (above 1MB) as *extended* or as *expanded* memory. If you are a CEMist who really just wants to run big numerical models on a PC and prefers to leave the mysteries of a PC's innards to the "bit-freaks", you can read up on memory and managers and will probably end up with a set of aching brains. After I tried to unthread all the jargon found in (older) DOS manuals - new DOS documentation is in help files, not in books - I decided that I could master the CONFIG.SYS snakepit and set up the forest of PC towers in our lab for 32-bit NECing. All FORTRAN vendors supply you with memory "checking" programs such as TELLME and WHATMEM that examine your PC setup and report on how much memory of what type is actually accessible by your 32-bit application. So if you understand your version of DOS's memory managers, you should be able to use most of those expensive SIMMS memory boards you have been able to afford. And, of course, running problems in swift electronic memory beats running on disk-based virtual memory.

III. MOTHERBOARD ARCHITECTURE

Since NPS is a US government agency, all purchases must pass through the portals of the Supply Department, whose prime directive is to purchase, at the lowest price possible, from small businesses. Thus, PC needs and desires revert to "spec writing contests" between the end-user and the Purchasing Agent. Since we are always in a win-lose situation, we collect a strange mix of PC hardware that becomes a real challenge when your goal is to provide staff and students NEC PC engines that can compete with a mainframe.

Our PC corral currently contains a Compaq 486-66 C "sewing machine" portable, an HP Vectra EISA 486-66, a Zeos VESA 486-66, two Mylex 486-66s, and a Micronix EISA 486-66. The current version of NEC3-PC is configured for 2000 unknowns, with an in-core of 1200. This requires at least 27+MB of available upper memory, in a configuration that conforms to the VCPI (Virtual Control Program Interface), XMS expanded or EMS extended memory standard. I have chosen to use Compaq's DOS 5.0 for my 486C , Zeos and Vectra. MS DOS 5.0, 6.0 and 6.2 are on the other three PCs. We recently spent four days benchmarking the performance of NEC3-PC on these machines. Most of the four days were devoted to "software dice rolling" as we tried combinations of HIMEM.SYS, HIMEM.EXE, CEMM.EXE, HPMM.EXE, and EMM386.EXE from all four operating systems in a mix and match set of CONFIG.SYS files. Some hardware/software combinations produced VCPI memory, some XMS and some EMS memory. Our NEC3 was compiled by Lahey's F77L-EM/32 FORTRAN version 4.1 with a Phar Lap DOS Extender. (The Lahey 5.1 compiler produced an executable module that was very slow to load into memory and ran the same as the 4.1 version, which loaded very swiftly.) The results:

- The Zeos VESA machine responded with HIMEM.EXE, no options from Compaq DOS 5.0 and EMM386.EXE, RAM option from MS DOS 6.0. (The kernel in DOS 6.0 is identical to the one in DOS 5.0, which suggests to me that DOS 6.0 is merely a "hot-patched" 5.0 without a decent user manual, with a few weak utilities tossed in to help justify the cost.)

- The Compaq 486C responded with Compaq DOS's HIMEM.EXE, no options and CEMM.EXE, RAM option.

- The slow Mylex board produced extended memory with only MS DOS HIMEM.SYS, /HMAMIN and /NUMHANDLES options.

- The speed-king Micronix VLB/ISA motherboard was content with MS DOS HIMEM.SYS, no options.

- The proprietary HP Vectra board resisted all attempts to allow access to all of its 36MB memory. The most we could access was 16MB, although the BIOS setup revealed 36MB. A group of calls to HP Tech Support resulted in the usual wide-ranging suggestions, typical of responses from support personnel whose experience and understanding range from near-zero to hands-on. The consensus of opinion from five attempts to understand if there was a solution or not was that HP had taken the IBM PC-AT "standard" of the early '80s to heart, and designed the motherboard to "toss an interrupt" back at all DOS applications that asked for upper memory beyond 16MB, the IBM standard. In other words, HP was still making 80286 boards with 486 CPUs because they made a decision to adhere to the IBM AT standard for DOS. They quickly reminded me that the Vectra is more at home with OS/2 or UNIX, and that I should consider dropping DOS for applications that used more than 16MB of memory! (SIGH!)

This was a major blow to my ego, as I had pride in my "specsmanship" that had resulted in the Purchasing department's decision to buy the Vectra I had wanted. It reminded me of the ill-fated IBM PC-RT "super-lemon" purchase of 1986. My colleagues would pass by the RT in the lab and snicker and joke about its buggy AIX/UNIX operating system and the 2MHz speed of the AT co-processor card it housed. Now my pride and joy Vectra had resurrected the '86 nightmares I had as I admitted that HP made great proprietary computers and UNIX workstations, but just didn't quite understand the PC-DOS world.

With a heavy heart, I closed my office door and spoke in low tones to the Vectra. I promised it I would not make it subject to the mockery that the RT had so richly deserved, but would quietly give it a brain transplant so it could live out the rest of its useful days with respect. For some reason, I opened the Vectra manual to the setup section and flipped through the section on memory managers. The current version of Windows that was in existence when the Vectra was born was the buggy 3.0 version. HP had developed a memory manager module, HPMM.EXE that would allow Windows 3.0 to run. Since I never ran Windows 3.0 on the Vectra, and noted that when 3.1 arrived, it listed memory managers that would *not* work and that HPMM.EXE was verboten, I never installed it and stayed with the Windows 3.1-supplied HIMEM and EMM386.EXE. Just for fun, I setup the "V" with HPMM and viola! All 36MB became available! I cancelled the brain transplant (it wouldn't have fit anyway) and stroked the "V"'s steel, well-shielded cabinet. Then I pondered why the HP techies hadn't suggested HPMM......

IV. Reflections

All of this confusion and time consuming frustration may not be worth it. I think that I will hire a computer science student part-time to fuss over these hardware/software incompatibilities and stick to NECing as a true CEMist should. 73, K3CXZ

References

[1] Stephen Lamont, "NEC3 on a PC", *Proceedings of the Second Annual Review of Progress in Applied Computational Electromagnetics (ACES '86)*, Monterey, CA, March 1986.

[2] Timothy M. O'Hara and Richard W. Adler, "NEC3 on a PC, Re-visited: Three Years Later", *Proceedings of the Fifth Annual Review of Progress in Applied Computational Electromagnetics (ACES '89)*, Monterey, CA, March 1989.

[3] Richard W. Adler, "Information on the History & Availability of NEC-MOM Codes for PCs & UNIX", *Applied Computational Electromagnetics Society Newsletter*, November 1993.

What is a Controlled Current (CCD) Antenna ?

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I. INTRODUCTION

From time to time articles appear in amateur radio literature on the subject of controlled current distribution (CCD) antennas. The articles generally contain information on how to build a CCD antenna but there is very little discussion of the theoretical aspects of the CCD antenna. Also, many claims have been made for the CCD antenna including:

1. gain greater than a dipole
2. reduced end effects
3. higher feed point impedance than a dipole
4. a pattern with many strong lobes and nulls

The author tested these claims by modelling a series of CCD antennas with MININEC. The MININEC data were also used to check the predictions of the theoretical CCD model presented in the next section.

II. WHAT IS A CCD ANTENNA ?

A. BASIC DESCRIPTION

In the broadest sense a CCD antenna is any antenna into which additional components, such as inductors or capacitors, have been introduced to modify the current distribution on the antenna's radiators. (see FIG 1.)

This definition is very general and includes some antennas that one would not normally consider to be a CCD antenna such as trapped multi-band dipoles and verticals. Certain multi-band antennas such as the W3DZZ 5 band trap dipole [1] use some of the techniques that will be discussed here. In this paper the definition of the CCD antenna will be restricted as follows:

1. it will be center-fed
2. there will be equal numbers of series impedances in each leg of the antenna
3. Impedances in one leg will be equal to corresponding impedances in the other leg
4. All impedances will be capacitive
5. All interconnecting wire segments will be the same length

These restrictions make the CCD antenna a centro-symmetric capacitively loaded antenna. The design parameters are the overall length of the antenna, the values of the capacitors, the diameter of the wire segments and the number of segments. It is customary to express the length of a CCD antenna in terms of the Stretch Ratio, S, which is the ratio of the overall length of the antenna to a half-wavelength at the operating frequency. Antennas in this paper have a stretch ratio S = 2.0 unless otherwise specified.

B. TRANSMISSION LINE (TL) MODEL OF THE CCD ANTENNA

Consider the CCD antenna pictured in FIG 1. The antenna contains two capacitors in each leg and all capacitors have the same value, C. The number of segments, N, can be seen by inspection to be 6. S = 2; therefore the total antenna length is λ. Each leg of the antenna can be modelled as an open ended transmission line with surge impedance Z_c .

If the antenna is resonant then the input impedance of the transmission line would be zero. The impedance at any point on the antenna can be determined by moving the appropriate distance clockwise along the outer circle (R=0) of the Smith Chart, starting from the infinite impedance point. Since only the periphery of the Smith Chart is used in this analysis, a streamlined graphical presentation results from unwrapping the R=0 circle from the Smith Chart and displaying it as a straight line as shown in FIG 2. Throughout this paper, this graphical display of CCD line impedance will be referred to as a CCD impedance map.

Also in FIG 2 are several vectors; vectors pointing to the right represent impedance transformations resulting from the N/2 segments of wire in each leg of the CCD antenna. The vectors pointing to the left represent the lumped negative impedance contributed by each of the (N-2)/2 capacitors in this leg of the CCD antenna.

Since the capacitors move the line impedance in the opposite direction as the wire sections of the antenna, it is convenient to consider the capacitors as being equivalent to "negative lengths" of transmission line. The CCD antenna will be resonant when the net length is a quarter wavelength, that is:

$$\frac{N}{2}*\frac{\lambda}{N}+l_{c,tot}=\frac{\lambda}{4} \quad thus: \; l_{c,tot}= -\frac{\lambda}{4} \qquad \text{(Eq 1)}$$

where $l_{c,tot}$ = the total "negative" line length due to the series capacitors. Notice that only the total negative line length has been specified. The lengths of the individual negative sections and thus the values of the individual capacitors are not specified by this equation. In the case that all the capacitors are equal this model can be used to determine the values of those capacitances.

Consider FIG 2 again. The outermost segment of the CCD antenna has a (normalized) length ϕ_1 and the first series capacitance has a "negative" length ϕ_2 - ϕ_1. The middle segment has length ϕ_3 - ϕ_2 and the second capacitor has negative length ϕ_4 - ϕ_3 . The length of the innermost segment is $\lambda/4$ - ϕ_4.

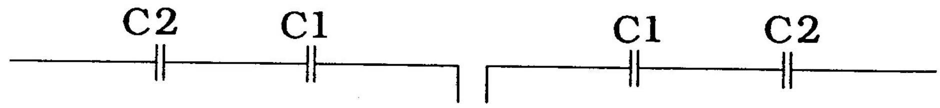


FIG 1: CCD DIPOLE N = 6

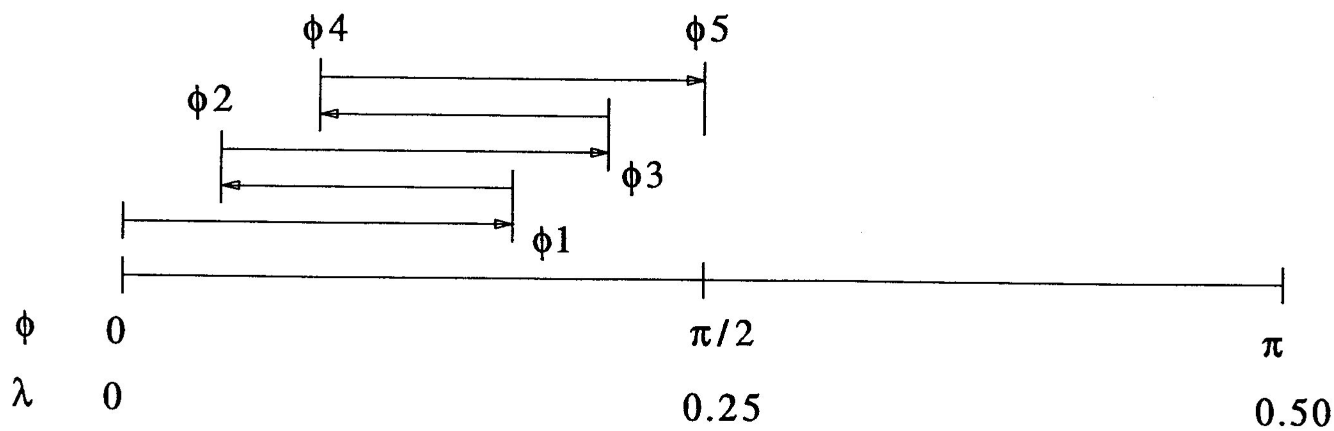


FIG 2: CCD IMPEDANCE MAP

If all capacitances are equal, then they all have the same normalized reactance, x_c given by:

$$X_c = \cot(k\phi_2) - \cot(k\phi_1) = \cot(k\phi_4) - \cot(k\phi_3) \quad where: k = \frac{2\pi}{\lambda}$$

(Eq 2)

The normalization constant for these reactances is Z_0 the surge impedance of the antenna, which can be determined from the following equation:

$$Z_0 = 1000 * \sqrt{\frac{0.06096 \ln\left(\frac{48l}{d}\right) \log\left(\frac{24l}{d}\right)}{7.36}}$$

(Eq 3)

The variables l and d represent the length of the antenna in feet and the diameter of the antenna in inches respectively.

Generalizing the above results to an antenna with N segments yields:

$$\cot(k\phi_{2i}) - \cot(k\phi_{2i-1}) = x_c \quad 1 \le i \le \frac{N}{2} - 1$$

(Eq 4)

and:

$$\phi_0 = 0, \quad \phi_{2i+1} - \phi_{2i} = \frac{\lambda}{N} \quad 0 \le i \le \frac{N}{2} - 1 \quad \phi_{N-1} = \frac{\lambda}{4}$$

(Eq 5)

This system of non-linear equations can be solved for the normalized reactance, x_c. The table below shows the variation between N and x_c for a CCD antenna with S = 2.

Table 0: Variation of Equivalent Reactance

No. of Segments (N)	Equiv. Reactance (x_c)
6	1.633
8	0.9032
10	0.6373
20	0.2660
40	0.1245

The equivalent reactance can be converted to actual capacitance values (in pf) by using the following formula:

$$C = \frac{159155}{x_c f_0 Z_0}$$

(Eq 7)

It should be possible to test the accuracy of the equivalent reactance prediction with MININEC.

Equations 5 and 6 can be used to locate higher order resonances of the antenna if one introduces u, the relative frequency (u = f/f0) and m = { 1,3,5,7 ....}, the order of the resonance. These equations may be rewritten as:

$$\cot(ku\phi_{2i}) - \cot(ku\phi_{2i-1}) = x_c \quad 1 \le i \le \frac{N}{2} - 1$$

(Eq 7)

$$\phi_0 = 0 \quad \phi_{2i+1} - \phi_{2i} = \frac{u\lambda}{N} \quad 0 \le i \le \frac{N}{2} - 2 \quad \phi_{N-1} = \frac{m\lambda}{4}$$

(Eq 8)

This model predicts resonances at u = 1.00, 1.78, 2.69, 3.60 ... This prediction will be tested by MININEC.

The TL model predicts that for certain values of N there is no x_c that results in a resonant CCD antenna. Consider a CCD antenna of stretch factor, S, divided into N_0 segments so that all the capacitors are separated by $\lambda/4$. The impedance at the feed point is:

$$Z_{feed} = \frac{Z_0^2}{Z_1} = \frac{Z_0^2}{Z_2 - \frac{j}{\omega C}}$$

Z_2 represents the impedance of the entire antenna except for the innermost capacitor, C. In order for the antenna to be resonant, Z_{feed} must be zero. This can only happen if C = 0. In this case it is not possible to construct a CCD antenna. Solving for the critical value of N, N_{crit}, yields:

$$\frac{l}{\frac{\lambda}{2}} = S \quad also: \quad \frac{\lambda}{4} = \frac{l}{N_{crit}}$$

Combining these results:

$$S\frac{\lambda}{2} = N_{crit}\frac{\lambda}{4} \quad or: \quad N_{crit} = 2S$$

(Eq 9)

The number of segments, N, must not be equal to N_0 in order to have a CCD antenna. For S = 2 this means that N must not be equal to 4. This is a prediction that will be tested by MININEC.

III. Data taken from MININEC Simulations of a CCD antenna

A. Basic Analysis

A centro-symmetric CCD antenna was modeled by MININEC. It has the following design parameters:

Resonant frequency (f0)	=	3.50	MHz
Overall length (l)	=	42.856	m
Wire radius (r)	=	0.0008	m (#14 wire)
Stretch Factor (S)	=	2.0	

TABLE 1 Basic Properties of a 3.5 MHz CCD dipole

No of Segments (N)	Capacitance pf			Input Impedance ohms	Gain dBi
	MININEC	TL Model	Kaplan [2]		
6	44	41	84	119	2.82
8	83	75	126	147	2.95
10	120	106	168	164	3.02
20	291	254	377	202	3.11
40	625	544	797	222	3.14

Graphs of these results appear on the next page.

Table 4: Comparison of higher order resonances taken from MININEC and the transmission line (TL) model

Relative Frequency

m	from MININEC	from TL Model
1	1.00	1.00
3	1.71	1.78
5	2.61	2.69
7	3.47	3.60

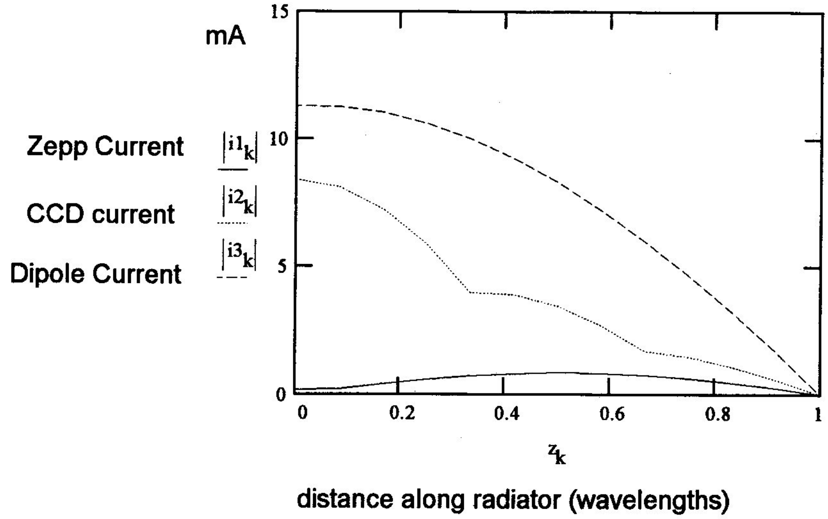
C. Effect of wire radius on required Series Capacitance

A series of CCD antennas with radii ranging from 0.001 to 0.008 m and with resonant frequencies from 3.5 to 28 MHz were modelled on MININEC. The following equations were fitted to the MININEC output to permit calculation of C for any radius:

$$fC = 147 * 1.075^{\ln\left(\frac{r}{4.6668E\text{-}06\lambda}\right)} \quad N=6$$

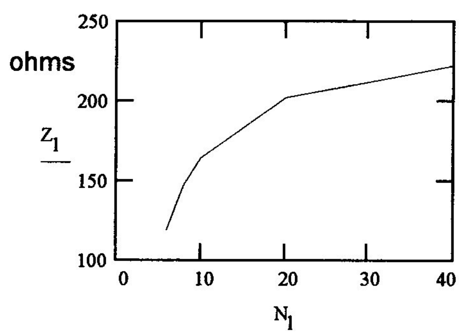
$$fC = (-161+55N) * 1.075^{\ln\left(\frac{r}{4.6668E\text{-}06\lambda}\right)} \quad N\geq 8$$

FIG 3: Comparison of current distributions of a CCD antenna and a double Zepp antenna one wavelength long
Driving voltage = i+j0 volts

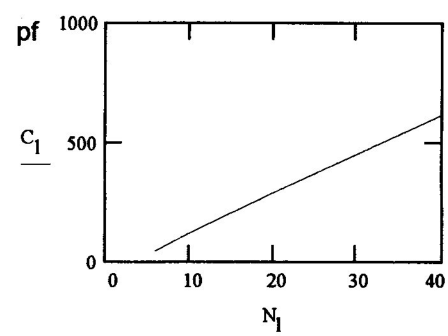


Graphs 4 - 7: Key Parameters of the CCD as a function of the number of segments (N)

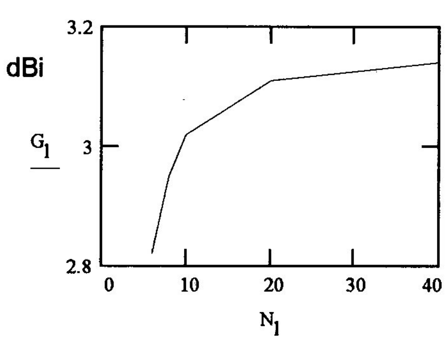
Input Impedance (Z) vs N



Series Capacitance (C) vs N



Gain (G) in dBi vs N



Half Power Bandwidth vs N

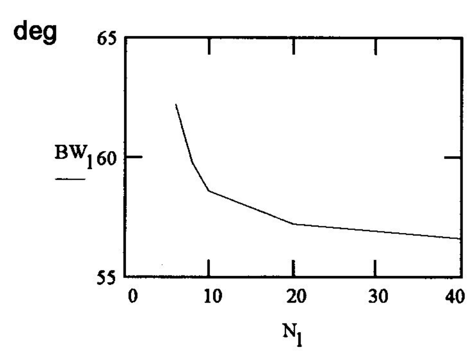


FIG 8: Radiation patterns of a Double Zepp, CCD dipole and halfwave dipole
(all patterns normalized so that maximum radiation = 1.00)

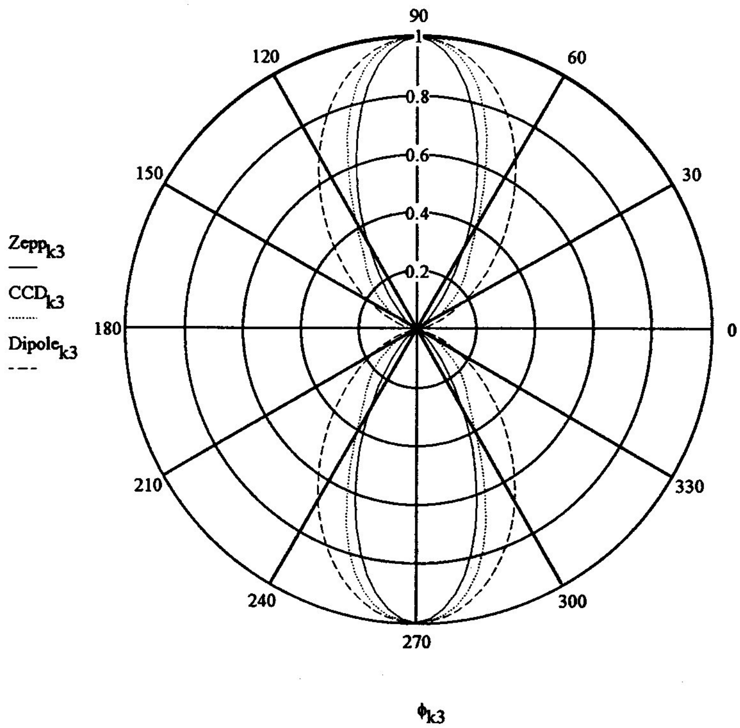


FIG 9: Comparison of current and voltage distributions
in a CCD antenna N=6. Input power = 100 W

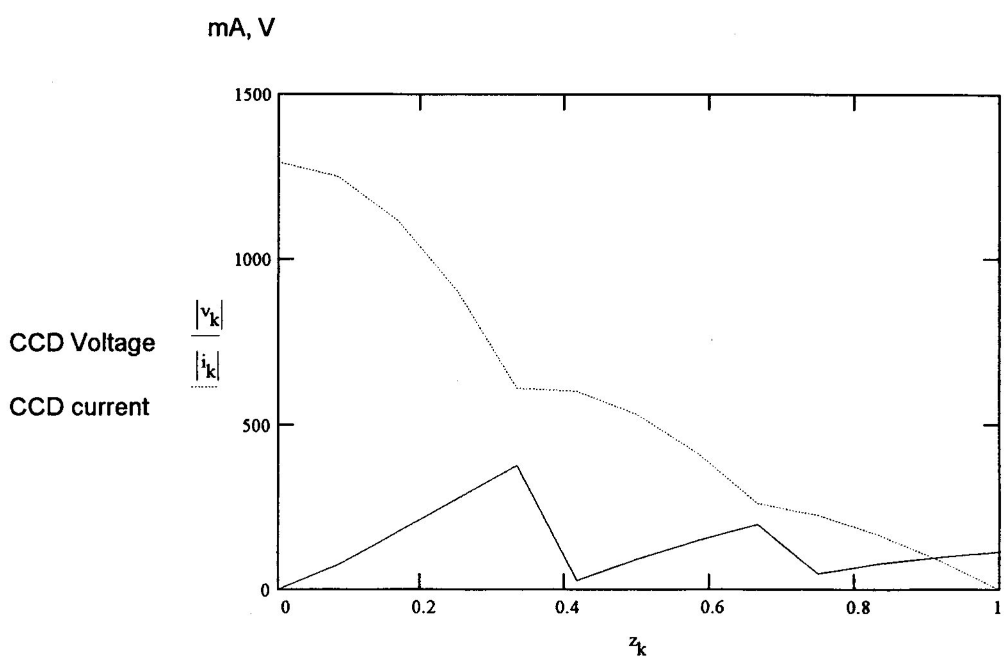
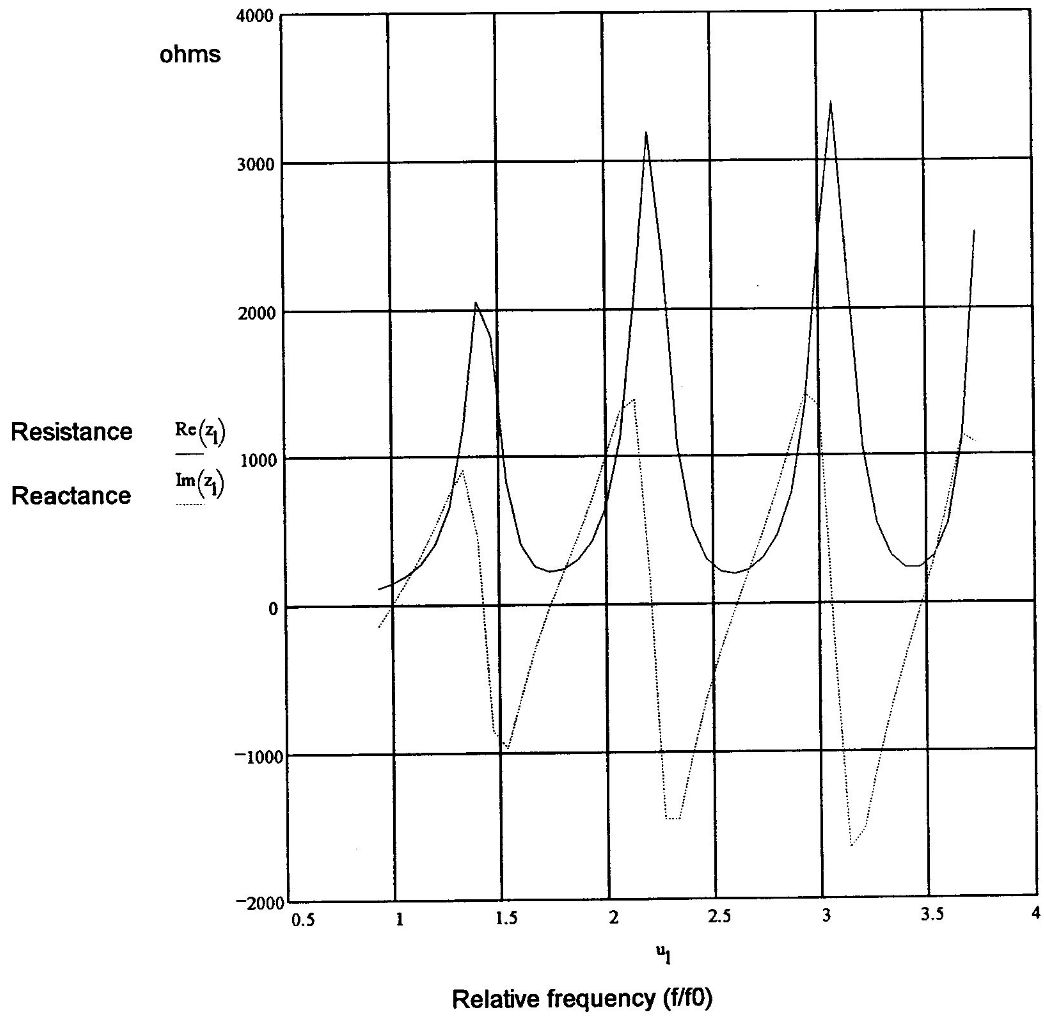


Fig 10: Input Impedance of a CCD antenna (S=2) as a function of relative frequency (f0 = 1.00)



Resonances occur at u = 1.708, 2.608, 3.472

Where: f - frequency in MHz
C - capacitance in pf
λ - wavelength in m
r - wire radius in m

As the wire radius increases, the capacitance required for resonance decreases. This is correctly predicted by Kaplan [2].

IV. Discussion

Four claims for the CCD antenna were made in the introduction of this paper, not all of which are supported by the MININEC data. MININEC however, has shed light on this antenna's harmonic performance, bandwidth and effects of wire radius.

The directivity of the CCD antenna is greater than a half wave dipole, but less than the double Zepp (see graphs, prior pages). The gain increases with increasing N, but there is not much improvement beyond N = 10. It is not known if there is an optimum set of capacitance values that result in maximum directivity.

To determine susceptibility to "end effects", the end voltage of the CCD antenna was computed from the current distribution [3],[4].The voltage at the ends of the CCD antenna (FIG 8) is lower than a dipole or double Zepp; voltage drops across the capacitors buck the voltages along the wire segments. As N increases, one would expect the end voltage to decrease, leading to reduced end effects.

The free space feed point impedance of the CCD antenna as determined by MININEC, varies from approximately 120 ohms to over 200 ohms. These values are consistent with Kaplan's observations that the feed point impedance of a resonant CCD antenna is increased by three or four times (that of a half wavelength dipole) [2].

The radiation pattern of the CCD appears in FIG 9. It is similar to the radiation pattern of a double Zepp with overall length = 1λ, but with larger beamwidth. The beamwidth of the CCD decreases as N increases. This pattern is consistent with the current distribution of the CCD antenna which is similar to a dipole but extended over a full wavelength. These data do not support claims in the literature [2], [5] that the CCD antenna has a pattern with strong lobes and minima.

No resonant CCD antenna was found using MININEC for the case N = 4. This is consistent with a prediction made by the transmission line model. Other articles on CCD antennas ignore this aspect of CCD antennas, assuming that N >> 1.

The TL model correlates much better to the MININEC output than Kaplan's algorithm, for small values of N. In the worse case, for large N, the TL model predicts values approximately 15% lower than those found from MININEC but still much closer than Kaplan. This improvement comes at a price however. The TL model requires the solution of a set of non-linear equations whose solution becomes difficult to determine for large N.

The TL model indicated the possibility of higher order resonances for a CCD antenna not unlike a regular half wavelength dipole. FIG 10 shows well defined resonances and anti-resonances. The results from the TL model are about 4% higher than those determined by MININEC. The pattern of resonances seems strange compared to a standard dipole, which has higher resonances at $u \approx 3,5,7$ ..... However, if one takes the stretch factor (S=2) of the CCD antenna into account, the higher resonances fall into the same pattern relative to the fundamental resonance of a dipole the same overall length as the CCD. In essence, the CCD forces the resonance that would normally occur when the antenna is one half wavelength long to occur when it is one wavelength long.

One may also determine the bandwidth of the CCD antenna (for 2:1 SWR) with N = 8, by examining the curves of FIG 10 in the neighborhood of $u = 1$. It is assumed that the antenna is fed with 50 ohm coax, through a 3:1 transformer. The lower and upper frequency limits in this case are $u = 0.957$ and $u = 1.047$. The resulting bandwidth is approximately 9%. This is considerably greater than the bandwidth of a normal half wavelength dipole. This is an important advantage on wide amateur bands such as 160 M, 80 M or 10 M.

In summary, the CCD antenna is an interesting antenna worthy of additional study. It has the advantage of higher gain than a dipole and should be easier to feed than a double Zepp. Several issues relating to the CCD need to be looked at; optimization of directive gain, adaptation of CCD techniques to other wire antennas such as loops and vees, and the feasibility of incorporating CCD antennas into parasitic arrays.

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On Models of Appropriate Complexity

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Abstract— **In CEM modeling, there often is an unfounded phobia about using simple models and small codes. The result is frequent 'overkill' with an unnecessarily complex model and use of a more cumbersome code, which results in substantial loss of time. An example experience is reported, which reinforces the common sense approach of beginning with simple, first principles and only escalating the modeling and computational power used on a given problem as it becomes necessary.**

I. Introduction

In a recent study, the relationship of ideal feed-point impedances for wire antennas to actual observed (that is, practical) input impedances was considered. Results of that study for the specific case of a trailing-wire HF antenna are presented in considerable detail in [1], where the premise is developed that the coefficients for a bilinear transformation relationship between the two impedances can be determined at fixed frequencies and over limited bandwidths. Measured impedances are obtained readily nowadays with an automated network analyzer. It is assumed in [1] that the accuracy of numerical results from moment method (MoM) computer codes is sufficient for many wire antenna types of interest that impedances calculated by such codes can be taken for the theoretical, or ideal, impedance values. Because the source models used for the application of numerical methods have limitations (resulting from idealization and simplification), CEMists generally have greater confidence in the radiation pattern predictions from codes such as NEC or MININEC than in their impedance predictions. However, experience suggests that the impedance calculations are at least consistent for many wire antenna geometries and environments, so that the desired theoretical-to-practical relationship can be established in such a way that reliable impedance prediction of impedances at new intermediate frequencies of interest is possible.

The modeling required to obtain the calculated impedances for the subject study provides a good object lesson in 'appropriate and measured response to a CEM modeling problem, and is an example of where a fear of simple models and simple codes has taken us. In the following, the trailing-wire HF antenna depicted in Figure 1 is discussed.

II. Overkill

The antenna, deployed to a length of approximately 16.75 meters, is clearly visible in the profile view of Figure 1. Because the calculated impedance requirements were viewed as stringent, the decision was made quickly to apply the full Numerical Electromagnetics Code (NEC) [2] to a wire-grid model of the fixed-wing aircraft with wire antenna. The NEC-2 code was available on an IBM personal computer, and NEC-3 (in executable module form) on an IBM 3090 mainframe computer.

CAD files for the aircraft were acquired. In addition to producing the drawings in Figure 1, these files provided the geometry database from which all the (x,y,z) coordinates were determined for a wire-grid model. The model shown in Figure 2 consists of some eighty-nine (89) wires. The end coordinates for each wire were extracted from the CAD files and manually entered into an appropriate NEC input file. Feed-point impedances were subsequently calculated by NEC at numerous frequencies in the 5 to 30 MHz range. This procedure, clearly, was rather labor-intensive.

III. Hindsight

It was only later that serious consideration was given to the possibility that a significantly more simple model and code could have produced acceptable results. A 17-wire 'stick' model of the same problem was quickly constructed, with five of these straight wires used as an approximation to the trailing-wire antenna. The stick model is

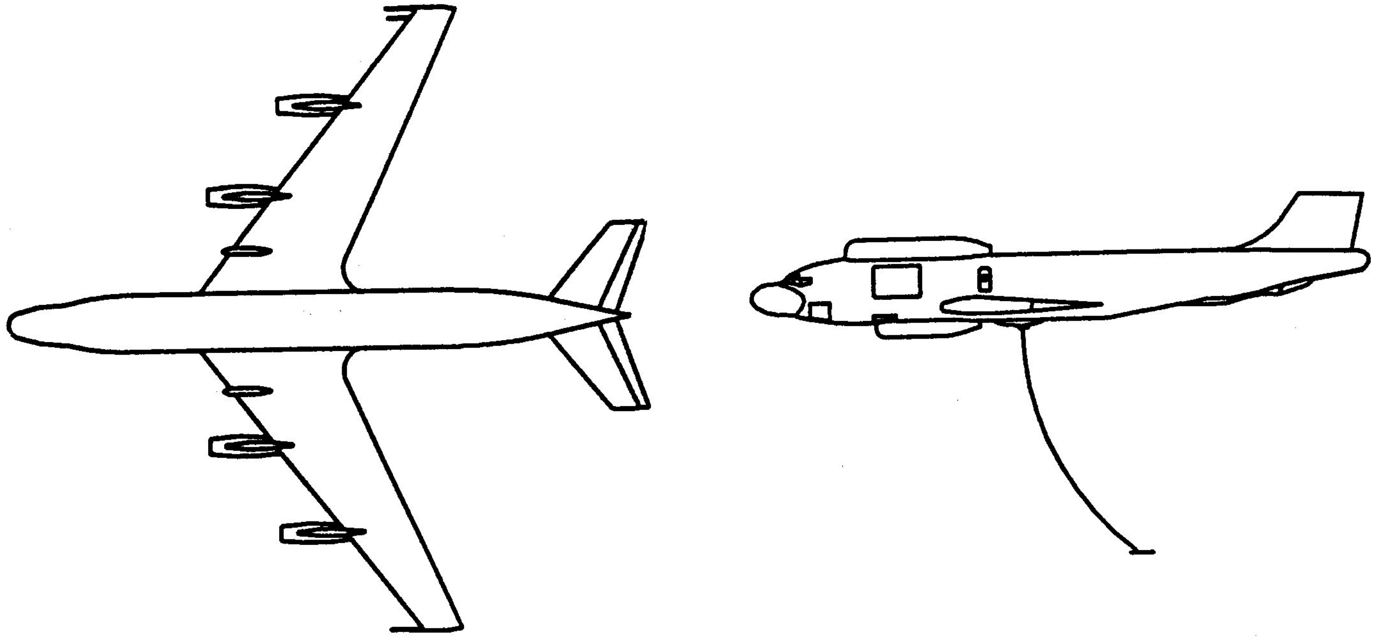

Figure 1. Top and profile views of aircraft with trailing-wire hf antenna.

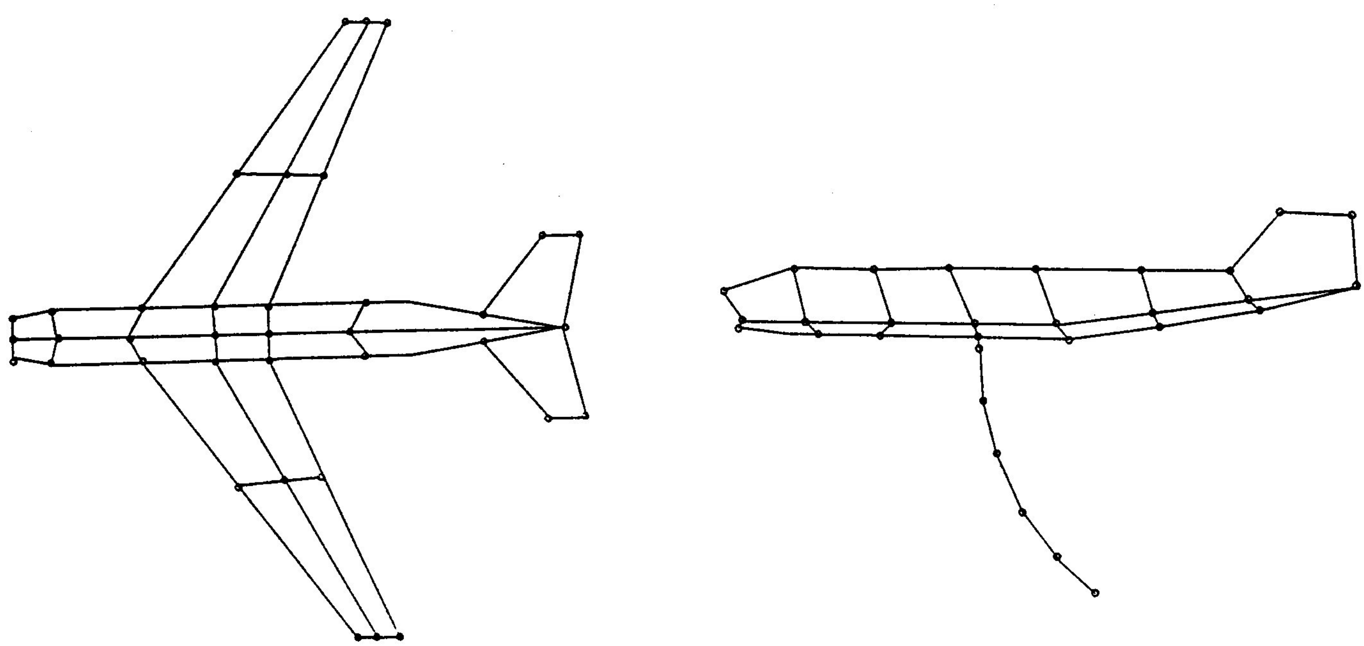

Figure 2. Top and profile views of wire-grid model for NEC analysis.

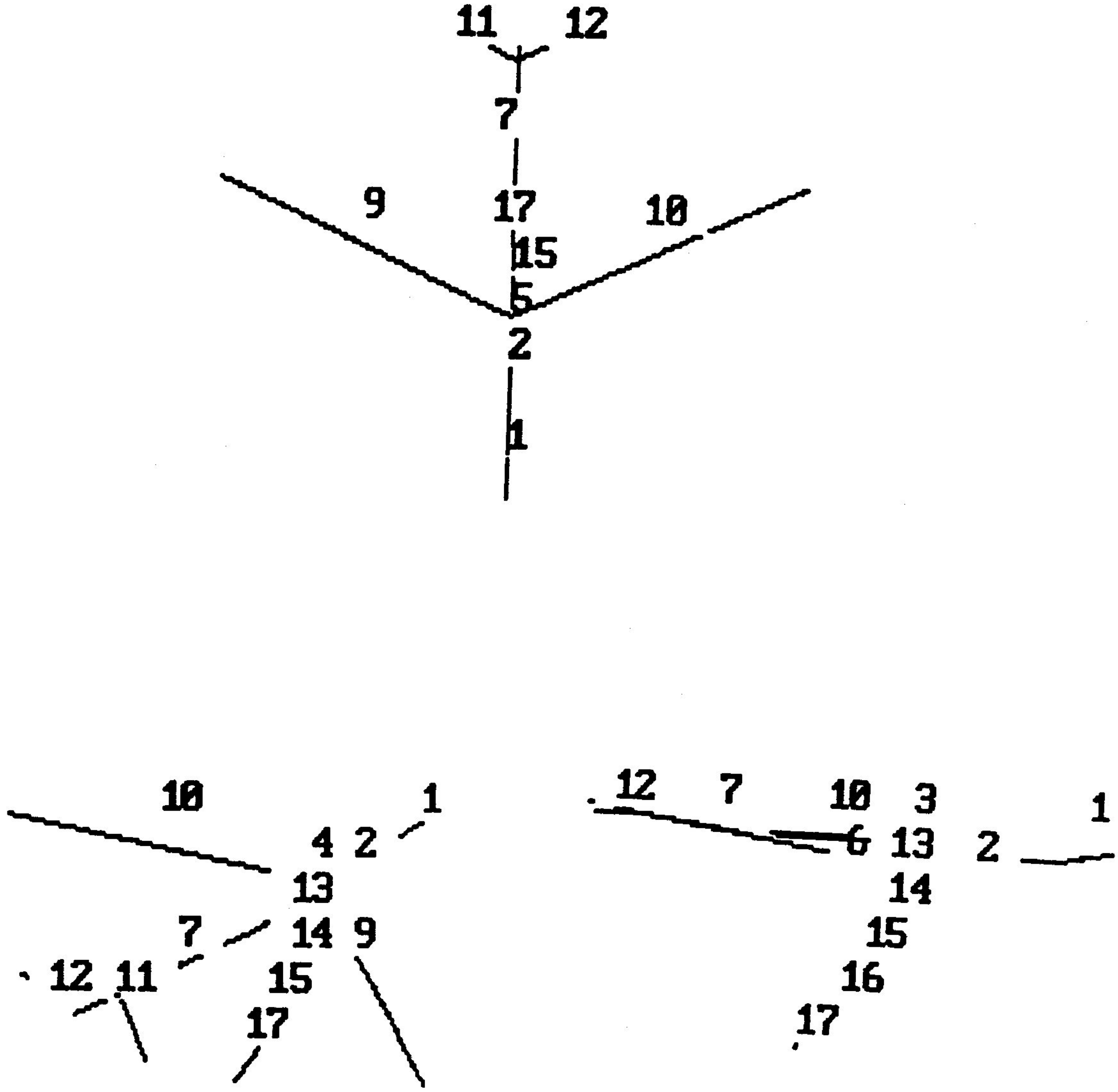

Figure 3. Three views of stick model for MININEC analysis.

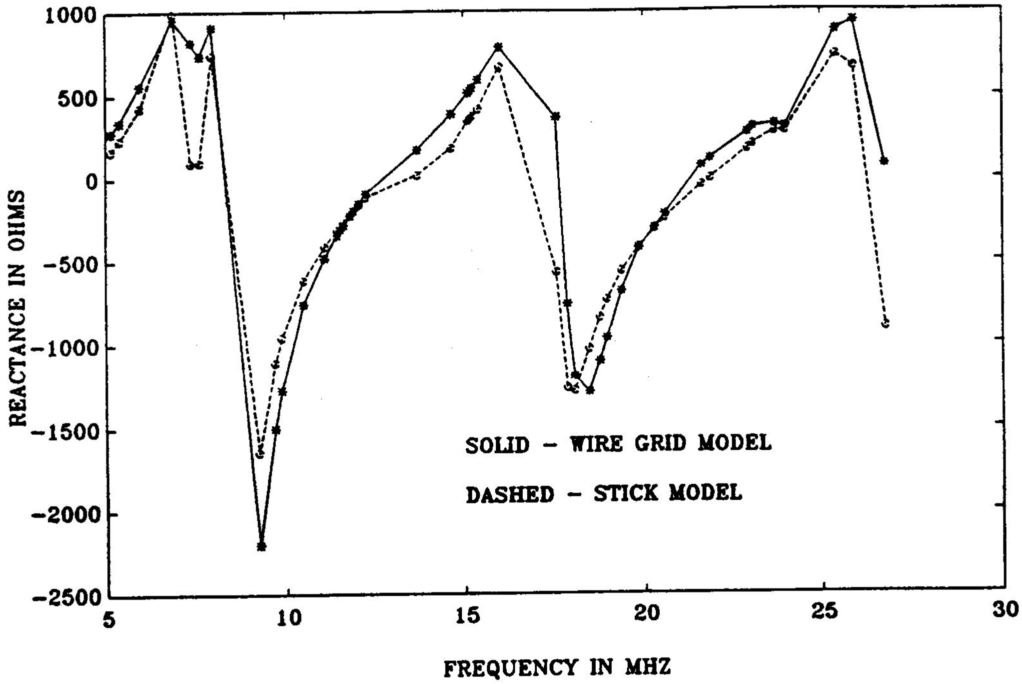

Figure 4. Reactance versus frequency, wire-grid and stick models.

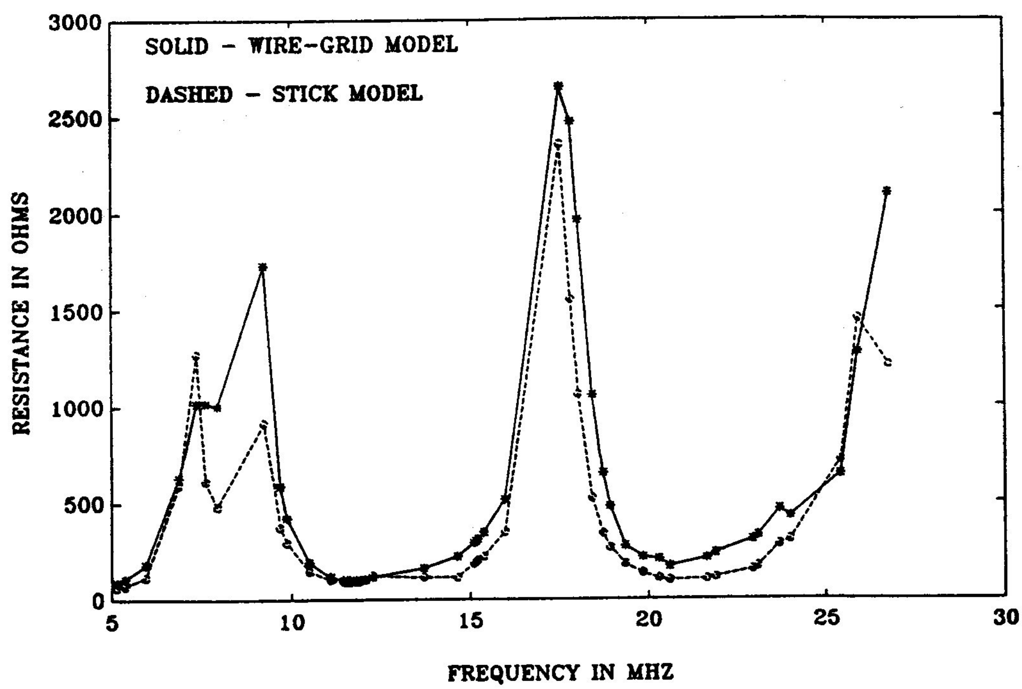

Figure 5. Resistance versus frequency, wire-grid and stick models.

shown in three views (from above, profile, and a rotated view from underneath the aircraft) in Figure 3. The stick model was analyzed at the same frequencies using the MININEC [3] code on a personal computer. As one would expect, the time involved in executing the MININEC analysis with a stick model is *much* less than that required to set up and execute the NEC study on a wire-grid model.

IV. Comparison of Results

For purposes of this article, it suffices to present the results of this wire-grid/stick NEC/MININEC comparison by two rectangular plots. Figure 4 shows the feed-point reactance versus frequency results for the two models, and Figure 5 has the corresponding resistance plots. The two different models yield plots which are qualitatively very similar, and exhibit substantial quantitative disagreement at only a few discrete frequencies.

The analysis procedure in [1] solves an overdetermined system of equations in a least squares sense. Because the impedance trends are consistent between the wire-grid and stick models, and the procedure lessens the influence of the few discrete points where there is appreciable discrepancy between the two models, it becomes apparent that the results from analysis of the stick model with MININEC are acceptable for the subject study! A considerable amount of time was non productively invested in the more elaborate NEC model and analysis.

V. Conclusions

CEMists are continually pressured, mostly in subtle ways, to use 'state of the art' techniques and to choose more sophisticated methodologies whenever choices exist. There has been a tendency to discredit straightforward models and small codes in recent years. However, this report provides additional evidence that there is intrinsic merit in starting with the most simple analysis imaginable, and escalating from that point only as necessary. The cost of using a cannon on a butterfly is becoming prohibitive.

Time permitting, another analysis with a second model which is one level more advanced than the first in order typically is done to reinforce one's confidence level. For example, the NEC wire-grid model well may have been done in the case of the subject example paper as a follow-up to a stick model with MININEC analysis. Nonetheless, there are still advantages to starting with basics. First, the CEM analysis is often for the purpose of providing information, or data, for another procedure. Fast CEM analysis with a simple model allows one to proceed with going through the mechanics of subsequent procedures, either establishing proof-of-principle or uncovering problems in the early going of a project. Second, there is no guarantee that we will have time tomorrow to continue a lengthy analysis, so one is generally better off to get some reasonable results 'in the bank' at the earliest opportunity. Then, should lack of time preclude the completion of a more sophisticated study, one has the option to forego the confidence reinforcement phase and proceed.

Another point of this experience is that, frequently, inadequate time is devoted in the embryonic stages of a project to conceptualizing a model appropriate to the complexity of the problem at hand. Of course, a major driver in many cases is the nature and capabilities of available codes, as we doubtless tend to view any given CEM problem as a nail for just that particular analysis 'hammer' we have in our toolbox. Again, with more advance thought, it is likely that a stick model would have been employed first in the subject study. Spending more time in creative thought to select an appropriate model truly qualifies as a *parsimonious allocation of resources*, and will pay dividends in saved time and effort later in the project.

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Resonant Characteristics of Eccentric Ring Microstrip Antenna

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ABSTRACT: In this paper, resonant characteristic of eccentric ring microstrip antenna has been studied using Point Matching method. The good agreement between measured and calculated resonant wave numbers of eccentric circular ring microstrip antenna indicates that the method can be used to analyze the resonant characteristic of arbitrary shape microstrip antennas.

INTRODUCTION: For an arbitrary shape microstrip antenna, no exact solution can be obtained by the conventional method of solving the boundary-value problem such as transmission line method and separation of variable method, etc. In such cases, approximations are available. Recently, the Point-Matching technique has been utilized to solve eigenvalue problem[2], but the formulation caried out in that paper is not adopted to solve the boundary-value problem of eccentric ring microstrip antenna. In this paper. a new formulation using the Point-Matching is suggested.

THEORY: Fig 1 shows the configuration of an eccentric ring microstrip antenna with coaxial feed, the substrate used here has thickness h and relative dielectric constant ϵ_r. The feed current due to the coaxial line excitation is taken to be Jz, it has a z-component only with no variation along the z-direction, the thickness of the substrate is assumed to be very small compared to λ. The boundary-value problem of electromagnetics in the region bounded by the patch and ground plane can always be reduced to a simple two-dimensional problem. [3]

$$E_z = \psi_{mn} \vec{Z} \tag{1}$$

E_z can be expresed in terms of the resonant model ψ_{mn}, and ψ_{mn} must satisfy below. [3]

$$(\nabla_T^2 + k_{mn}^2)\psi_{mn} = 0 \tag{2}$$

and $(\partial/\partial n)\psi_{mn} = 0$ on S_m.

ψ_{mn} and k_{mn} are the eigenfunction and the corresponding eigenvalue for m, n the model of patch, the solution may be written in terms of wave model as follow[1].

$$\psi_e = \sum_{n=0}^{\infty} [A_{en} J_n(kr) + B_{en} Y_n(kr)] \cos n\theta \tag{3}$$

$$\psi_o = \sum_{n=1}^{\infty} [A_{on} J_n(kr) + B_{on} Y_n(kr)] \sin n\theta \tag{4}$$

Assuming that series in (3) and (4) converge rapidly and uniformly for the cases under consideration, the wave function may be approximated by a finite number of terms

$$\psi_e = \sum_{n=0}^{N-1} [A_{en} J_n(kr) + B_{en} Y_n(kr)] \cos n\theta \tag{5}$$

$$\psi_o = \sum_{n=1}^{N} [A_{on} J_n(kr) + B_{on} Y_n(kr)] \sin n\theta \tag{6}$$

Where the subscripts e and o stand for even and odd respectively, n is an integer, and r and θ are the polar coordinates. Jn and Yn are the the N th-order Bessel function of first and second kinds, respectively. The quantities An and Bn are constants to be determined by the boundary conditions, k_{mn} is the resonant wave number.

The Point-Matching technique requires (5) and (6) to satisfy the boundary condition at a finite number of points, namely 2N points. Let the points $(r_1, \theta_1), (r_2, \theta_2) \cdots\cdots (r_N, \theta_N)$ be a set of chosen points around the outer contour and $(r_{N+1}, \theta_{N+1}) \cdots\cdots (r_{2N}, \theta_{2N})$ be the corrsponding set of chosen points around the inner contour. The boundary conditions at these points require.

$$\vec{n} \cdot \nabla_T \sum_n [A_n J_n(kr_m) + B_n Y_n(kr_m)] \begin{matrix} \cos \\ \sin \end{matrix} n\theta_m = 0 \tag{7}$$

where $m=1, 2, 3, 2N$, $\vec{n}$ is the unit vector normal to surface, in a more precise form, (7) may be written as:

$$\sum_n \{kr_m [A_n J'_n(kr_m) + B_n Y'_n(kr_m)] \begin{matrix} \cos \\ \sin \end{matrix} n\theta_m \mp tan\alpha_m [A_n J_n(kr_m) + B_n Y_n(kr_m)] \begin{matrix} \cos \\ \sin \end{matrix} n\theta_m\} \tag{8}$$

where $\cos\alpha_m = \vec{n} \cdot \vec{r}_m$ for $m=1, 2, \cdots\cdots N$, $\cos\alpha_m = \vec{n} \cdot \vec{r}_m$ for $m=N+1, N+2, \cdots 2N$; and $\vec{r}_m$ is the unit vector in the r-direction at (r_m, θ_n) as shown in Fig 1 (b).

The above formulations insure the wave functions satisfying the boundary conditions simultaneously at chosen on the outer and the inner contours. The formulation (8) forms a system of $2N$ homogeneous algebraic equations of $2N$ expansion coefficients An and Bn with the resonant k as the parameter. To obtain nontrivial solutions of An and Bn, the determinant of these coefficients must be zero, that is

$$D(k) = det|d_{ij}| = 0 \tag{9}$$

$$d_{ij} = kr_j \begin{matrix} \cos \\ \sin \end{matrix} i\theta_j J'_i(kr_j) \mp i tan\alpha_i \begin{matrix} \sin \\ \cos \end{matrix} i\theta_j J_i(kr_j) \qquad i=1,2,3,\cdots,N \tag{10}$$

$$d_{ij} = kr_j \begin{matrix} \cos \\ \sin \end{matrix} (i-N)\theta_j Y_{i-N'}(kr_j) \mp (i-N) tan\alpha_i \begin{matrix} \sin \\ \cos \end{matrix} (i-N)\theta_j Y_{i-N}(kr_j) \qquad i=N+1, N+2, \cdots 2N \tag{11}$$

$$j=1,2,\cdots,2N.$$

The roots of the above equations (10) (11) are the values of k which are infinite in number, each of which corresponds to a model, Having determined the resonant wavenumber k, for a specific model, the expansion coefficients An and Bn can be found from (10) (11)

EXAMPLE

1. Circular microstrip patch antenna. In this case, r_{N+1}, r_{N+2}, r_{2N} are all zero, r_1, r_2, r_N are equal to constant a_1, therefore, equations (8) can be written. It is easy to see that formulation yield exact solution: $J'_n = (ka_1) = 0$.

2. Inner ring with circular while outer ring with arbitrary shape.

If one of the rings is circular, (8) can also be reduced from a determinant of order $2N$ to a determinant of N, the boundary condition can be satisfied exactly at the boundary of $r=a$, considering that conditions at $r=a$, require that

$$\sum_n \{[J'_n(kr_m)Y'_n(ka) - J'_n(ka)Y'_n(kr_m)]kr_m \cdot \left(\begin{matrix} \cos \\ \sin \end{matrix} n\theta_m\right) \Big/ Y'_n(ka) \mp tan\alpha_m [J_n(kr_m)Y'_n(ka)$$

$$- J'_n(ka)Y_n(kr_m)]n\left(\begin{matrix} \sin \\ \cos \end{matrix} n\theta_m\right) \Big/ Y'_n(ka)\} A_n = 0 \tag{12}$$

$$m=1,2,3,\cdots,N.$$

Where $(r_1, \theta_1), (r_2, \theta_2) \cdots\cdots (r_n, \theta_n)$ are N points properly chosen around the general contour, the limits of the sumtotal are between 0 and $N-1$ for the even model and between 1 and N for the odd model, since that the factor $1/Y_n(ka)$ is the same for every column of the matrix inside the same braces of (12), the determinant of this matrix being equal to zero is with the resonant wavenumber determined, the expansion coefficients An and Bn can be computed. It is easy to see that (12) are reducible to exact solutions when applied to annular ring.

3. Eccentric ring microstrip patch antennas

As showen in Fig 2, the eccentric ring was fed through a probe of diameten 1. 25mm, the feed line was a 50Ω coaxial, inner radius $R_1=2$cm, outer radius $R_2=1.5R_1$, the eccentric distance between the two circular rings $L=0.3R_1$,

$$R_{1e}=2a-a\left[1+\frac{2h}{\pi a\varepsilon_r}\left(ln\frac{\pi a}{2h}+1.7726\right)\right]^{1/2} \qquad (13)$$

$$R_{2e}=R_2\left[1+\frac{2h}{\pi R_2\varepsilon_r}\left(ln\frac{\pi R_2}{2h}+1.7726\right)\right]^{1/2} \qquad (14)$$

where R_{2e} R_{2e} are the effective inner radius and outer radius, respectively, which take accout of fringe field[2]. The plots in Fig (3) are based on the calculated value of (12). It is observed that if the intervats between the chosen points are made sufficiently small (smaller than the resonant wavelength), the deviation between the measured and calculated values is expected to be small.

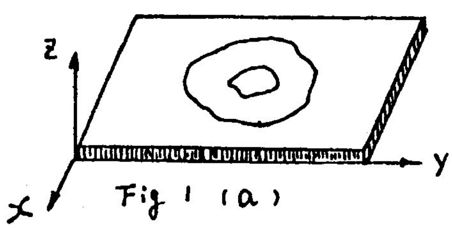

Fig 1 (a)

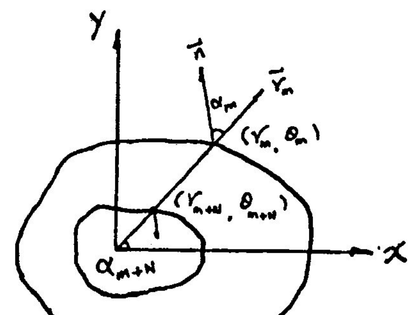

Fig 1 (b)

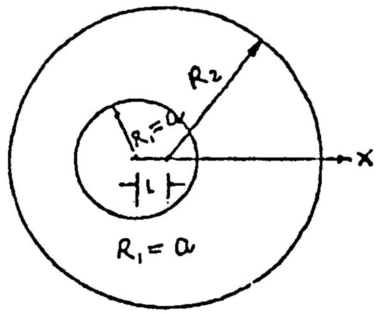

Fig 2

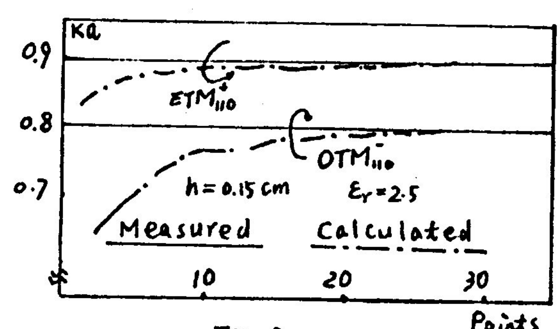

Fig 3

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(3) Lo, Y. T., D. Solomon and W. F. Richards "Theory and Experiment on Microstrip Antennas" IEEE Trans on Antennas and Propagation, AP-27, 1979, $P_{137\text{-}145}$.

HIGHLIGHTS

OF THE

10TH ANNUAL REVIEW OF PROGRESS

IN APPLIED COMPUTATIONAL ELECTROMAGNETICS

21-26 MARCH 1994

- **Continental Breakfast** 0700-0800, Tuesday 22 March, DeAnza Foyer
  0730-0830 Wednesday 23 March, DeAnza Ballroom
  0730-0830 Thursday 24 March, DeAnza Ballroom
  0730-0830 Friday 25 March, DeAnza Ballroom
- **Vendor Exhibit/Reception** - 1700-2000 Tuesday 22 March, DeAnza Ballroom
- **Complimentary wine/appetizer reception,** 1600 Tuesday 22 March, DeAnza Ballrom.
- **Exhibits** 0800-1700 Wednesday 23 March, starting with a Complimentary Continental Breakfast, DeAnza Ballroom.
- **Exhibits** 0800-1330 Thursday 24 March, starting with a Complimentary Continental Breakfast.
- **Interactive Technical Session** - 1700-2000 Tuesday 22 March, DeAnza Ballroom
- **Monterey Bay Aquarium Private Party** - Wednesday 23 March.
- **Wine Tasting Seminar** - Thursday 24 March.
- **10th Anniversary Banquet** - Thursday 24 March.
- **11 short courses** are offered this year, Monday March 21 and Saturday March 26

Full-day Courses:

1. "Wavelet Electrodynamics"
2. "Time-Frequency Analysis"
3. "Finite Element Methods for Electromagnetics"
4. "GEMACS from A-Z"
5. "Wire Antenna Modeling Using NEC"

Half-day Courses:

6. "FDTD for Antennas and Scattering"
7. "Volume-Integral Equations in Eddy-Current Nondestructive Evaluation"
8. "Using Model-Based Parameter Estimation to Increase Efficiency and Effectiveness of Computational Electromagnetics"
9. "General Application of Physical Optics to Curved Surface Scattering Using QSP"
10. "Electromagnetic Characterization of Electronic Packages"
11. "Measurement Validation for Computational Electromagnetics"

(full details are contained elsewhere in this Newsletter)

The Tenth Annual Review of Progress in Applied Computational Electromagnetics

DOUBLETREE HOTEL AND CONVENTION CENTER
MONTEREY, CALIFORNIA
21 - 26 MARCH 1994

SUNDAY MARCH 20

1500 - 1700	BOARD OF DIRECTORS MEETING (Members are invited to observe)	BONSAI I
1800	PUBLICATIONS COMMITTEE DINNER	TBD

MONDAY MARCH 21

0830 - 1630	"WAVELET ELECTRODYNAMICS" Short Course by Gerald Kaiser, Dept. of Mathematical Sciences, UMass-Lowell	TBD
0830 - 1630	"TIME-FREQUENCY ANALYSIS" Short Course by Leon Cohen, Hunter College and Graduate Center of CUNY	TBD
0830 - 1630	"GEMACS FROM A-Z" Short Course by Buddy Coffey, Advanced EM	TBD
0830 - 1130	"FDTD FOR ANTENNAS AND SCATTERING" Short Course by Ray Luebbers, Penn State University	TBD
0830 - 1130	"USING MODEL-BASED PARAMETER ESTIMATION TO INCREASE EFFICIENCY AND EFFECTIVENESS OF COMPUTATIONAL ELECTROMAGNETICS" Short Course by Ed Miller, Los Alamos National Lab	TBD
0830 - 1130	"GENERAL APPLICATION OF PHYSICAL OPTICS TO CURVED SURFACE SCATTERING (QSP)" Short Course by Glenn Crabtree, General Electric	TBD
0830 - 1130	"MEASUREMENT VALIDATION FOR COMPUTATIONAL ELECTROMAGNETICS" Short Course by Al Dominek, Ohio State University	TBD
0800 - 2030	CONFERENCE REGISTRATION	REDWOOD ROOM I
1200 - 1300	PUBLICATIONS COMMITTEE MEETING	BONSAI III
1800	BOARD OF DIRECTORS DINNER	

TUESDAY MARCH 22

0700	**CONFERENCE REGISTRATION**		DeANZA FOYER
0700 - 0800	**CONTINENTAL BREAKFAST**		DeANZA FOYER
0730	**ACES BUSINESS MEETING**	Hal Sabbagh, ACES President	STEINBECK FORUM
0820	**WELCOME**	Andy Terzuoli, ACES '94 Chairman	STEINBECK FORUM

SESSION 1: RECENT IMPACTS OF MATHEMATICS ON COMPUTATIONAL ELECTROMAGNETICS
(parallel with Session 2)
Chair: Arje Nachman — STEINBECK FORUM

0830 "Review of FD-TD Based Algorithms for Electromagnetic Wave Propagation in Dispersive Dielectric Material"
by J. Blaschak

0850 "Modeling Propagation and Scattering in Dispersive Dielectrics with FD-TD" by P. Petropoulos

0910 "Analysis of Finite Element Time Domain Methods in Electromagnetic Scattering" by P. Monk, A.K. Parrott and P.J. Wesson

0930 "Faster Single-Stage Multipole Method for the Wave Equation" by S. M. Wandzura, R. Coifman and V. Rokhlin

1000 BREAK

1030 "Rapid Pulse Responses for Scattering Problems" by G. A. Kriegsmann and J. Luke

1050 "Numerical Solution of the High Frequency Asymptotic Expansion for Wave Equations" by S. Osher, E. Fatemi and B. Engquist

1110 "A New Technique for Synthesis of Offset Dual Reflector Systems" by V. Oliker and L.D. Prussner

1130 "Fast and Accurate Algorithm for Computing the Matrix Elements by the Unified Full-Wave Analysis for (M)MIC Applications" by S. Wu

1200 LUNCH

SESSION 2: TRANSMISSION LINE METHOD (TLM) - (parallel with Session 1)
Chair: Wolfgang Hoefer — FERRANTE ROOM

0830 "Plane-Wave Illumination for the TLM Method Using a Partial Huygen's Surface" by J. Dawson, D.D. Ward, S.J. Porter and S. Lawton

0850 "Modeling a Resonant Length Center Driven Dipole Using the Symmetric Condensed Node (SCN) Transmission Line Matrix (TLM) Method" by M. Hendrick, L.S. Riggs and K. Sherbondy

0910 "Computation of S-Parameters of Microstrip Meander Lines on GaAs Substrate Using TLM Method" by C. Eswarappa and W.J.R. Hoefer

0930 "New Rectangular Nodes in 2D-TLM Network" by Q. Zhang and W.J.R. Hoefer

1000 BREAK

1030 "TLM Analysis of a Choked Circular Waveguide Antenna" by K. W. Stricklin, L.S. Riggs and M. Oberhart

1050 "Digital Computer Studies of Back Flashover Phenomena In EHV Transmission Lines" by B.Vahidi, S.H. Hosseinian and M. Abedi

1130 LUNCH

SESSION 3: FINITE ELEMENT METHOD (I) - (parallel with Session 4)
Chair: Jin-Fa Lee — Co-Chair: John Volakis — STEINBECK FORUM

1300 "Analysis of Dielectric-Loaded Waveguides Using Covariant Projection Vector" by B.R. Crain and A.F. Peterson

1320 "A Finite Element Formulation for Multipole Modes in Axisymmetric Structures" by E.M. Nelson

1340 "Azimuthally-Dependent Finite Element Solution to the Cylindrical Resonator" by R.A. Osegueda, J.H. Pierluissi, L.M. Gil, A. Revilla, G.J. Villalva, G.J. Dick, D.G. Santiago and R.T. Wang

1400 "On the "Metron" in the Method of Measured Equation of Invariance" by F.W. Hong, K.M. Kenneth, and Y.W. Liu

1430 BREAK

1500 "Three-Dimensional Finite Element Time Domain Approach with Automatic Mesh Generation for Microwave Cavities" by S. Mohan and J. Lee

1520 "Time Stepping for Transient Analysis of Magnetodynamic Problems" by F. Delince, A. Nicolet, F. Henrotte, A. Genon and W. Legros

1540 "Complex Periodic Boundary Conditions for AC Finite Element Models" by A. Frenkel, J.R. Brauer, and M.A. Gockel

1600 "Finite Element Computer Codes for the Analysis of Planar and Cylindrically Conformal Printed Antennas" by J. Gong, J.L. Volakis and L.C. Kempel

SESSION 4: MULTIPOLE - (parallel with Session 3)
Chair: Dan Reuster FERRANTE ROOM

1300 "Curved Line Multipoles for the MMP-Code" by M. Gnos and P. Leuchtmann

1320 "Comparison of the Multipole Technique with the Method of Moments" by D.D. Reuster and P.A. Ryan

1340 "A Comparison Between the Discrete Dipole Approximation and Multipole Expansion Method for Computing the Scattering from Arbitrary Shaped Dielectric Objects" by P.A. Ryan, D.D. Reuster and D.P. Forria

1400 "Efficient MMP Computation of Periodic Structures" by C. Hafner and L.H. Bomholt

1430 BREAK

SESSION 5: BOUNDARY CONDITIONS - (parallel with Session 6 and 7)
Chair: Carey Rappaport STEINBECK FORUM

1500 "Comparison and Generation of Higher Order FDTD Absorbing Boundaries" by D. Steich and R. Luebbers

1520 "Adaptive Absorbing Boundary Conditions in Finite Difference Time Domain Applications for EMI Simulations" by B.R. Archambeault and O.M. Ramahi

1540 "A Dispersive Outer Radiation Boundary Condition for FDTD Calculations" by B.J. Zook

1550 "FDTD Analysis of a Curved Saw-Tooth Anechoic Chamber Absorbing Boundary Condition" by C.M. Rappaport and T. Gurel

SESSION 6: OPTIMIZATION - (parallel with Session 5 and 7)
Chair: Richard Gordon FERRANTE ROOM

1500 "Optimized Backscattering Sidelobes From an Array of Strips Using a Genetic Algorithm" by R. Haupt and A. Azar

1520 "Numerical Electromagnetics Code Optimization Design Software" by J. Breakall, T. Erdley and J. Young

1540 "On the Computation of an Optimized Interference Adaptive Radar Signal" by H. Kuschel

1600 "Optimization Techniques Applied to Electromagnetics" by F.M. Landstorfer

SESSION 7: EDUCATION - (THIS SESSION IS BEING RESCHEDULED FOR FRIDAY)
Chair: Magdy Iskander TBD

1500 "Building Mapping Skills in Electromagnetics with the CAEME Software" by R. Cole, D. Banks and S. Tooker

1520 "EMAG 2.0 - Enhanced 2D Electrostatic and Magnetostatic Solver in MATLAB" by D.P. Wells and J. Lebaric

1540 "Using Numerical Electromagnetic Code (NEC) to Improve Student Understanding of Monopole Antennas and to Design a Two Element Monople Array" by M. McKaughan and W.M. Randall

1600 "Finite Difference Analysis with MATLAB and VMAP in Undergraduate Instruction" by W.P. Wheless and C.S. Wheless

1700 - 2000 **INTERACTIVE TECHNICAL SESSION** DeANZA BALLROOM

"Developing Optimal and Automatic Frequency Sampling in Moment-Method Solutions" by G.J. Burke and E.K. Miller (Paper to be published in the Moment Method Section of the proceedings)

"Electric Field Strength Predictions in the Near Field of Some Common HF Antennas Using NEC-3" by N. DeMinco (Paper to be published in the Antenna Section of the proceedings)

"Symbolic Programming With Series Expansions: Applications to Optical Waveguides" by R.L. Gallawa, A. Kumar and A. Weisshaar (Paper to be published in the High Frequency Section of the proceedings)

"Multipoles as Metrons for the MEI-Method: A Testing Toolkit" by P. Leuchtmann and N. Piller (Paper to be published in the Multipole Section of the proceedings)

"A 3-Dimensional, Time-Domain Algorithm for EM Fields" by D. Mitrovich (Paper to be published in the EMI/EMP/EMC Section of the proceedings)

"Superimposed Magnetic Field in Forced Convection Laminar Boundary Layer" by A.M. Morega and M. Morega (Paper to be published in the Bounday Conditions Section of the proceedings)

"Computational Studies of Factors Affecting Laser Doppler Velocimeter Measurements" by J. Whalen (Paper to be published in the TLM Section of the proceedings)

"EAM:BSC An Electromagnetic Scattering Analysis Tool for Windows" by A.P. Tsitsopoulos and M.J. Packer (Paper to be published in the High Frequency Section of the proceedings)

"Analysis of a Cavity-Backed Slot Antenna Mounted on an Infinite Ground Plane Using the 2-D TLM Method" by J.B. Erwin and S.M. Wentworth (Paper to be published in the TLM Section of the proceedings)

1700 - 2000 **VENDOR EXHIBITS/RECEPTION** DeANZA BALLROOM

WEDNESDAY MARCH 23

0730 - 0830 **CONTINENTAL BREAKFAST** DeANZA BALLROOM

0730 - 1730 **EXHIBITS OPEN** DeANZA BALLROOM

SESSION 8: **FINITE ELEMENT METHODS (II) - (parallel with Session 9)**
Chair: Jin-Fa Lee Co-Chair: John Volakis STEINBECK FORUM

0830 "An Adapting Grid Algorithm for Solving Maxwell's Equations" by D.W. Harmony

0850 "Three-Dimensional Finite Element Analysis on a Parallel Computer" by R.K.Gordon

0910 "The Performance of a Partitioning Finite Element Method on the Gamma and Delta Parallel Machines" by Y.S. Choi-Grogan, R. Lee, K. Eswart and P. Sadayappan

0930 "Inlet/Engine Scattering" by J. Gong, J.L. Volakis and L.C. Kempel

1000 BREAK

SESSION 9: **ANTENNAS - (parallel with Session 8)**
Chair: Gary Thiele STEINBECK FORUM

0830 "NEC Modeling and Testing of an Ultra-Wideband Antenna for High-Power Operation" by C.D. Hechtman, B.S. Perlman and E.H. Lenzing

0850 "A Practical Application of NEC Impedance Calculations" by W.P. Wheless and D. Kajfez

0910 "NEC4 Analysis of a Navy VLF Antenna" by C. Deneris, J.H. Schukantz, P.M. Hansen and J.C. Logan

0930 "Nearly Seven Years of Success Using MININEC for Analysis and Design of Standard Broadcast Medium Wave AM Directional Antennas" by J.B. Hatfield and B.F. Dawson

1000 BREAK

1030 "Analysis of Airborne Antennas with the NEC, ESP, NEC-BSC, and NEC-Air Codes" by B.V. Andersson, U. Lidvall, A. Johansson, and T. Lundin

1050 "H-60 Helicopter Antenna Placement Evaluation: Experimental and NEC-BSC Results" by J.M. Harris and M.L. Wheeler

1110 "An Antenna Simulation Superstructure for the OSU ESP4 Program" by K.L. Van Voorhies

1130 "A Study of Two-Dimensional Tapered Periodic Edge Treatments for the Reduction of Diffraction" by R.A. Burleson, A.J. Terzuoli, E. English and L. Henderson

SESSION 10: FINITE DIFFERENCE TIME DOMAIN I - (parallel with Session 11)
Chair: Jiayuan Fang Co-Chair: Bruce Archambeault FERRANTE ROOM

1300 "Application of an Upwind Leap-Frog Method for Electromagnetics" by B. Nguyen and P. Roe

1320 "Linear Super Position of Phased Array Antenna Near Field Patterns Using the FDTD Method" by C.E. Reuter E.T. Thiele, A. Taflove, M.J. Piket-May and A.J. Fenn

1340 "Radiation and Scattering from Curved Surface Scatterers with Stair-Cased FDTD" by H.S. Langdon and R.J. Luebbers

1400 "Input Impedance, Radiation Pattern, and Radar Cross-Section of Spiral Antennas using FDTD" by C.W. Penney and R.J. Luebbers

1430 BREAK

1500 "FDTD Simulation of an Open-Ended Metallized Ceramic Probe for Broadband and High-Temperature Dielectric Properties Measurements" by M.F. Iskander and S. Bringhurst

1520 "FDTD Simulation of RF Drying and Induction Heating Processes" by M.F. Iskander, P. Gartside and M. White

1540 "A Generalized Finite-Volume Algorithm for Solving the Maxwell Equations on Arbitrary Grids" by Y. Liu

1600 "Massively Parallel Finite-Difference Time-Domain Methods for Electromagnetic Scattering Problems" by R.S. David and L.T. Wille

SESSION 11: ARRAYS - (parallel with Session 10)
Chair: Vaughn Cable FERRANTE ROOM

1300 "Computation of Phased Array Active Impedances and Comparision with Measurements" by P. Elliot, P. Koert, J. Cha, R. Groff and T. Collins

1320 "The Effects of Exceeding Mechanical Design Constraints on the Performance of Log-Periodic Dipole Arrays" by D.C. Baker, J.T. de Beer and N. Stander

1340 "Modeling of a Cylindrical Waveguide Slot Array, a Loop-Fed Slot Antenna and an Annular Slot Antenna with the BSC and ESP Codes" by W.L. Lippincott and J.A. Bohar

1400 "Multiple FSS and Array Analysis Program (MFAA)" by H. Karwacki, R. Gilbert, G. Pirrung and J. Abbasi

1430 BREAK

1450 "Frequency Perturbation for Circular Array of Coupled Cylindrical Dipole Antennas" by F.M. El-Hefnawi

1510 "On Effect of Phased Quantization Upon Peak Sidelobe Level in Phased Array Antennas" by G. Tie, G. Yanchan and L. Jianxin

1530 "A Closed Loop Algorithm for Real Phase-Only Weighted Nulling Synthesis in Phased Array Antennas" by G. Tie G. Yanchange and F. Nenghang

1550 "Full Wave Analysis of Infinite Phased Array of Arbitrary Shape Printed Line Microstrip Antennas" by E.M. Eid, A.M. Attiya, E. Eldiwany, and F. Elhefnawi

1610 "Efficient Mutual Coupling Computation for Symmetrical Arrays" by S. Christopher, S.D. Sree and V.V.S. Prakash

THURSDAY MARCH 24

0730 - 0830 **CONTINENTAL BREAKFAST** DeANZA BALLROOM

0730 - 1500 **EXHIBITS OPEN** DeANZA BALLROOM

SESSION 12: FINITE DIFFERENCE TIME DOMAIN II - (parallel with Session 13)
Chair: Raymond Luebbers Co-Chair: John Beggs STEINBECK FORUM

0830 "FD-TD Algorithm for the Nonlinear Maxwell's Equations with Applications to Femtosecond Soliton Propagation" by P.M. Goorjian, R.M. Joseph and A. Taflove

0850 "Finite Difference - Time Domain Tests of Random Media Propagation Theory" by L.J. Nickisch and P.M. Franke

0910 "High Order FDTD Algorithm to Reduce Numerical Dispersion and Staircasing" by T. Deveze

0930 "Performance Prediction for Three-Dimensional Anechoic Chambers using FDTD" by V. Cable, R. Luebbers, C. Penney, S. Langdon and J. Schuster

1000 BREAK

1030 "Application of the Finite-Difference Time-Domain Method in the Simulation of Delta-I Noise in Electronic Packagir by J. Fang, Z. Wu, Y. Chen and Y. Liu

1050 "A Closed Form Solution of the Input Impedance of Two-Dimensional FDTD Grids" by Z. Wu, J. Fang and Y. Liu

1110 "Deriving a Synthetic Conductivity To Enable Accurate Prediction of Losses In Good Conductors Using FDTD" by K. Chamberlin and L. Gordon

1130 "Creating FDTD Models of Aircraft with GWTO-FDTD" by C.W. Trueman, S.J. Kubina and B. Messier

1200 LUNCH

SESSION 13: GEMACS - (parallel with Session 12)
Chair: Ken Siarkiewicz Co-Chair: Buddy Coffey FERRANTE ROOM

0830 "Recent Enhancements to GEMACS 5.3" by E.L. Coffey

0850 "Estimation of GEMACS Computer Resource Requirements" by R. Fisher, E.L. Coffey and J.D. Letterio

0910 "Modeling Cavity Problems with GEMACS 5.3" by E.L. Coffey

0930 "F-16 Structure Modeling Using GEMACS 5.3" by B. Fisher, E.L. Coffey and T.J. Timmerman

1000 BREAK

1030 "The Microwave and Millimeter-Wave Advanced Computational Environment Program - A Computer Based Desig Environment for High Frequency Electronics" by R.H. Jackson

1050 "Further Considerations Regarding the Electromagnetic Modeling and Simulation Environment for Systems (EMSES)" by K.R. Siarkiewicz

SESSION 14: MOMENT METHODS - (parallel with Sessions 15 and 16)
Chair: Paul Goggins STEINBECK FORUM

1300 "Results Using IML with a New CFIE" by F.X. Canning

1320 "A New Method for Evaluating the Generalized Exponential Integrals Associated with Thin Straight-Wire Antennas" by P.L. Werner and D.H. Werner

1340 "Techniques for Evaluating the Uniform Current Vector Potential at the Isolated Singularity of the Cylindrical Wire Kernel" by D.H. Werner, J.A. Huffman, and P.L. Werner

1400 "A Parallel Implementation of a Thin Wire EFIE Code" by A. Tinniswood, A.M. Tyrrell, and S.R. Cloude

1430 BREAK

1500 "More Improvements in the Method of Moments Solution of Antennas and Arrays using Pocklington's and Hallen's Integral Equations" by F.M. El-Hefnawi

1520 "Upgrading Common Wire-Grid MoM Computer Codes" by A. Blank and S. Averbuch

1540 "Utilizing Structure Symmetry in Reducing the CPU Time for Computing the Moment Method [Z] Matrix Elements" by Z.O. Al-Hekail

1600 "Numerical-Analytical Algorithms Based on Dual Series Equation Techniques" by Y. Tuchkin, V. Veremey, Y. Svischov and V. Dudka

1620 "Moment Method Analysis of Non-Orthogonal Waveguide to Waveguide Coupling Through Slot" by S. Christropher, B.V.A. Rao, A.K. Singh and K.U. Limaye

1640 "Reflections on Some of the Folklore of the Moment Method" by R.C. Booton

SESSION 15: VALIDATION - (parallel with Sessions 14 and 16)
Chair: Mike Hazlett FERRANTE ROOM

1300 "A Database of Measured Data for RCS Code Validation" by S. R. Mishra, C.L. Larose, M. Flynn and C.W. Trueman

1320 "Validation of a Diffraction Program" by P.R. Foster

1340 "Validation of Target Measurements in Multipath Environment" by A.J. Stoyanov, K.M. Wilson and Y.J. Stoyanov

1400 "On the Benchmark Solution of a Typical Engineering Loss Problem" by Z. Cheng, Q. Hu, S. Gao, Z. Liu, C. Ye, and M. Wu

1430 BREAK

1500 "Evaluation of Radar Signature Predictions Using XPATCH" by R.O. Jernejcic, A.J. Terzuoli, and R. Schindel,

1520 "Transformable Scale Aircraft Model for the Validation of Computional Electromagnetic Models and Algorithms" by D.R. Pflug and D.E. Warren

1540 "Infrared Verification of Electromagnetic Code Predictions" by S. Blocher, J. Norgard, J. Sadler, R.R. Sega and W. Prather

SESSION 16: EMI/EMP/EMC - (parallel with Sessions 14 and 15)
Chair: Frank Walker Co-Chair: Reinaldo Perez TBD

1300 "Validation of a Numerical Finite Integration Code to Solve Transient Electromagnetic, Acoustic and Elastic Wave Scattering in 2D" by K.J. Langenberg and R. Marklein

1320 "Comparison Between LEMP & NEMP Induced Overvoltages in 33 kV Overhead Distribution Lines" by R. Moini, B. Kordi, B. Vahidi and M. Abedi

1340 "Monopole Near-Field Coupling Analysis -- Comparison of Experimental and NEC Results" by M.L. Wheeler and R.J. Levin

1400 "Development of an High Power Microwave Susceptibility Simulation Capability in the Satellite Assessment Center" by M.L. Zywien

1430 BREAK

1500 "Test Fidelity in Anechoic Chambers" by C. Courtney and D. Voss

1520 "An Investigation Into Alternate Construction Techniques to Reduce Shielded Room Resonance Effects" by B.R. Archambeault and K. Chamberlin

1540 "Electromagnetic Interference (EMI) Susceptibility Analysis of an Airborne Phased Array Antenna System" by F.E. Walker and S.L. Badger

FRIDAY MARCH 25

0730 - 0830 **CONTINENTAL BREAKFAST** DeANZA BALLROOM

SESSION 17: HYBRID - (parallel with Sessions 18 and 19)
Chair: Bob Burkholder STEINBECK FORUM

0830 "A Hybrid Approach for Computing the EM Scattering From Complex Terminations Inside Large Open Cavities" by R.J. Burkholder, P.R. Rousseau and P.H. Pathak

0850 "Electromagnetic Modeling of Jet Engine Cavities with the CAVERN Code" by J.L. Karty and S.D. Alspach

0910 "An Iterative Method for Computing the Scattered Electric Fields at the Apertures of Large Perfectly Conducting Cavities" by D. Reuster and G.A. Thiele

0930 "Hybrid Formulation for Arbitrary 3-D Bodies" by L.N. Medgyesi-Mitschang and J.M. Putnam

1000 BREAK

1030 "Hybrid (MM-UTD) Analysis of EM Scattering by Large Convex Objects with Appendages" by M. Hsu, P.H. Pathak and H. Tseng

1050 "Reducing the Operation Count in Computational Electromagnetics Using Hybrid Models" by E.K. Miller

1110 "A Hybird Technique for NEC (Numerical Electromagnetics Code)" by S.R. Rousselle and W.F. Perger

1130 "An Approach for Solving System-Level Electromagnetic Coupling Problems" by E.G. Farr and R.J. Antinone

1150 "On the Combination of MMP with MOM" by Ch. Hafner, J. Mosig, Y. Brand and J. Zheng

1215 LUNCH

SESSION 18: PROPAGATION AND IMAGING - (parallel with Session 17 and 19)
Chair: Dennis Andersh FERRANTE ROOM

0830 "A Physical Optics Model for Scattering of HF Radiation by Irregular Terrain" by G.J. Burke

0850 "Enhanced Facet Model for Terrain: XPATCH SAR Image Prediction for Ground Vehicles in Benign Clutter Environments" by P. Ryan, R.F. Schindel, K. Knurr, D.J. Andersh and E.K. Zelnio

0910 "On the Use of Ray Tracing for Complex Targets" by T. Moore, E. Burt and F. Hunsberger

0930 "Technique to Calculate the Cross-Section of the Optoelectronic Radar with Impulse Source of Electromagnetic Radiation" by V. Ovod, K. Bauckhage, S.T. Koval, A.V. Perekrest and A.E. Ivanisov

1000 BREAK

1030 "Technique to Increase the Computional Accuracy of the Scattered Electromagnetic Field in the Simulation of the Phased-Doppler Particle Size Analyzer" by V. Ovod, T. Wriedt, K. Bauckhage and V.M. Zemljansky

1050 "Time-Domain Electromagnetic Responses and Model Uncertainties" by R. Inguva, C.R. Smith, P.M.Goggons and D.J. Andersh

1110 "EAM:BSC An Electromagnetic Scattering Analysis Tool for Windows" by A.P. Tsitsopoulos and M.J. Packer

SESSION 19: **PRE AND POST PROCESSING - (parallel with Session 17 and 18)**
Chair: Todd Hubing Co-Chair: Linda Russell TBD

0830 "NEC - MoM Workstation: NEEDS 3.0" by L. Russell, D. Tam, J. Rockway, D. Wentworth and J. Eadie

0850 "AutoNEC....A Marriage of Convenience" by A. Nott

0910 "A Ray Tracer for the NEC Basic Scattering Code" by D.P. Davis, R. Paknys and S.J. Kubina

0930 "SOURCE to FIELD, What Happens in Between? A New Method for Graphical Display of GTD Scattering" by J.A. Evans and E.L. Coffey

1000 BREAK

1030 "Interactive Numerical Electromagnetics Modeling & Analysis Using Computer-Aided Engineering Software" by S.R. Rousselle, S.S. Marlor and W.F. Perger

1050 "A Proposed EM Code Interface Standard" by E.L. Coffey

1110 "A Geometry Description Language for 3D Electromagnetic Analysis Codes" by T. Hubing, C.H. Lim and J. Drewniak

SESSION 20: **HIGH FREQUENCY - (parallel with Session 21)**
Chair: Janice Karty STEINBECK FORUI

1300 "XPATCH: A High Frequency Electromagnetic Scattering Prediction Code Using Shooting and Bouncing Rays by D.J. Andersh, S.W. Lee, F.L. Beckner, M. Gilkey, R. Schindel, M. Hazlett and C.L. Yu

1320 "A Simple Physical Optics Algorithm Perfect For Parallel Computing Architecture" by W.A. Imbriale and T. Cwil

1340 "A UGO/EUTD with Application to Fourth Order Polynomial Strips" by R.J. Marhefka, and E.D. Constantinides

1400 "Radiation Due to a Convex Curvature Discontinuity of a Dielectric Coated Perfect Conductor" by D.H. Monteitl and R.G. Olsen

1420 BREAK

1440 "High Frequency Scattering by a Conducting Circular Cylinder Coated with a Lossy Dielectric of Non Uniform Thickness-TE Case" by S.G. Tanyer and R.G. Olsen

1500 "Computer Simulation of Diffraction and Focusing Processes in Quasioptics" by A.V. Popov, A.V. Vinogradov and Y.V. Kopylov

1520 "Efficient Computational Technique for Backscattering from a Discontinuity Along a Piecewise Continous Curv on a Planar Surface" by J. Kim and O.B. Kesler

SESSION 21: **MICROWAVE - (parallel with Session 20)**
Chair: Dr. Richard Booton FERRANTE ROOM

1300 "Optimization of Microwave Structures Using a Parallel TLM Module" by P.P.M. Poman and W.J.R. Hoefer

1320 "Statistical Response of Enclosed Systems to HPM Environments" by R. Holland and R. St. John

1340 "A Time-Domain Technique for the Analysis of Nonlinear Devices and Circuits" by N. Marin, K. Fobelets, J. Genoe and G. Borghs

1400 "Full-Wave Analysis of Coplanar Waveguide Discontinuities by a Partial Wave Synthesis" by R. Schmidt and P. Russer

1430 BREAK

SESSION 22: **LOW FREQUENCY - (parallel with Session 23)**
Chair: John Brauer Co-Chair: Abd Arkadan STEINBECK FORUM

1550 "A Comparison of Two Low-Frequency Formulations for the Electric Field Integral Equation" by W. Wu, A.W. Glisson and D. Kajfez

1610 "Computations of Induced Electric Fields in Biological Cells Exposed to Magnetic Fields: Impedance Method with Improved Spatial Resolution" by W. Xi and M. Stuchly

1630 "Induced Currents in Biological Bodies in Low Frequency Magnetic Fields: Impedance Method with Improved Spatial Resolution" by W. Xi and M. Stuchly

1650 "The Two-Dimensional Finite Integral Technique Combined with the Measured Equation of Invariance Applied to Open Region Scattering Problems" by G.K. Gothard and S.M. Rao

1710 "A T-Matrix Solution for the Scattering from Dielectric Cylinders" by J.P. Skinner

SESSION 23: **MATERIALS - (parallel with Session 22)**
Chair: TBD FERRANTE ROOM

1500 "Modeling Transverse Electromagnetic Waves in Conducting Anisotropic Media by a Spectral Time-Domain Technique" by J.M. Carcione and F. Cavallini

1520 "Simulation of Scattering Phenomena for Coated Bodies by Exact Controlability Methods" by R. Glowinski, M.O. Bristeau, V. Kwock, and J. Periaux

1540 "CCM: Circular Cylinders Modeler for Electromagnetic Scattering from Composite Two Dimensional Objects" by A.Z. Eisherbeni and C.D. Taylor

1600 "Determination of Velocity and Attenuation of Surface Acoustic Waves in Layered Piezoelectric Media" by R. Weigel, U. Rosler, H. Meier and P. Russer

1620 "An Application of Mini-Max Criterion For LSM-LSE Modes Determination In Ferrite-Dielectric Loaded Waveguides" by B.Y. Kapilevich and T.A. Rahman

SATURDAY MARCH 26

0830 - 1630 "FINITE ELEMENT METHODS FOR ELECTROMAGNETICS" Short Course by Jin-Fa Lee, Worcester Polytechnic Institute; Robert Lee, Ohio State University; Tom Cwik, Jet Propulsion Laboratory; and John Brauer, MacNeal-Schwendler Corporation. TBD

0830 - 1630 "WIRE ANTENNA MODELING USING NEC" Short Course by Richard Adler, Naval Postgraduate School; James Breakall, Penn State University; and Gerald Burke, Lawrence Livermore National Lab TBD

0830 - 1130 "VOLUME-INTEGRAL EQUATIONS IN EDDY-CURRENT NONDESTRUCTIVE EVALUATION" Short Course by Hal Sabbagh, Sabbagh Associates TBD

0830 - 1130 "ELECTROMAGNETIC CHARACTERIZATION OF ELECTRONIC PACKAGES" Short Course by Andreas Cangellaris, University of Arizona TBD

SHORT COURSES AT THE 10TH ANNUAL REVIEW OF PROGRESS IN APPLIED COMPUTATIONAL ELECTROMAGNETICS

The Applied Computational Electromagnetics Society (ACES) is pleased to announce eleven short courses to be offered with its annual meeting of March 21-26, 1994. Times of the individual short courses are noted. Registration begins at 7:30 AM on Monday, 22 March 1994. ACES has the right to cancel a course at any time with full refund. For further information contact Jodi Nix, Conference Facilitator, Phone: (513) 476-3550, Fax: (513) 476-3557.

COURSE INFORMATION

FULL-DAY COURSES (Monday 21 March, 1994, 0830-1630)

"Wavelet Electrodynamics" by Gerald Kaiser, Dept. of Mathematical Sciences, UMass-Lowell

The course will consist of four 90-minute lectures. Lecture 1 will be a general introduction to wavelet analysis, and lectures 2-4 will cover applications to electromagnetic waves. Notes will be provided.

"Time-Frequency Analysis" by Leon Cohen, Hunter College and Graduate Center of CUNY.

This course will present the traditional and new methods to study such non-stationary signals. These methods include the short time Fourier transform, the Wigner distribution, the Choi-Williams method, the ZAM distribution, and the general class of time frequency representation.

"GEMACS From A-Z" by Buddy Coffey, Advanced EM.

The General Electromagnetic Model for the Analysis of Complex Systems (GEMACS) includes capabilities for method of moments, uniform theory of diffraction, finite differences, and numerically rigorous hybrids of any and all techniques. The code is supported by a rich command and geometry language consisting of over 100 commands. Students will walk through the GEMACS command set and geometry elements as electromagnetic models are constructed for practical electromagnetic problems, such as antenna radiation, structure coupling, scattering, etc. Emphasis in on "how to" and participants are encouraged to bring portable computers to the class. A copy of the unlimited distribution version of the GEMACS software will be given to each participant.

MORNING HALF -DAY (Monday 21 March 1994, 0830-1130)

"FDTD for Antennas and Scattering" by Ray Luebbers, Penn State University.

This course will cover the fundamentals of the Finite Difference Time Domain (FDTD) method. Applications include various antenna geometries (wire, patch, and aperture antennas) and scattering problems. The course is based on notes and the book, "The Finite Difference Time Domain Method for Electromagnetics", by Kunz and Luebbers. Attendees will receive a general purpose FDTD code.

"Using Model-Based Parameter Estimation to Increase Efficiency and Effectiveness of Computational Electromagnetics" by Ed Miller.

Hidden beneath the mathematical detail associated with most electromagnetic analysis is the possibility of representing physical observables in simpler ways using reduced-order models. Knowledge of such mosels can be helpful in ways ranging from reducing the computer cost of achieving desired solutions to developing more compact representations of observables. This lecture will survey applications of MBPE (Model-Based Parameter Estimation) in electromagnetic modeling and demonstrate some of our benefits that result.

SHORT COURSES AT THE 10TH ANNUAL REVIEW OF PROGRESS IN APPLIED COMPUTATIONAL ELECTROMAGNETICS (cont)

MORNING HALF -DAY (Monday 21 March 1994, 0830-1130)

"General Application of Physical Optics to Curved Surface Scattering Using QSP" by Glenn Crabtree, General Electric.

Topics include an overview of physical optics, parametric patch geometry representations, numerical integration techniques, physical theory of diffraction, monostatic/bistatic scattering, ray tracing, and materials effects especially as they apply to the Quadratic Surface Patch (QSP) code. The focus of this course will be on the practical implementation of physical optics techniques for general (electrically large) scatterers.

"Measurement Validation for Computational Electromagnetics" by Al Dominek, Ohio State Univ.

This course will explore measurement methodology, errors, and accuracy as it applies to computational electromagnetics. Time-range gating and comparison of calculated versus measured data will be discussed.

FULL-DAY COURSES (Saturday 26 March, 1994, 0830-1630)

"Finite Element Methods for Electromagnetics" by Jin-Fa Lee, Worcester Polytechnic Institute; Rob Lee, Ohio State University; Tom Cwik, Jet Propulsion laboratory; and John Brauer, MacNeal-Swendler Corp.

This course will look at the development of nodal-based and edge-based finite element methods, including higher order tangential vector finite elements and causes of spurious modes. Local and global boundary truncation techniques will be examined including the Measured Equation of Invariance (MEI). Parallel algorithms for the solution of large sparse matrices on massively parallel multiprocessors will be discussed. Some applications include antennas, electronic packaging, nonlinear magnetic devices, and microwave circuits.

"Wire Antenna Modeling Using NEC" by Dick Adler, Naval Postgraduate School; Jim Breakall, Penn State University; and Gerry Burke, Lawrence Livermore National Lab.

This popular course will cover twenty years of successes, failures, and lessons learned using NEC code for wire antenna modeling. Modeling guidelines and some useful utility programs will be discussed.

MORNING HALF -DAY (Saturday 26 March 1994, 0830-1130)

"Volume-Integral Equations in Eddy-Current Nondestructive Evaluation" by Hal Sabbagh, Sabbagh Associates.

This course will illustrate how computational electromagnetics can be used for modeling both forward and inverse problems. The Sabbagh Associates code, VIC3D (a volume integral equation code which uses conjugate gradient and FFT's to solve problems, with 25,000 to 50,000 unknowns on PC's) will be used. Applicable to realistic, practical, direct, and inverse problems.

"Electromagnetic Characterization of Electronic Packages" by Andreas Cangellaris, University of Arizona.

The course objective is to present the various issues associated with the electromagnetic modeling and simulation of interconnect and package structures used in high-speed, high-density electronic systems. State-of-the-art applications of finite element finite difference, and integral equation techniques used to extract package parasitics, and predict electromagnetic performance will be discussed.

SHORT COURSE REGISTRATION

The price for a full day course is $140 before 1 March 1994, and $160 after 1 March 1994. The price for a half day course is $90 before 1 March 1994, and $110 after 1 March 1994. Short Course attendees will receive a copy of the course notes. If you are not able to attend any short courses, notes will be made available for the full price of the respective short course registration fee (these must be ordered prior to 1 March 1994. See order form below). If you are attending a short course which conflicts with the schedule of another course you would like to take, you may purchase the notes for half of the registration fee. *ACES has the right to cancel a course at any time with a full refund.* Return the form and payment to: Jodi Nix, Veda Inc., 5200 Springfield Pike, Suite 200, Dayton, OH 45431 as soon as possible. If you have any questions, call Jodi Nix at (513) 476-3550.

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Short Course fees do not include attendance at the symposium. Short courses can be taken without attendance at symposium, if desired.

Please make checks payable to ACES. Non-USA participants should remit via: (1) International Money Order drawn in U.S. dollars, payable in U.S.; (2) Traveler's Checks (in U.S. dollars); (3) Bank checks, [Only if: (a) drawn on a U.S. bank, (b) have U.S. bank address; (c) contain a series of nine (9) digit routing numbers put on check when originated].

Class Only	Notes Only	
☐	☐	Wavelet Electrodynamics; March 21, full-day
☐	☐	Time-Frequency Analysis; March 21, full-day
☐	☐	FDTD for Antennas and Scattering; March 21, half-day
☐	☐	Volume-Integral Equations in Eddy-Current Nondestructive Evaluation; March 21, half-day
☐	☐	Using Model-Based Parameter Estimation to Increase Efficiency and Effectiveness of Computational Electromagnetics; March 21, half-day
☐	☐	Finite Element Methods for Electromagnetics; March 26, full-day
☐	☐	GEMACS from A-Z; March 21, full-day
☐	☐	Wire Antenna Modeling Using NEC; March 26, full-day
☐	☐	Measurement Validation for Computational Electromagnetics; March 21, half-day
☐	☐	General Application of Physical Optics to Curved Surface Scattering Using QSP; March 21, half-day
☐	☐	Electromagnetic Characterization of Electronic Packages; March 26, half-day

SYMPOSIUM REGISTRATION

If you would like to register for the 1994 ACES Tenth Anniversary Conference, please fill out the form below and send to Jodi Nix, Conference Facilitator, Veda Incorporated, 5200 Springfield Pike, Suite 200, Dayton, OH 45431 as soon as possible . If you have any questions, please call Jodi Nix at (513) 476-3550.

Registration fee includes: Attendance at all formal and interactive technical sessions (excluding short courses); vendor exhibits and conference proceedings.

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CONFERENCE REGISTRATION				
	Before 1/14/94	1/15/94 to 3/1/94	After 3/1/94	Total Cost
Member Price	$235	$250	$265	
Non-Member Price	$260	$275	$290	
Full-Time Student*	$150	$160	$170	
Retired/Unemployed	$150	$160	$170	

BANQUET	**Price**	**Tickets Requested**	**# of Tickets**
Grilled Sirloin w/Teriyaki Glaze	$ 27	1 or 2	
Rosemary Garlic Chicken	$ 27	1 or 2	
WINE APPRECIATION SEMINAR	**Price**	**Tickets Requested**	**# of Tickets**
Yes, I will be attending the Seminar	$ 12	1 or 2	
AQUARIUM PRIVATE PARTY	**Price**	**Tickets Requested**	**# or Tickets**
Yes, I will be attending the party	$ 10	1 or 2	

* Proof of Full-Time Student Status is Required

THE APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY

1995 CALL FOR PAPERS 1995

The 11th Annual Review of Progress in Applied Computational Electromagnetics

March 21-26, 1995

Naval Postgraduate School, Monterey, CA

Share your knowledge and expertise with your colleagues

The Annual ACES Symposium is an ideal opportunity to participate in a large gathering of EM analysis enthusiasts. The purpose of the Symposium is to bring analysts together to share information and experience about the practical application of EM analysis using computational methods. The Symposium features four areas of interest: technical publication, demonstrations, vendor booths and short courses. All aspects of electromagnetic computational analysis are represented. The Symposium will also include invited speakers and interactive forums. Contact Ray Luebbers (814) 865-2362 for details.

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1995 ACES Symposium

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THE APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY

1995 CALL FOR PAPERS 1995

The 11th Annual Review of Progress in Applied Computational Electromagnetics

Papers may address general issues in applied computational electromagnetics, or may focus on specific applications, techniques, codes, or computational issues of potential interest to the Applied Computational Electromagnetics Society membership. Areas and topics include:

- Code validation
- Code Performance analysis
- Computational studies of basic physics
- "Tricks of the Trade" in selecting and applying codes and techniques
- New Codes, algorithms, code enhancements, and code fixes
- Code input/output issues
- Computer hardware issues
- Partial list of applications:

antennas
static fields
shielding
EMP, EMI/EMC
charge transport
microwave components
fiberoptics
communications systems
particle accelerators
wave propagation
dielectric & magnetic materials
eddy currents
radar cross section
bioelectromagnetics
power transmission
inverse scattering
MMIC technology
remote sensing & geophysics
plasmas
generators & motors
non-destructive evaluation
networks

- Partial list of techniques:

frequency-domain & time-domain techniques
integral equation & differential equation techniques
finite differences & finite element techniques
diffraction theories
modal expansions
hybrid methods
physical optics
perturbation methods
moment methods

TIMETABLE

October 3rd 1994:- Submission deadline.
Submit four copies of a 300-500 word summary to the Symposium Chairman.
November 18th 1994: Authors notified of acceptance.
January 16 1995 : Submissiondeadline for camera-ready copy, not more than 8 pages including figures. For both summary and final paper, please supply the following data for the principal author - name, address, email address, FAX, and phone numbers for both work and home.

Registration fee per person for the Symposium will be approximately $235. The exact fee will be announced later.

SHORT COURSE

Short courses will be offered in conjunction with the Symposium. covering numerical techniques, computational methods, surveys of EM analysis and code usage instruction. It is anticipated that short courses will be conducted principally on Monday 20 March and Friday 24 March. Fee for a short course is expected to be approximately $90 per person for a half-day course and $140 for a full-day course, if booked before 3 March, 1995. Full details of 1995 Symposium will be available by November 1994.

EXHIBITS

Vendor booths and demonstrations will feature commercial products, computer hardware and software demonstrations and small company capabilities.

For information regarding ACES or to become a member in the Applied Computational Electromagnetics Society, contact Dr. Richard W. Adler, ECE Department, Code ECAB, Naval Postgraduate School, 833 Dyer Rd, Rm 437, Monterey, CA. 93943-5121, telephone (408) 646-1111, Fax: (408) 649-0300, E-mail:5541304@mcimail.com. You can subscribe to the Journal and become a member of ACES by completing and returning the form below.

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EUROPE, FORMER USSR TURKEY, SCANDINAVIA	( ) $63	( ) $73	( ) $110
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