APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY (ACES)

NEWSLETTER

Vol. 8 No. 3 November 1993

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ACES NEWSLETTER STAFF

Paul Elliot, Editor
ARCO Power Technologies, Inc.
1250 24th St. NW, Suite 850
Washington, DC 20037 U.S.A.
Phone: (202) 223-8808 Work
Phone: (703) 938-3626 Home
Fax: (202) 223-1377
E-mail:Pelliot-apti@access.digex.net

Reinaldo Perez, Associate Editor
Jet Propulsion Lab. Mail Sta. 301-460
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109 U.S.A.
Phone:(818) 354-9771
Fax: (818) 393-4699
E-mail:Perez@elm.jpl.nasa.gov

David B. Davidson, Associate Editor
Dept. Electrical and Electronic Engineering
University of Stellenbosch
Stellenbosch 7600, South Africa
Phone: Int+27 2231 77 4458 Work
Phone: Int+27 2231 77 6577 Home
Fax: Int+27 2231 77 4981
E-Mail:Davidson@firga.sun.ac.za

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Send copy to Paul Elliot at the above address 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.

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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.

OFFICER'S REPORTS

PRESIDENT'S REPORT

Summertime, and the email is buzzing. Judging from the email that is being ethered around between ACE's folks, things are moving pretty well, especially regarding plans for the 10th Annual Review to be held in Monterey in March '94, Jodi Nix, of VEDA, and Jeff Fath are planning an excellent program, both technical and nontechnical, and I'm certain that you will want to be there when it happens.

The ACES BOD had an excellent meeting at Ann Arbor on 29 June; honestly! All of the attendees, including Frank Walker and Perry Wheless, who joined via teleconference (and where would we be without electrons and applied computational electromagneticists?), were well prepared in their reports. As a result, we accomplished a great deal, and even left a half-hour early, which was great because the time on my parking meter was about to expire. The reports of the various committee chairmen will appear elsewhere in the newsletter. Here, I want to cite three fellows who are leaving as committee chairmen.

Shing Ted ('Pete') Li has long served ACES honorably and diligently as chairman of the Elections Committee. He believes that it is time for someone else to assume this post, while he recharges himself for a new responsibity within ACES. I am looking for volunteers for this position, but keep in mind, Pete's will be a hard act to follow. Fortunately, we have a new Nominations and Elections Handbook which will make the chairman's job easier. Thanks for a very nice job, Pete.

Lee Corrington will retire as chairman of the Awards Committee. This is an extremely important committee, because it allows us to recognize the activities of our hardworking volunteers, who are the backbone of our voluntary society. Lee has done a great job, and we thank him for his service.

David Stein has long worn two hats, one as Journal Editor, and the other as Publications Chairman. Now, he believes that it's time for two people to wear one hat, each, and fortunately we've (rather, he has) found them. Perry Wheless, who has done a thing or two in the past for ACES, will serve as Publications Chairman, and Duncan Baker, of the University of Pretoria, South Africa, will serve as Journal Editor. I had a pleasant visit with Duncan at the recent URSI meeting in Kyoto, Japan, and I like his ideas for publishing papers in the Journal.

We can all be confident in the new men who are handling our publications, while we all join in thanking Dave for his dedicated past service.

Speaking of Kyoto, Ray Luebbers was there, too. He and his wife stayed at the same hotel as my wife and I. To those of you who worry about such things, I can say that Ray and I, as vice-president and president, did not embarrass ourselves or ACES, except, perhaps, for that one night on the roof of the hotel.....

As for the weather here, it's quite rainy, today. Tomorrow, I'm supposed to represent my company in the local Corporate Challenge Bicycle Race. I hope it keeps raining. Soon the leaves will change color, and we'll re-experience fall in Southern Indiana. Then the leaves will fall, winter will set in, and we will start thinking of Monterey in March. Please don't spend too much time re-reading this column; get to work on your Symposium papers.

Hal Sabbagh

Sabbagh Associates, Inc.
4635 Morningside Drive
Bloomington, IN 47408
Phone: (812) 339-8273
FAX: (812) 339-8292
email: has@sabbagh.com

COMMITTEE REPORTS

PUBLICATIONS COMMITTEE REPORT

SUCCESSORS

My two successors have been appointed by ACES President **Hal Sabbagh** and assumed their respective positions on 23 September 1993. **Perry Wheless** (USA) is the new ACES Editor-in-Chief / Publications Chairperson, and **Duncan Baker** (South Africa) is the new ***ACES Journal*** Editor-in-Chief. Both individuals were highly recommended by several other Editors and Directors on the strength of their publications experience, their distinguished service to ACES, and their new visions for the ACES Publications. **Paul Elliot** (USA) will continue his service as Editor of the ***ACES Newsletter.*** (Inasmuch as my successors assumed office only two days prior to the ***ACES Newsletter*** press deadline, Perry Wheless and I agreed that I would submit the present committee report as my final report).

BUDGET ISSUES

As a result of budgetary constraints, the Board of Directors enacted several measures at the March 1993 meeting:

1. A new VOLUNTARY page charge of US$75/page, which will apply to ***ACES Journal*** papers beginning in 1994

2. New page limits, applicable to each issue of the ***ACES Journal*** and the ***ACES Newsletter***

3. Supplementary measures, one of which imperils our ongoing efforts to provide to our authors visibility among prestigious research and funding agencies.

Meanwhile, we remain limited to publishing two ***ACES Journal*** issues and three ***ACES Newsletter*** issues per year. This limitation is unfortunate, especially in the case of the ***ACES Journal***, which -- as several ACES members have suggested -- now merits tri-annual if not quarterly publication. One consequence of this limitation is the requirement to publish special issues, which have considerable promotional value, in place of regular issues. This, in turn, increases the interval between successive regular issues to one year -- thereby putting at risk our capability to publish acceptable (regular issue) papers promptly. To many authors, a delay of one year or longer is unacceptable. (Special sections of regular issues have been suggested, but these have substantially less impact and promotional value than do special issues, the only exception identified to date being the special sections consisting of benchmark problem solutions). The foregoing considerations substantiate the need for tri-annual publication of the ***ACES Journal.*** Let me also add that as a result of the two issues per year limitation, we almost lost one recent special issue (because authors were becoming antsy, and understandably so), to the point that they were considering withdrawing their papers and publishing them elsewhere -- and we may lose the opportunity to publish another which would include papers from a prestigious international symposium.

The aforementioned new measures have already resulted in adverse consequences. The ***ACES Journal*** page limits became applicable beginning with the mid-1993 issue and in a sense were retroactive. (Prior to the enactment of these limits, we had already scheduled more papers for this issue than we could publish under the new limits, notwithstanding a 25% overrun, authorized for 1993 to accomodate previous commitments to authors). Accordingly, we were faced with the grim prospect of re-scheduling some of the papers at least by six months. To avert this possibility, we asked authors to pay the page charges, if possible, even though no page charges existed when their papers were first submitted! With no "good" options available, the page charge request was the least unfavorable option under the circumstances, but a "last-minute" request for page charge payment is no way to administer a professional journal!

The VOLUNTARY page charge policy, applicable henceforth until rescinded, is based on the premise that authors and subscribers (ACES members), who share in benefitting from published papers, should likewise share in the costs.

This premise ignores the fact that authors can choose from among several journals and that as a consequence, even subtle pressures to pay the page charges, especially in conjunction with delayed publication of acceptable papers, can prove to be disincentives for authors to choose the ***ACES Journal.*** Realistically, the disincentive factor associated with the VOLUNTARY page charges by themselves is not of immediate concern, but whether these charges result in substantial new revenue remains to be seen.

Of far greater concern is the possibility that (if our situation does NOT improve in 1994) fewer papers will be published. The ***ACES Journal,*** now well on its way to international preeminence, is attracting more top-quality papers from around the world than ever before, and the interests of ACES are best served if we find ways to publish them. (An increased rejection rate is the easy solution, but unlike many other Editors-in-Chief, I do not accept the premise that a high rejection rate is a necessary condition for success. However, in not accepting that premise, I recognize our need to perform well by several other measures). Alternatives presently under consideration are (1) absolute page limits or (2) "free" page limits on all papers with mandatory page charges applicable to excess pages. I shall leave this decision to my successors: however, they may find such page limits to be unrealistic and counterproductive for the types of papers which we publish.

It is recognized that in ACES as elsewhere, maintaining a balanced budget is no trivial task. Practical limits exist in regard to subscription rate (membership dues) increases, if worldwide membership affordability is to be maintained. Salary scales vary among nations, and we would not want to price ourselves beyond reach of all but the most senior scientists and engineers. Yet, we must avail ourselves of every opportunity to find innovative solutions. As we might learn by observing the corporate world, managers rely almost exclusively on cost-cutting, but true leaders must do more.

Now, the good news. First, no reductions were made in the number of ***ACES Journal*** and ***ACES Newsletter*** issues published each year. Secondly, there exist preliminary indications that next year will be substantially better and may even be a "banner year". If so, then there exist the possibilities of rescinding the recently-enacted measures of limitation and of publishing the ***ACES Journal*** tri-annually, if the Board of Directors so authorizes. Finally, ACES now has a Ways and Means Committee, chaired by the ACES Vice President *ex officio* and charged with the responsibility to find new revenue sources, consistent with our status as a non-profit corporation. (Several editors have already suggested new revenue source possibilities; however, to ask them to continue bearing a disproportionate share of the "legwork" is inappropriate).

ORGANIZATIONAL CLIMATE AND CRITICAL NEEDS

During my six-plus years of service to ACES, and especially during recent months, I have identified several critical needs, three of which require immediate attention:

1. Innovative ways to raise new revenue, consistent with our status as a non-profit corporation, to support publication of more papers and issues than presently possible.

2. Innovative ways to make service to ACES at the committee level more attractive to our members. (ACES is highly dependent upon volunteer labor, and as one Director recently observed, several individuals who chair active committees in other professional societies are ACES members! The right committee activity will provide additional incentives for our colleagues to affiliate with ACES, and this in turn will expand our circulation base and make our publications more attractive to authors of top-quality papers. In addition, some committee activities themselves will generate publishable material, especially for the ***ACES Newsletter***).

3. Increased stragegic planning, especially the identification of projected new needs within the professional community and of ways in which ACES can address these needs. (This focus we have attempted to maintain in Publications).

The common denominators to these critical needs are vision and possibility thinking (or creative problem-solving), which only infrequently have ever been the basis for our *modus operandi*. For example, a substantial portion of recent ACES business has involved issues such as term limits, election procedures, ***ACES Journal*** page limits and enforcement of such limits, and even the legitimate uses of official letterhead! Granted, issues such as these require occasional attention, and the position-holders who focus on these issues have the best of intentions. A disproportionate emphasis on such issues, however, is counterproductive because it leaves little room for the possibility thinking and strategic planning.

The recent time and effort expended on committee structure and on election rules could have been better expended on finding ways to make service at the committee level more attractive. Although in recent years we have had more than enough members interested in positions on the Board of Directors, we have been less fortunate at the committee level. This must change if the long-needed synergistic relationship between the committees and ***ACES Newsletter*** is to manifest. ACES needs more doers, not more policy-makers!

It is also noted that an administration-intensive environment is sub-optimal and even de-motivating for proactive visionaries such as those in Publications and elsewhere who built ACES during the past several years. To prevent such an environment from manifesting, and immediate reversal of present trends is needed. (How many scientists, engineers, and other professionals grumble, grunt, and groan about the "administrivia" associated with their full-time jobs, and can we expect them to maintain high tolerance for "administrivia" associated with a volunteer job)? In consideration of the dependence of ACES upon volunteer labor, we need to focus more on inspiration and motivation and correspondingly less on administration and regulation.

Let ACES henceforth be an environment of opportunity, possibility, empowerment, vision, and action -- not an environment of limitation. In this regard, ACES is fortunate to have several role models in the persons of ACES President Hal Sabbagh, various directors, chairpersons of the three most recent ACES symposia, my two successors, and others who presently serve with me in Publications. Some of the remainding powers-that-be, however, can better serve ACES if they alter their priorities.

THANK YOU

On behalf of the ACES Editorial Board, I thank you for your continued support and confidence during these budget-constrained but otherwise promising times. Please join Perry Wheless, Duncan Baker, Paul Elliot, and the other ACES Editors in contributing to future chapters of the ACES success story!

David E. Stein
Editor-in-Chief
March 1987 - September 1993

AWARDS COMMITTEE

The next ACES Awards Banquet is scheduled for March 1994 in conjunction with the Tenth Anniversary ACES Annual Symposium. Provisions exist both for technical achievement awards and for ACES service awards.

As an ACES member, YOU are invited to nominate other ACES members for any of the following awards:

FOUNDERS AWARD -- This award recognizes individuals who, while serving ACES, have demonstrated exceptional vision and leadership as exemplified by the "founding fathers" of ACES. Although recipients need not be ACES Officers or Committee Chairpersons, they must have clearly assumed a leadership role in the affairs of the society.

MAINSTAY AWARD -- This award recognizes individuals who have devoted their time and talents throughout a sustained period to benefit the functions and activities of ACES.

VALUED SERVICE AWARD -- This award is presented to individuals to honor valued services or contributions to single events or functions of ACES.

EXEMPLARY SERVICE AWARD -- This award is presented to individuals who have served ACES above and beyond the call of duty at the committee (or equivalent) level while NOT occupying a prominent position within ACES. Exemplary service shall normally assume the form of spearheading a project; however, in some cases, exceptional service throughout a sustained period may also qualify. The Officers, Directors, and committee chairpersons (including the Editor-in-Chief) shall be ineligible for this award, except that in rare cases, they may receive this award for exemplary service which pre-dates their election or appointment to these respective positions.

TECHNICAL ACHIEVEMENT AWARD -- This award is presented to ACES members who demonstrate technical achievement in applied electromagnetic modeling through activities other than ACES Publications. Appropriate factors for consideration include efforts to support computational techniques, electromagnetic modeling software, code validation and distributions, and emphasis on applications, rather than electromagnetic theory.

Service award recipients need not be ACES officers or Committee Chairpersons; however, they will generally be highly active at the committee level.

In addition to the aforementioned awards, provisions exist for an OUTSTANDING PAPER AWARD (formerly, a BEST PAPER AWARD). This award may be presented to authors of ACES Journal papers and to authors of ACES Symposium papers. The procedures for selecting recipients of this award are not yet finalized; however, the nominations and possibly the final selections will be made by the ACES Editorial Board or the ACES Symposium Committee as appropriate.

The Awards Committee may select more than one recipient for a particular award or may choose not to present a particular award for a given year. Although the EXEMPLARY SERVICE AWARD is reserved for individuals who contribute substantially to ACES in non-prominent capacities. these individuals are also eligible for the FOUNDERS AWARD, the MAINSTAY AWARD, and the VALUED SERVICE AWARD.

All nominations should be accompanied by a list of technical or service accomplishments (whichever is appropriate). Recipients off ACES service awards will be selected on the basis of contributions made to ACES -- NOT on the basis of offices or other positions held. From a procedural standpoint, selection will be based on the strength of the nomination and supporting justification. In no cases will the number of nominations which a candidate receives be the primary basis for award selection.

Please send your nominations to me at Post Office Box 169, Linthicum Heights, MD 21090, USA or via e-mail at 74250.3401@compuserve.com prior to 31 January 1994. Include your telephone number and/or e-mail address so that we can contact you if additional information is needed.

David E. Stein
Chairperson, Awards Committee

SOFTWARE EXCHANGE COMMITTEE REPORT

This short note was written to address the many requests ACES receives concerning the status of the NEC-MOM codes [NEC2 (ca 1981), NEC3 (ca 1985), and NEC4 (1993)]. The Software Exchange Committee is tasked to distribute information on the availability of all major CEM tools. The committee's Software Source Book (under development) will list all available CEM codes and will cite information on eligibility for purchasing restricted codes like NEC3 and NEC4.

INFORMATION ON THE HISTORY & AVAILABILITY OF NEC-MOM CODES FOR PC's & UNIX

NEC2

The original NEC2 was developed for the Navy by Lawrence Livermore Labs in 1981. Jerry Burke has been and still is the major contributor to the NEC-MOM family of codes. The code has always been a "card image input/batch run" operation initially designed for CDC and later for VAX computers. It has been ported to many other machines by myriad individuals. Any existing copy of the code has a genealogy, but few users are aware of where their copy "has been" and how "up to date" its capabilities are.

NEC2's identifying features are the Sommerfeld-Norton ground interaction for wire structures above lossy ground and a Numerical Green's function that provides the option of modifying a structure without repeating the complete solution.

The documentation that exists FOR THE ORIGNAL VERSION OF THE CODE is in 3 parts: A theory manual (Vol.1, Pt. I), a code manual (Vol.1 Pt. II) containing a detailed description of the Fortran source code and a user manual (Vol.2, Pt. III) containing instructions on using the code with some sample input/outputs. Jerry Burke can sometimes provide some of these manuals or they can be obtained through NTIA as NOSC TD 116.

The PC versions of NEC2 fall into two categories:

1. A code that "fits into" the DOS-limited 640KB of memory space, and

2. A code that will compile and run (hopefully) under DOS-extended 16 and 32 bit Fortran 77 compilers. (The 32-bit versions of these compilers are usually derived from 32-bit UNIX Fortran 77 compilers. Typical companies providing these compilers and DOS extenders are Lahey, Microway, OTG/Salford, Waterloo, Microsoft (Powerbook Fortran), etc. If a particular version of a modified NEC2 compiles and runs under one release of one version of these compilers, it does not mean it will still run under newer, updated releases. Sometimes the problems are traceable to the ability or tolerance of the compiler to accept non-77 statements that abound in NEC2.)

IGUANA

NOSC began development, in the early 1980's, of a software package called IGUANA (Interactive Graphics Utilities for Automated NEC Analysis). IGUANA was developed on an IBM-PC compatible platform with CGA graphics and with peripherals available at the time. It featured a heavily prompted input editor for creating NEC input data sets (card decks). It also allowed a serious user to input geometry data via an acoustic digitizer. The visualization of the input structure (wires only) was a useful feature. The output data could be plotted via a simple graphics package called GRAPS which allowed linear, log, polar, Smith chart and limited 2-D contour plots. IGUANA was intended to feed a mainframe-resident version of NEC2 and to receive ASCII output data for plotting. A collection of other utilities was included in IGUANA. As is often the case with software development, the limited funds available to NOSC did not provide for a bug-free version of the several IGUANA's that were developed. Nevertheless, users learned to live with the

limitations and quirks of early IGUANAs . Version 4.2 was the most useable and formed the basis for NEEDS 1.0, (The Numerical Electromagnetics Engineering Design System) that would become the first PC-based NEC software package, in 1987. The current NEEDS 2.0 contains IGUANA 5.4. Version 6 of IGUANA was initiated several years ago, but was never debugged.

NEEDS and NEC81

During the mid-80's, mainframe NEC users modified NEC2 to "fit" into the severe 640KB limit of the PC-DOS environment. Compilers available at that time (noteably Microsoft Fortran 3.31 and RM Fortran 2.4) allowed overlay structures and NEC2 versions sprung up all over the planet. Some were limited to 75 unknowns (no overlay) and some boasted over 500 unknowns (by stripping out many of NEC's memory-consuming features). The version of NEC-PC in NEEDS 1.0 was somewhat limited in capability, but still provided many users with a useable miniature version of NEC2 on a PC. The most bug-free and successful porting of NEC2 to the PC was completed in 1989 by David J. Pinion, P.E., who named it NEC81. Dave, starting with an IBM mainframe version which had been overlaid to fit into a 360KB "mainframe" at NPS, managed to squeeze 90 unknowns (an array of 8100 elements) into memory, with a maximum limit of 300 unknowns, using the NEC2 out-of-core capability. (Out-of-core uses RAM disk or hard disk to store files when the in-core capability is exceeded. Notice the use of mainframe terms like "core" in place of memory.) Dave generously made version 2.2 of the code available to ACES for inclusion in NEEDS 2.0, the still-current version.

DOS-EXTENDED NEC2's

During the mid 1980's (before the 80386 arrived), IBM introduced their ill-fated PC/RT which used a 32 bit RISC processor, running under AIX, a version of UNIX. The PC/RT was aimed at the frustrated PC user that refused to take the UNIX "cold shower". It offered a "DOS" capability (80286) under the UNIX banner. Theoretically, one could port a mainframe NEC to the RT, compile and link it under the 32-bit RT Fortran, run NEC jobs under UNIX, while at the same time, under the DOS umbrella, crank out input datasets and process outputs. It failed miserably. The Fortran was a version that Bell Labs "threw into the garbage can" because it was too buggy to fix. Someone forked it out of the trash and "repaired" it, but the repairs could not fix the slow, inaccurate performance. And the RT's DOS operation was slower than the original 6 MHz IBM-PC/AT; the DOS operations were emulated under UNIX and screen writes were done at about 300 baud, and looked like a Selectric typewriter!

Other attempts to juice-up AT-based Fortran codes involved special 6800-based co-processor add-in cards. The Definicon 20 MHz board was popular, but its Achilles heel was an ill-fated compiler that had the same roots as the IBM RT compiler. Several other early 32-bit extended DOS compilers suffered from the same origins. (Their common ancestry was discovered when the same identical error numbers and error messages arose with every new compiler we tried!)

The first successful PC Fort77 32-bit compiler that was robust enough to handle NEC was the Microway NDP Fortran v.1.4.3. Unfortunately, the compiler was modified and upgraded so often that very few people could keep up with the "improvements". As the version numbers increased, the solution times of NEC problems also increased. Meanwhile, Microsoft was never able to produce a true 32-bit complier. Rumor has it that their early 32-bit compiler staff abandoned the ship and went to Absoft and produced an excellent Macintosh 32-bit Fortran compiler, which Jerry Burke uses very successfully on all versions of NEC. During the last 3-4 years, a flood of 32-bit compilers has washed over the PC community. There does not seem to be a comprehensive list of each version with documented highlights of successes and failures. The ACES Newsletter is a logical home for such an effort. Perhaps this short note will spark interest in sharing information among the NEC-PC community, via the Newsletter.

The various 32-bit compilers all support the xxx87 Intel math co-processor which features a double-precision sized mantissa. The speedy Weitek math coprocessor has been used on NEC but ultimately fails in high-precision solutions due to its limited single-precision mantissa. Most Weitek chip versions have not supported DOUBLE PRECISION computations. Use of single precision computations with the xxx87 coprocessor is not successful. The NEC code was designed for a 64-bit CDC system, so VAX and IBM 32-bit systems demand double precision versions of the source code, or the use of an auto-double option at compile time. NEC81 judiciously uses double precision based on a trial and error elimination of unneeded double precision calls, a technique that allowed the maximum number of unknowns in the restricted DOS contiguous memory space. Such careful use of DP is not necessary in DOS-extended operation. The penalty for brute force DP use is only about 15% increase in run-time for most current 32-bit compilers.

32-BIT NEC2's:

A MACINTOSH version of NEC2 was produced by Jerry Burke then was converted to a PC version via the Microway compiler by Tom Wallace of Arco Power Technology Inc. of Washington DC and was increased to 2000 or more unknowns and was called NEC2S and NEC2D. It has not been extensively tested by the ACES Software Exchange Committee and as such is not considered a supported code. It will be sent to requestors with no prediction of performance capability, but any and all experiences with its use that are reported will be shared via the Newsletter. These reports will be used to help elevate the code to placement on ACES SOFTWARE LIST for distribution to anyone.

NEC2S and NEC2D for a UNIX SUN4 workstation has been provided to ACES by Per Hj. Lehne of Norwegian Telcom Research for use on a UNIX SUN SPARC4 workstation. The same conditions of support are in existence as for the ARCO PC NEC2. The origin of NEC2/UNIX is the ARCO NEC2D.

NEC2S/MAC and NEC2D/MAC for the Macintosh, originated by Jerry Burke, are available from Jerry under the same conditions.

MININEC CODES AND SUPPORT SOFTWARE

The NOSC public domain version of MININEC 3.13 is distributed via ACES as part of the NEEDS 2.0 package. It is interactive but has no built-in structure viewer nor output plotting. Several amateur radio-targeted third-party versions of MININEC have been developed by computer-savvy amateurs and are for sale. The two most popular MININEC derivatives are MN by Brian Beezley of Vista, CA and ELNEC by Roy Lewellan of Beaverton, OR. Both have excellent structure viewers and pattern plotters. Both can superimpose wire currents (including phase) on the structure views and ELNEC supports a one-plane radiation pattern overlaid on the structure view. ELNEC's data input scheme is easy to use for the beginner and offers limited geometery manipulation and duplication features, including a tapering option for segments. MN provides near fields; ELNEC does not.

NEC3 and NEC4

The remaining NEC codes in the preface paragraph, NEC3 (allows buried wires) and NEC4 (improved accuracy for stepped-radius wires and electrically-small segments, adds end caps and insulated wires, smart input card-reader, catenary-shaped wires and improved error detection) are still Military Critical technology. That status is under question and may hopefully disappear eventually.

Dick Adler,
Software Exchange Committee

PERMANENT STANDING COMMITTEES OF ACES INC.

COMMITTEE	CHAIRMAN	ADDRESS
NOMINATIONS	Stan Kubina	Concordia U/ECE Dept. 7141 Sherbrooke St. West, Montreal, Quebec, CANADA , H4B 1R6
ELECTIONS	(OPEN)	
FINANCE	James Logan	NRAD Code 824 271 Catalina Blvd. San Diego, CA 92152
WAYS & MEANS	Ray Luebbers	Penna State U EE Dept /121 EE East University Park, PA 16802
PUBLICATIONS	Perry Wheless	3200 Carlisle Blvd. NE #209 Albuquerque, NM 87110
CONFERENCE	Richard Adler	ECE Dept. Code ECAB 833 Dyer Rd, Room 437 Naval Postgraduate School Monterey, CA 93943-5121
AWARDS	David Stein	PO Box 169 Linthicum Heights, MD 21090

MEMBERSHIP ACTIVITY COMMITTEES OF ACES INC.

COMMITTEE	CHAIRMAN	ADDRESS
CODE USER GROUP	Russell Taylor	McDonnell Douglas Helicopters 5000 E McDowell Rd. Mesa, AZ 85205
SOFTWARE EXCHANGE	Frank Walker	Boeing Defence & Space Gp. MS 82-11 Box 3999 Seattle, WA 98124-2499
SOFTWARE PERFORMANCE STANDARDS	(OPEN)	
AI & EXPERT SYSTEMS	Wayne Harrader	Ball Communications PO Box 1235 Broomfield, CO 80020
HISTORICAL	Robert Bevensee	Boma Enterprises 128 Irongate Court Alamo, CA 94507

On Using the Near-field Option for Far-zone Observation Points in MININEC

R. P. Zeineddin, and R. D. Radcliff
Electrical and Computer Engineering Department
Ohio University
Athens, OH 45701-2979

Abstract

There appears to be nothing in the mathematical foundations of MININEC that suggests that the near-field option cannot be used to find the field in the far zone as well as in the near zone. The near-field option (NFO) enables the user to solve for the radiated fields anywhere in space. The far-field option (FFO) lacks this flexibility; it can only calculate the field at a constant radius from the user-specified antenna. A "bouncing-signal" problem was cited [1] when the near-field option was run to find the field at far-zone observation points. As with many numerical-instability problems, this problem may be located in the algorithm, the code, or the implementation of the code on a certain type of machine, i.e. microprocessor. A simple antenna structure was selected and simulated with MININEC in order to demonstrate the problem. A careful tracing of the code served to locate and solve the problem [2].

Using the Near-field Option in the Far Zone

The validity of running the NFO with far-zone observation points can be verified by examining the dependence of the equations used in the near-field algorithm on the location of the observation points. This algorithm is based on determining the open-circuit voltage of a virtual dipole placed at the observation point [3]. The concept of open-circuit voltage does not impose any theoretical constraints on the distance between the source and the observation point. The open-circuit voltage is calculated by

$$V_d = \sum_{i=1}^{N} Z_{di} I_i \tag{1}$$

where I_i is the i^{th} current distribution pulse on the source, Z_{di} is the mutual impedance between the virtual dipole and the i^{th} segment of the source, and N is the number of current pulses. The electric field is then calculated by

$$E_d = \frac{-V_d}{\text{length of the virtual dipole}} \tag{2}$$

In the above equation, the only term affected by the location of the virtual dipole is the mutual impedance term (Z_{di}) which is computed by

$$Z_{di} = \frac{-1}{4\pi j\omega\varepsilon}\left[k^2\left(\vec{r}_{d+1/2} - \vec{r}_{d-1/2}\right)\cdot\left(\hat{s}_{i+1/2}\psi_{d,i,i+1/2} + \hat{s}_{i-1/2}\psi_{d,i-1/2,i}\right) - \frac{\psi_{d-1/2,i,i+1}}{s_{i+1} - s_i} + \frac{\psi_{d+1/2,i-1,i}}{s_i - s_{i-1}} + \frac{\psi_{d+1/2,i,i+1}}{s_{i+1} - s_i} - \frac{\psi_{d+1/2,i-1,i}}{s_i - s_{i-1}}\right] \tag{3}$$

Since the mutual dipole is not a part of the original wire structure, none of the Z_{di} terms correspond to a self impedance. Therefore the kernel of the integration, abbreviated by the ψ term, will always be the integration of the reduced kernel given by

$$\psi_{d,j,j+0.5} = \int_{s_j}^{s_{j+0.5}} \frac{e^{-jk\sqrt{\left|\overset{v}{r}(s_d)-\overset{v}{r}(s')\right|^2+a^2(s')}}}{\sqrt{\left|\overset{v}{r}(s_d)-\overset{v}{r}(s')\right|^2+a^2(s')}}\, ds' \qquad (4)$$

where $\left|\overset{v}{r}(s_d)-\overset{v}{r}(s')\right|$ refers to the distance between the virtual dipole and the jth expansion pulse. The integration takes place over the second half of the jth expansion pulse to find its mathematical dependence on the location of the virtual dipole.

When running the NFO for observation points located in the far zone, the only terms affected by the location of the virtual dipole are the parts involving the term $\overset{v}{r}(s)$, which is the distance from the i^{th} segment to the virtual dipole. It appears that large values of $\overset{v}{r}(s)$ should not invalidate any of the above equations.

This enables the user of MININEC to take advantage of the flexibility of the input format of the NFO. One example was when MININEC was run for verification of a radio antenna site analysis model. The far-zone observation points were located along the path of a departing (or incoming) airplane as shown in Figure 1. Instead of running the FFO n times, n being the number of the observation points, the NFO was run with a single set of input variables that specified the Cartesian coordinates of the n observation points. The output of these runs showed a "bouncing signal" [1] rather than the expected smooth one. This finding suggested the presence of an instability problem that needed to be investigated.

Demonstrating the Existence of the Problem

In order to demonstrate that the problem is not caused by a specific aircraft-measurement antenna model, a simple antenna structure was selected and modeled as follows: the frequency was chosen to be 299.8 MHz, yielding a wavelength of 1 m. The simple structure selected was a half-wavelength center fed dipole lying on the z-axis with end coordinates: x_1=0, y_1=0, z_1=17 m and x_2=0, y_2=0, z_2=17.5 m. Its radius was r = 0.0001 m (r << l) thus qualifying the dipole as a thin wire. The dipole was divided into ten segments, yielding nine current pulses.

This structure was simulated in both a free-space environment and in the presence of a perfectly conducting ground plane. One way of verifying the existence of the instability problem was to test MININEC by using the near field option (NFO) to compute the electric field at various points in the far zone. As a basis of comparison MININEC was also run for the same points using the far field option (FFO). The comparison was done by calculating the relative error between the NFO and FFO values for each point. The relative error, or percentage difference, was calculated by

$$\%\ \text{Difference} = \frac{|\text{FFO values} - \text{NFO values}|}{\text{FFO values}} \qquad (5)$$

Since numerical instabilities may be caused by machine or compiler dependencies, it was also necessary to investigate different executable versions of MININEC3. The executable files used were:

- Microsoft QuickBASIC for the IBM compiled version [3].
- MININEC as a part of the Numerical Electromagnetic Engineering Design System software package (NEEDS) for the IBM personal computers [4].
- C language IBM compiled version [1].
- Microsoft QuickBASIC for the Macintosh compiled version.

The first of the four versions is the original version and the most widely used. The C language version is a translation of the original BASIC version. The purpose of using it was to investigate possible programming language dependency. The last version was compiled on the Macintosh machine to investigate possible microprocessor dependencies.

The four versions of MININEC were run for various sets of observation points. Each set was run twice, first in free space then in the presence of a PEC ground plane. The output of these runs yielded two different types of results. The Microsoft QuickBASIC for the IBM version and the C version had very similar output, thus constituting the first type. Because of the strong similarity and to avoid confusion, the title "Type I" was used for the first type and Microsoft QuickBASIC for the IBM version was taken to be its example. The NEEDS package version had practically the same results as the Microsoft QuickBASIC for the Mac version. The title "Type II" was given to this second type of output and the Microsoft QuickBASIC for the Mac version was taken as its example.

Figure 2-a shows the Type I results when the testing example was run with a PEC ground plane for the second set of observation points x=20000-20001, y=0, and z=300 m. Figure 2-b shows the percentage error between the FFO values and the NFO. Figure 3 shows the Type II output for the same case. While the FFO computed the electric field to be 3.831E-6 V/m for both types of versions. The NFO for the MAC version, Type II, found the field to be 3.420118E-6 V/m while the Microsoft QuickBASIC version, Type I, yielded 6.141682E-6 V/m. This is a case where both versions yielded different, but at the same time high relative errors, 60.3% for Type I and 10 % for Type II.

When running both the NFO and the FFO for points in the far zones, the FFO yielded the best results with monotonic curves for all cases. Conversely, the NFO always showed fluctuations for all different versions of MININEC. Fluctuations were minor in the case of the free space environment. It was apparent, however, that the existence of a PEC ground plane causes the NFO to yield highly unstable results. These runs showed that the Type II versions of MININEC yield better results than those of Type I especially when a ground plane is present. It is obvious that the NFO yields unstable results when it is run in the far zone for both types of environments. The PEC ground plane medium yielded unacceptably high relative errors. The fact that the free space case had yielded low relative errors did not justify the inconsistency of these errors. The inconsistency of the errors must be caused by a numerical instability since the theoretical approach has already been validated. Furthermore, the numerical instability is not language dependent since the C version and the IBM QuickBASIC version both yielded virtually identical results. The numerical instability was also not machine dependent since the Macintosh version and the NEEDS version, running on the IBM personal computers, yielded the same type of output.

Locating the Problem

The fact that the Microsoft QuickBASIC for the IBM and the C versions yielded different results from the ones of Microsoft QuickBASIC for the MAC and the NEEDS package (running on IBM), led to the belief in the existence of two different types (Type I and Type II) of executable files. It was useful to trace both types for the same set of input variables and watch for differences.

Tracing the code showed that the first difference between the two types of executable files appeared at line 360,

```
360    D3 = X3 * X3 + Y3 * Y3 + Z3 * Z3
```

In the above statement D3 represents the computed value of $\left|\vec{r}(s_d)-\vec{r}(s')\right|^2$ (the distance between the virtual dipole and the jth expansion pulse on the wire antenna), and the variables X3, Y3, Z3 represent its three components. The computed value of D3 is used to compute each ψ by equation (4). Since the virtual dipole is very far from the wire antenna, the computed values of the distances between the virtual dipole and neighboring expansion pulses on the wire antenna were truncated by the computer. This in term yielded erroneous computation in evaluating the ψ's in equation (3). It was interesting to note that although both versions show insensitivity to the location of the virtual dipole, the Type II version showed less insensitivity than the Type I version.

Type I	Type II
$\psi_{d,1,1.5} = \psi_{d,2,2.5} = \psi_{d,3,3.5}$	$\psi_{d,1,1.5} = \psi_{d,2,2.5}$
$\psi_{d,4,4.5} = \psi_{d,5,5.5}$	$\psi_{d,8,8.5} = \psi_{d,9,9.5}$
$\psi_{d,6,6.5} = \psi_{d,7,7.5}$	
$\psi_{d,8,8.5} = \psi_{d,9,9.5}$	

This justifies the fact that Type I results yielded higher percentage differences than those of Type II.

Diagnosis and Solution

The first step in diagnosing the problem was to understand the manner in which this statement is executed. The processor will first compute the first term (X3*X3) and store its result in a memory location, a register, located within the processor itself. The same will be done for the second and third terms, (Y3*Y3) and (Z3*Z3) respectively. Results of the first two terms are then added together and the new result is stored in another register within the processor. The third term is finally added to the summation of the first two terms. The final result is stored in the D3 storage cell located in the RAM. Since memory locations in the processor are not as spacious as the ones in the RAM, truncations occur when the results of (X3*X3), (Y3*Y3), and (Z3*Z3) are stored.

The manner in which a number is stored in the register depends on the types of machine and compiler used. Truncations due to insufficient space within the processor can be avoided by forcing all results to be stored in temporary locations in the RAM. This can be done to line 360 by expanding it in the following manner

```
360    TEMP1 = X3 * X3
361    TEMP2 = Y3 * Y3
362    TEMP3 = Z3 * Z3
363    D3 = TEMP1 + TEMP2 + TEMP3
```

In order to verify the effect of the temporary storage method, described above, on the performance of the code, line 360 was replaced by the four lines and the new version was compiled with Microsoft QuickBASIC for the IBM compiler, the same one used for the Type I version. These runs yielded the same output as the Type II versions. The temporary storage method eliminated the compiler dependency and raised the performance of the Type I versions to same level of the Type II versions. The results of this improvement were not satisfactory because of two reasons: considerable relative errors (10%) still occur when a PEC ground plane is present, minor relative errors that cause inconsistent fluctuations still occur with the free space environment. This is due to the fact that even the temporary storage method does not calculate the precise value for any of the D3. A better way was needed to improve the calculations of D3.

One way to increase the space within the register is to declare D3 as a double precision variable. This will force the processor to store the (X3*X3), (Y3*Y3), and (Z3*Z3) terms in registers with double

the amount of space previously used. The concept of using double precision was applied to MININEC by adding the following statement to the code:

```
DEF DBL D,D1,D2,D3,B,B1,B2
```

It was necessary to define all of the above variables as double precision since they directly depend on the value of D3. The reason for these additional declarations is the difference in the representations of the double precision and the IEEE floating point format default representation of the single precision variables. This new version of the code was run for the same sets of points used when verifying the existence of the problem. The output of this version is shown in figure 4. The accurate values of D3 resulted in extremely smooth curves, for all cases, even better than the one produced by the far field option.

Because of the small magnitude and constancy of this relative errors the results of this final solution were believed to be satisfactory. When the solution was applied to the C version of MININEC3 the outcome of showed a smooth monotonic curves. This verified the validity of the diagnosis stating that the instability problem was caused by the limited "space" in the memory allocation for the D3 variable. This also showed that the proposed solution of using double precision is not language dependent and that it can be applied to all code versions of MININEC.

Conclusion and Recommendations

When the Near Field Option of MININEC was run for points in the far zone the results indicated the existence of a bouncing signal, thus confirming earlier citations [1]. The validation of using the NFO in the far zone was carried out by examining the language, machine, and compiler dependencies. Tracing of the code showed that the bouncing signal is caused by a numerical instability. This instability is due to the insensitivity of the computer in calculating the distances from different segments of the antenna structure to the observation point that is located in the far field. In order to correct this the following variables need to be declared as double precision in the beginning of the code: D, D1, D2, D3, B, B1, B2.

This study has also served to present a case where different compilers, namely Microsoft QuickBASIC for the IBM and Microsoft QuickBASIC for the Macintosh, can react differently in the presence of a numerical instability. This is a rare finding since the "portability" of a certain code between different machines and/or compilers is usually thought of as an input/output difference rather than a "number crunching" one. This goes to reinforce the necessity of constant re-validation and the cross examining of the results of such sensitive codes.

References

[1] Frank Marcum, Research Engineer, Ohio University Avionics Center, Athens, Ohio 45701. Private communication.

[2] R. P. Zeineddin, *Numerical Electromagnetics Codes: Problems, Solutions and Applications*, M.S. Thesis, Ohio University, Athens, Ohio, March 1993.

[3] J. C. Logan & J. W. Rockway, *MININEC: A Mini-numerical Electromagnetics Code*, Technical Document 938, San Diego, California: Naval Ocean Systems Center, September 1986.

[4] *NEEDS: The Numerical Electromagnetic Engineering Design System*, Version 1.0, Monterey, California: The Applied Computational Electromagnetics Society, February 1988.

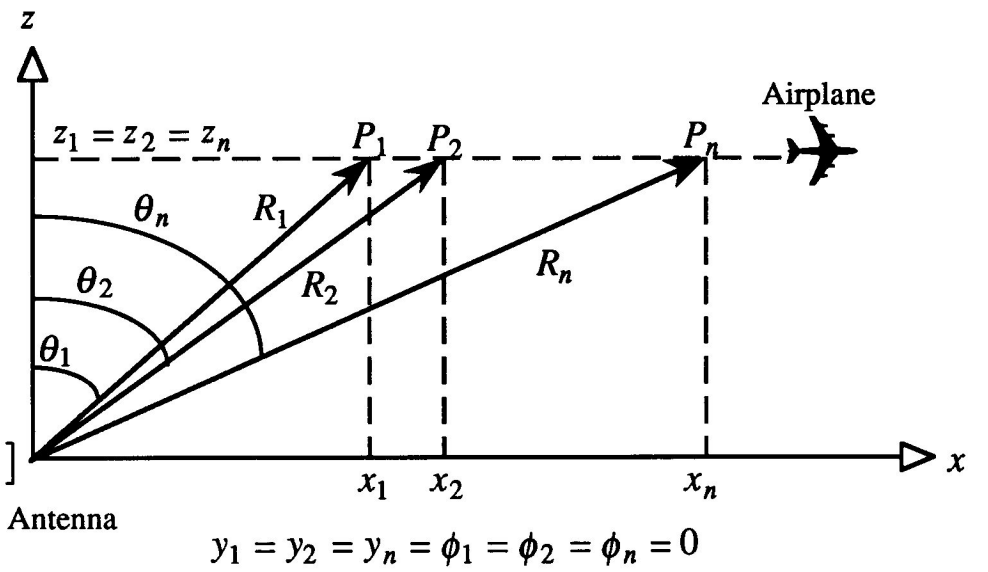
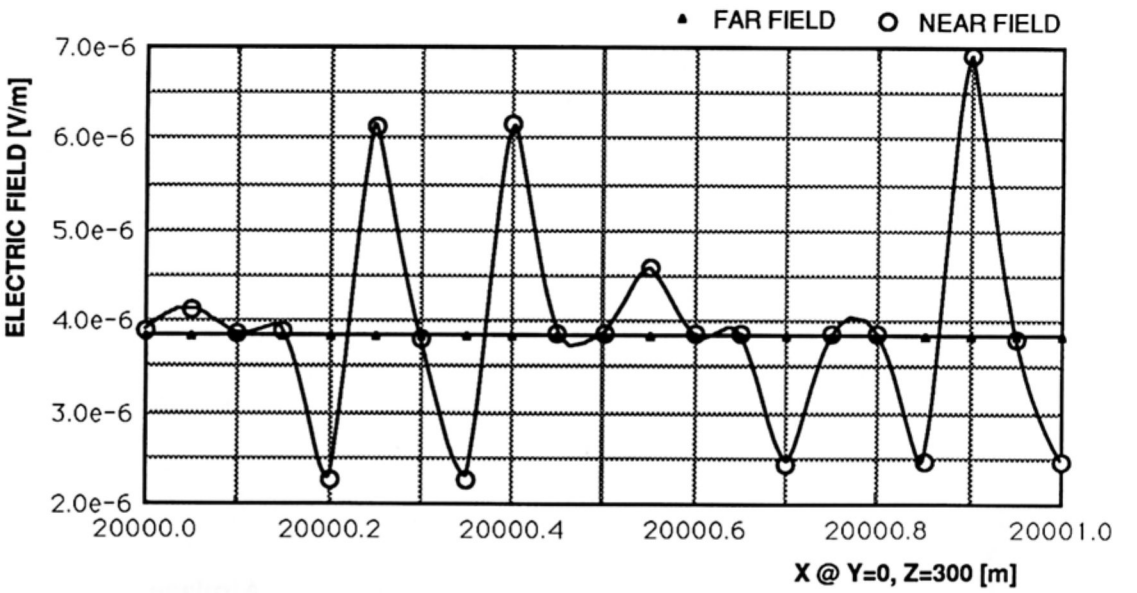
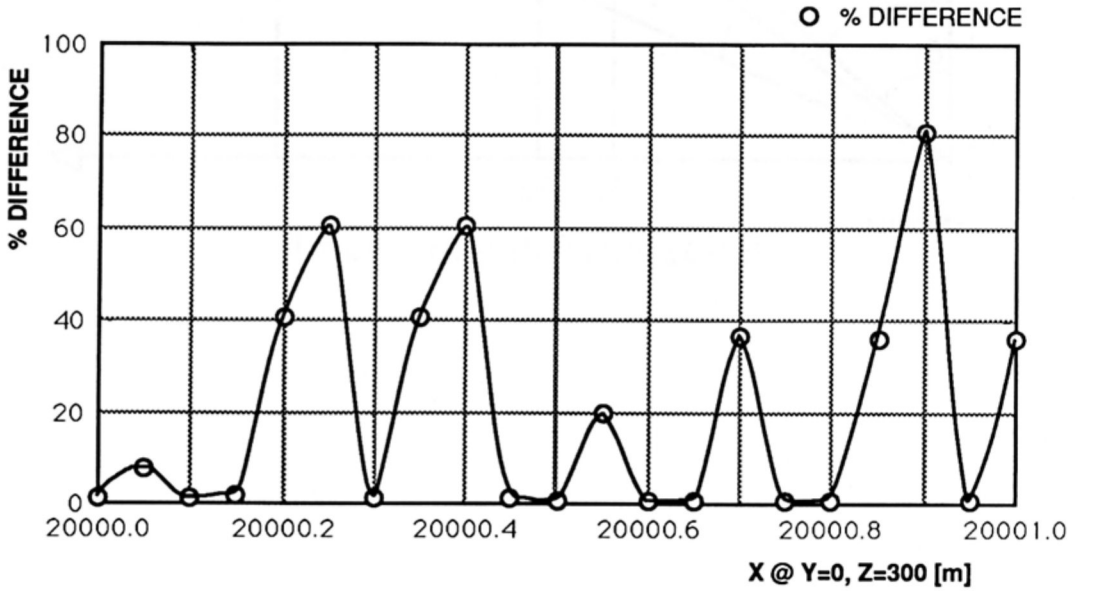


Figure 1 The path of an airplane with respect to the communications antenna.

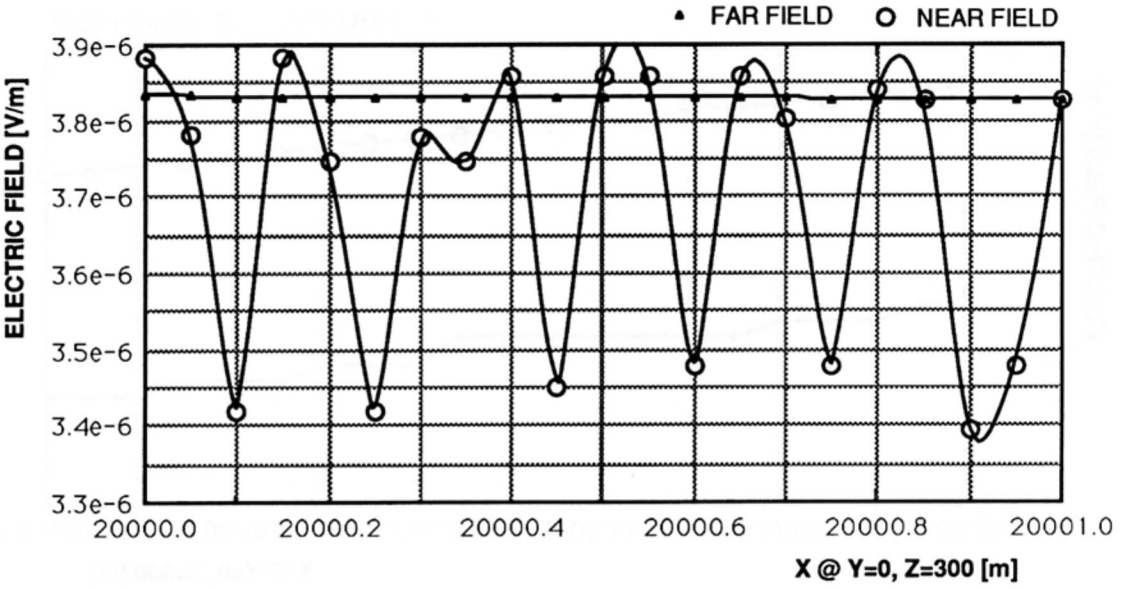


(a) Distance versus near and far fields

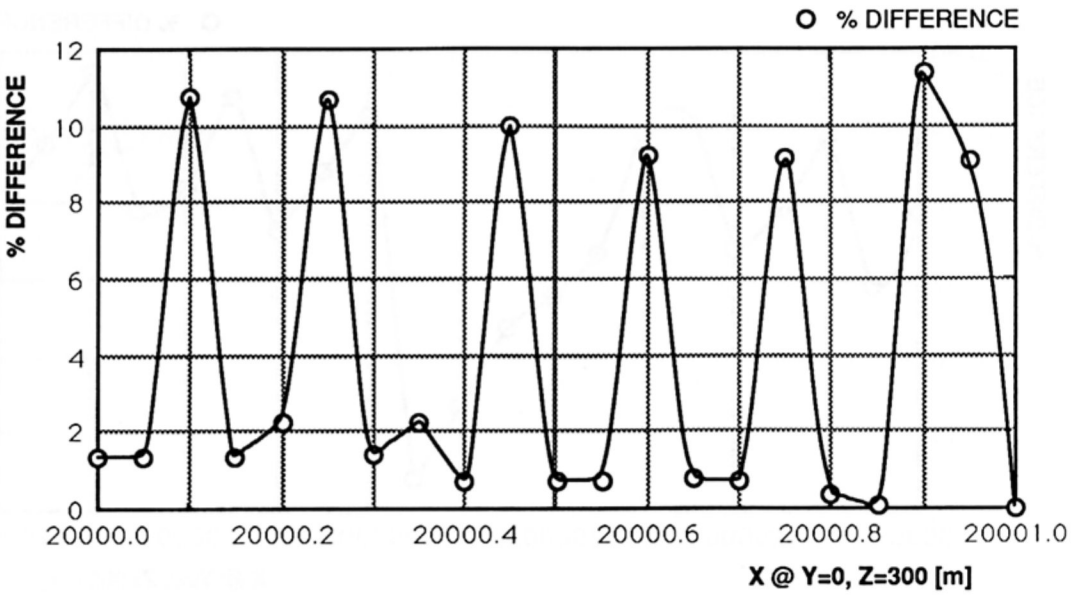


(b) Distance versus percent difference between far and near fields

Figure 2 Type I output for x=20000 to 20001 m with a perfectly-conducting ground plane.

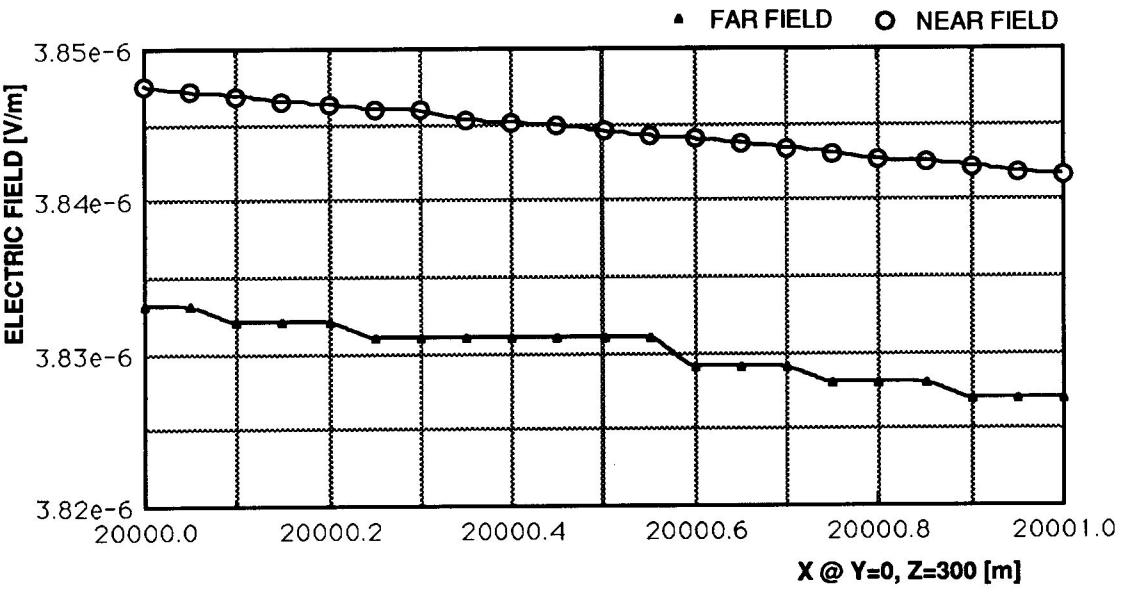


(a) Distance versus near and far fields

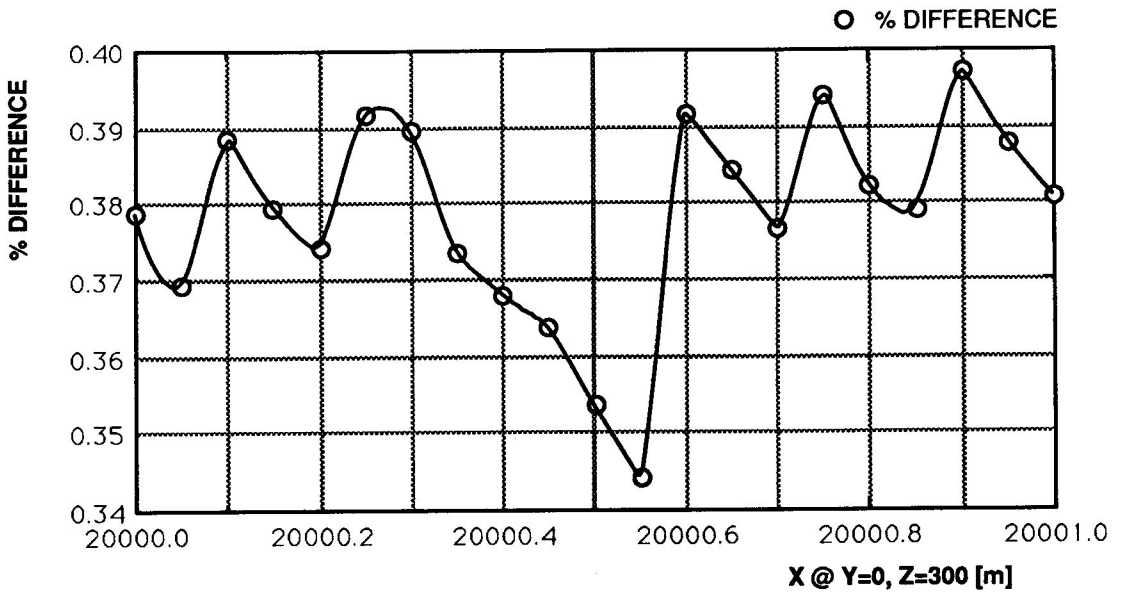


(b) Distance versus percent difference between far and near fields

Figure 3 Type II output for x=20000 to 20001 m with a perfectly-conducting ground plane.



(a) Distance versus near and far fields



(b) Distance versus percent difference between far and near fields

Figure 4 The corrected-version's output for x=20000 to 20001 m with a perfectly-conducting ground plane.

TOPICS IN TELECOMMUNICATIONS FOR EM

Randy J. Jost
SRI International
1611 N. Kent St.
Arlington, VA 22209-2192

Overview

This month we have a grab bag of topics to cover, some that I believe you will find very exciting (IMHO). First, an update on the status of an Internet server site for ACES and EM specific files. Then an update on the ACES E-mail database. Finally, a proposal to start an ACES E-mail Digest, to supplement the existing Journal and Newsletter.

ACES Server Site

Dr. Todd Hubing, of the University of Missouri-Rolla, has set up an anonymous FTP site for EMC related software and reports. If you are a member of the Electromagnetic Compatibility Society, you may have seen the announcement of this in the Summer 1993 EMC Society Newsletter. Todd has graciously made arrangements for the use of this FTP site for ACES related items such as the ACES E-mail database, tech reports, software, etc.. The procedure to access this resource on the Internet is a follows:

Activate your FTP program, whether it be FTP, Telnet, etc. If you are using Telnet, be sure to indicate that it is an FTP connection you are desiring, otherwise, you may access the wrong machine. The address of the UMR server is:

emclab.ee.umr.edu

When the server recognizes your connection request, and asks for a name, enter the name

anonymous

When the server asks for a password, enter your e-mail address as the password.

If you are successful, the machine will acknowledge your electronic existence by replying with the cryptic statement:

230 Guest login ok, access restrictions apply.

At this point, enter the public directory by giving the command

cd pub

You can also use the command **'ls'** to get a directory listing, but I prefer **'dir'**, because it gives more information, specifically the size of the files. To check the contents of the pub directory, enter the command

dir

To go to the ACES directory, drop down one more level by again giving the command

cd aces

At this point, you're ready to see what goodies we have for you. At the time this article was written, this included an index to what is in the directory, a readme file to give some general information, ASCII copies of my previous articles on "Internetting" (such vanity), the ACES E-mail address database, some software and who knows what else by the time you read this.

When downloading text files, you can use the ASCII mode of transfer. However, when downloading software, be sure to use the BINARY mode, unless the file has been previously converted to an ASCII format by a program such as BINHEX. The first things to download are the files README and 00INDEX, both of which are plain ASCII files. They will give you more information about using the ACES site (README) and the contents of the ACES directory (00INDEX).

We would like to encourage you to submit files that you think may be of broad (or narrow) interest to the EM community, especially your fellow ACES members. Whether it be a software routine, major program, tutorial articles, or reports on EM related topics, this is your opportunity to have a place to call "home" on the Internet. To date, we do have a few pieces of software in the directory, as well as some information in text files. Hopefully, by this time next year, we'll have a healthy collection of software and articles. If there are things you'd like to see at this site, let everyone else know, and chance are someone can help you. How so you communicate with everyone else? See below. But first ....

ACES E-mail Database

The ACES E-mail address database looks like it's finally come to life. Although still in its early stages, by the time you read this, you should be able to download it from the UMR server. The utility of this database will depend on you, the users. What do you like, what don't you like, what do you want to see. Corrections and additions are especially wanted and needed. If I have inadvertently included information that you don't want on-line, let me know and I will correct the situation immediately. Please send your comments to me, either by E-mail or "snail" mail.

At present, the database is actually a series of files. This is due to the fact that individuals have given permission for differing levels of information to be made available. Currently, I can provide the database in "plain vanilla" tab-delimited ASCII text and Macintosh Filemaker Pro format. I can put it in other formats, but I need to know what other forms are wanted. For more information, download the file readme-database.

For those of you who do not yet have the capability to do Internet downloads, I can also send you an E-mail message with the E-mail addresses. Finally, if you don't have E-mail access, but wish to have the information for future use, we can put the information on disk. My only request is that you send me a stamped, pre-addressed envelope or mailer for a floppy disk and a few loose stamps (for my children's collection). In exchange for the stamps, I'll provide the floppy disk itself.

ACES Electronic EM Digest

Finally, several members have made requests concerning the formation of topical user's groups, expressed a desire to know who is doing what in specific areas, or have questions concerning various codes. In considering ways to address these requests, several possibilities suggest themselves. One possibility is the development of an EM oriented E-mail digest.

Therefore, I would like to get the membership's feelings about developing and posting an E-mail version of an ACES EM Digest. This would be a supplement to the existing Journal and Newsletter. Depending on the amount of interest, it could be published on a monthly (or more often) basis to provide the membership with a timely forum for exchanging ideas, requests for information, announcements of upcoming meetings, calls for papers, etc. Initially, I envision potential contributors submitting articles, letters, bug reports for codes, etc. to me. I will collect the input, edit for some minimal consistency, and then re-post to those who wish to subscribe.

As a test of this concept, I intend to post a short example issue to the list of e-mail addresses I have available to me. This will probably come out before, or about the same time as, this issue of the Newsletter, and contain this article, as well as any other information I gather by then.

What do you think of this? Do you have any interest? Would you be willing to submit a short contribution? Let me know what your reaction is, good or bad, and we'll try to tailor this digest to your needs.

Miscellaneous

I haven't gotten too much feedback on this series of articles I have been doing. Is this information of any use to those reading it, assuming you do, or am I needlessly contributing to the destruction of trees? I'm sure that there are others who have much more expertise in using the Internet for communications, file transfer, etc. Because I am a Macintosh user, I often use examples from the Mac world. Are there any users of PCs out there that would like to submit PC specific telecommunication information for other members. What programs have you had success with, or believe others should avoid? Are there any topics you would like to see or present? Send some bits in my direction and let me know what you think.

Conclusion

Well, that wraps it up for this issue. Next issue, we'll take a look at Newsgroups and List Servers, as promised earlier. Remember, it's not too early to start planning for the ACES Conference in Monterey in 94. Being the 10th anniversary of the founding of ACES, the organizers have promised an outstanding conference. I hope to see you there.

PERSPECTIVES

The ACES Newsletter continues this series of "Perspectives" articles to provide a forum for discussion of present and future needs in computational electromagnetics, areas of challenge, and potential electromagnetic solutions, and personal viewpoints on the subject. As a result of this discourse it is hoped that electromagnetics related problems and requirements can converge with prospective solutions. Perspectives from a wide range of applications and work settings will be represented, including international scientific institutions, educational institutions, government labs and agencies, and industry. Associate Editor Ray Perez is coordinating this effort. This issue features the following "Perspectives" article from the EPA sent by David Kleffman.

PERSPECTIVE SERIES

(The following are excerpts from document EPA/600/9-91/016A: "A Research Strategy for Electric and Magnetic Fields: Research Needs and Priorities". Final draft was recently published by the EPA)

Office of Research and Development
US Environmental Protection Agency

Dr. David Kleffman of EPA

Preamble

Recently, widespread media attention has been focused on whether adverse human health effects could result from exposure to electric and magnetic fields (EMF). Public and private concerns are based on research reports of a statistical association between EMF exposure to human populations and some forms of cancer, as well as measurable biological effects in laboratory animals, tissues, and cells. Although the existing evidence is insufficient for discerning a cause-effect relationship for EMF exposure and human decease or injury, it does suggest the need for further research to allow for a realistic assessment of the possibility of health risks and their magnitude.

The following article has been extracted from a draft document published by the Environmental Protection Agency which describes a strategic framework which identifies the major research topics and their relative priorities concerning EMF effects. The priorities in the draft document are based on a determination of which research topics are most likely to provide near-term results that will improve and/or strengthen the assessment of EMF health risks. The material herein described is only a portion of the overall strategy outlined by the document, but this portion of the document deals specifically with existing needs in the developing EMF mathematical models that would account for propagation, interaction, absorption, and coupling of EMF with biological tissue.

Biophysical Mechanisms

(from Chapter 3)

Studies of biophysical mechanisms are important because the research examines both stages of the interaction process: 1) the nature of the initial/chemical interaction of EMF with biological systems and 2) the expression of the physical/chemical change as a biological response. This information is needed to identify field parameters and biological responses important for health research.

There is substantial body of literature upon which theinvestigation of biophysical mechanisms can be based. It is apparent from this literature that EMF should not be considered a single entity, but rather a genetic class of physical agents, similar to classes of chemicals. Because of the infinite number of potential combinations of exposure parameters, such as frequency, intensity, modulation, etc; it is possible that more than one mechanism may account for the variety of EMF effects. Examples of reported biological responses to electric and magnetic fields include: a) alteration of melatonin synthesis in the pineal gland, b) response of brain tissue, e.g; ion flux changes and behavioral changes, c) intervention in biochemical signaling across the plasma membrane, including second messenger systems and protein-kinase action pathways that are important in the hormone induced responses, d) alteration in circadian rhythms, e) effects on developmental and immune processes, f) bone fracture healing, and g) alterations in gene regulation that are implicated in tumor production.

The biological effects of EMF can be best understood by a three-step paradigm: transduction, amplification, and expression. In the first step, energy in electric or magnetic fields must be converted, or transduced, into a biochemical or biophysical change to affect a biological system. The EMF intensities reported to cause effects and the photon energy of frequencies in the 0 to 500 Khz range are very small. Even if the transduction step were 100 % efficient, there is insufficient energy to break chemical bonds.

The second step, amplification, is needed to boost the initial biophysical changes triggered by the field. Amplification would then lead to the third step, expression of the effect as an observable entity in the laboratory; expression could occur through a constellation of both intra- and extra-cellular biological changes.

Advances in understanding the principles of physical interactions of EMF with biochemical and living cells will further define both transduction and amplification. Well-known biochemical amplification systems are probably also important to study in the context of EMF. Expression appears to be primarily caused by the interplay of various biological and biochemical systems. The following discussion of biophysical mechanisms is presented in two parts: physical interactions and biological interactions.

Physical Interactions: In the past, characterization of the physical interactions of EMF with biological materials emphasized electric field interactions. Recently, this focus has changed because data from epidemiological studies suggest that the magnetic component may be the active agent. Thus, interest has shifted to the biological consequences of the induced current resulting from a changing magnetic field. The biological influence of these magnetically induced currents has not been well characterized. Magnetic fields may also affect biological objects by acting directly through naturally occurring magnetic dipoles in the body.

Recommended research: The interaction of magnetic fields with biological systems needs to be explored to test the hypothesis that induced currents from oscillating magnetic fields are causative. It is important to establish whether the effects of currents induced by electric fields differ categorically from those produced by magnetic fields. These two issues, in addition to the evidence that the magnetic fields also interact with biological systems vis magnetic dipoles (e.g magnetic resonance imaging), need to be developed and examined for physiological significance and risk implications.

Other physical parameters establish and define the electric and magnetic conditions that cause biological changes. The field frequency can influence the reaction sites and processes that are affected. The biological response as a function of frequency can be used to identify the number and character of response sites. The intensity of the field is equally important, because it can provide information about kinetics of the response, which leads to specific biological processes. Furthermore, signal shape and temporal dynamics, including high peak-intensity single or multiple pulses, can have a substantial effect. In more limited situations, the presence of a static magnetic field and its orientation with regard to alternating electric and magnetic components has been shown to be an important feature of exposure.

Recommended research: Principles established in ultraviolet radiation biology, which examines biological responses as functions of field intensity, frequency, and time, should form the basis for the investigation of the biological effects of EMF. Adjunct studies should include examination of frequency, bandwidth, signal shape and modulation, and the involvement of the earth's magnetic field with frequency-specific effects. Furthermore, the interaction of combined electric and magnetic fields in biological systems should be examined.

Models of the interactions of EMF with biological objects can identify the critical physical aspects of the exposure situation that should be tested. Models that successfully predict effects can provide a basis for extrapolating exposure outcomes to other situations and to focus research planning. To utilize modeling capabilities, measurements and analyses must be performed at various levels of biochemical and biological organization. These range from measurements of the dielectric constant and magnetic susceptibility, and analysis of the thermodynamic models of chemical reactions, to analyses incorporating complex reactions innon-equilibrium systems. The emphasis of such models should be on intensities of EMF that would provide a basis to understand ambient exposure levels in terms of risk identification and assessment.

Proposed research: Models of possible mechanisms of action are needed. Such models could be molecular, thermodynamic, or non-equilibrium in nature. Some of the models developed for the study of EMF at frequencies above 500 Khz should be examined for relevance to lower frequencies. New models may also be required.

Exposure Modeling

(from Chapter 4, Sec. D)

Mathematical models to estimate EMF exposure have been developed because measurements of fields at all locations and under all conditions of interest is not practical. Two types of models, theoretical and statistical, are described here. The application of theoretical models usually involves a numerical solution in which field parameters are determined as a function of current or voltage on electrical conductors. The frequency of interest has a wavelength that is large compared to the dimensions of the exposed object and thus models, such as "quasi-static" models, can be applied to a range of frequencies. For example, the same model used to calculate 60 Hz fields near a power line may be used to determine higher frequency transient fields generated by the power line.

Theoretical models can only be developed for well-documented configurations of electric conductors and field-perturbing material. Thus, most theoretical modeling of fields has been applied to power transmission lines because such models can be constructed easily. Home and work environments with a number of sources have not been modeled, although some models have been made of ground currents in water pipes.

Statistical modeling makes use of magnetic field measurements of appliances and equipments at non-standardized distances within homes and work places. These models are used to develop statistical estimates of average exposure. Statistical modeling does not predict individual exposures, but provides estimates for groups of the population. This approach could benefit from characterization of important microenvironments where exposures occur, such as schools, homes, offices, and factories.

A combination of statistical and theoretical approximations of measurements data could be used to develop specific source, microenvironment, and general environment models to estimate EMF exposure. A measurement and source data base could be used to create exposure models to estimate human exposure to EMF sources and to evaluate the effectiveness of control technologies

Proposed research: Research on exposure modeling is needed to develop more refined models to estimate exposures resulting from sources in the home, workplace, and the outside environment. Modeling data are needed to complement EMF measurements programs and to support quality control programs.

EMF Coupling to Biological Objects

(from Chapter 4, Sec. E)

The previous sections have dealt strictly with determining the unperturbed electric and magnetic field in the absence of the human body. In the presence of a body, the electric field immediately outside the body is strongly perturbed and the intensity of the field may differ greatly from the unperturbed field. In contrast to the electric field, the magnetic field that penetrates the body is essentially unchanged. Both external electric and magnetic fields that vary with time induce electric fields internally and electric current inside the body is proportional to the induced internal electric field.

It is a common assumption that biological effects are related to the induced currents. However, it is not known whether low-level effects are caused by the internal electric fields and associated currents, by the magnetic field acting directly on magnetic dipoles or on moving electric charges, or by other exposure parameters. If effects are due only to the magnetic field acting directly, then further study of inductive field coupling would not be a priority. If the effects are at least in part due to induced electric fields and currents, then field coupling research is critical. Internal electric fields depend strongly on the size and shape of the exposed body or system. Thus, EMF coupling analysis is necessary when scaling internal electric fields or current from animal and in vitro exposures to human exposures.

Much of the work on EMF coupling analysis has involved a model in which the sample is assumed to be electrically uniform and linear. The internal field values obtained under these assumptions may be misleading. At lower frequencies, for example, it is likely that current flow principally around and not through cells. Therefore, extracellular current density may be much greater than the average current density calculated over a mass of tissue. Even if the details of the model seem complete from the physical perspective, caution needs to be exercised in extrapolating the results to a living organism because of the complexity of biological systems. The reports that weak electric and magnetic fields cause biological effects implies that processes such as amplification, that is, discrete bands of frequency and intensity selectivity can occur. The latter includes "windowed" responses, that is, discrete bands of frequency and intensity that produce effects separated by bands that have no effect.

Recommended research: Exploratory research is needed to develop models to explain how electric and magnetic fields interact with cells and tissue to produce the reported biological effects. Efforts in progress to develop better cellular and anatomical models of the electric characteristics of human beings, laboratory animals, and in vitro samples need additional support. Work on implantable probes for macroscopic and microscopic measurements of internal currents, voltages, and other field parameters in living systems should continue. A long-term goal is the development of a standard formula and unit of "dose" that is dependent on external exposure field and is proportional to biological effect and/or human health risk.

Changing Times for R&D and its Effect on Electromagnetics Research.

Addendum

Reinaldo Perez, ACES Newsletter Assoc. Editor

In the previous two articles this editor has addressed the status of R&D in this present worldwide economic climate as well as some insights that will better equip us in the search and acquisition of R&D resources. This addendum introduces you to the book Directory of Research Grants 1988.

This book is of public domain and available at many libraries, including university libraries and contains an impressive list of federal and private funding agencies. The book is organized by agencies (e.g DOE, DOD, NASA, EPA, NSF, ...etc) as well as the type of funding that they sponsor. Some agencies, like DOD for example, are broken up among all its branches (e.g Air Force, Navy, Army) and then the funding agencies for each of those branches are outlined for each funding agency the following data is given: a) name of funding agency, b) address, c) person to contact, d) type of research sponsored. As I went through the book I was able to identify many agencies (both private and federal) that sponsor electromagnetics-related research. A peculiar fact about this book is that actual names and titles of individuals to contact are given in this list, which is a more accurate approach than just institutional names. As you can see, however, this book was published in 1988 and there is a good chance that some of the individuals may not be still present at their post, hence, it is recommended that before contact is attempted, you verify the names of the responsible parties. Also, it is highly recommended that before you put yourself in the business of writing a proposal (a time consuming process) you make some preliminary contacts with the funding agency of your choice in order to find out details such as: a) type of proposal, b) all ingredients needed in the proposal (agencies have different requirements and guidelines), and c) type of research of most interest to the agency (i.e customer needs)!.

US AGENCIES

Dr. Howard Sorrows
National Academy of Science
Commission of Physical Sciences and Mathematics
2001 Wisconsin Ave, NW
Washington DC 20007
Phone: (202) 334-3483

Dr. Irene Peden
National Science Foundation
Section Head: Electrical Engineering & Information Systems
(see address below)

Drs. George Lea and Larry Goldberg
National Science Foundation, Electromagnetics Group
1800 G Street, NW, Room 1151
Washington, DC 20550
Phone: (202) 357-9618

Dr. David Crandall
Department of Energy, ER-54-G242
1000 Independence Ave
Washington, DC 20585
Phone: (301) 903-4596

Dr. Enloe Ritter
Office of Energy Research
High Energy Physics Division/Department of Energy
Washington, DC 20545
Phone: (301) 353-5228

Dr. Richard Ries
National Science Foundation for International Affairs
International Programs
1800 G Street, NW
Washington DC 20550
Phone (202) 653-5387

Dr. Dusan S. Zrnic
NOAA-ERL
National Severe Storms Lab
1313 Halley Circle
Norman, OK 73069
Phone (405) 366-0403/0401

Dr. Trevor Bird
Division of RadioPhysics
CSIRO
P.O Box 76
Epping, NSW, 2121, AUSTRALIA

Dr. Dave Kleffman
US Environmental Protection Agency
Office of Health Research Studies/ RD--683
401 M Street, SW
Washington, DC 20460
Phone: (202) 260--5900

Dr. Arthur Jordan
Naval Research Laboratories/Code 4213
4555 Overlook Drive
Washington, DC 20375
Phone: (202) 767-3055 / 1937

Dr. Arje Nachman
AFOSR/NM
Building 410
Bolling Air Force Base, DC 20332-6448
Phone: (202) 767-4939

Mr. Joe Faison
WL/XPN
Wright-Patterson Air Force Base, OH 45433
Phone: (513) 255-0277

Mr. Peter Mailloux
RL/ER
Hanscom Air Force Base, MA 01731-5000
Phone: (617) 377-3710

Dr. George Abrahamson
USAF Chief Scientist
AF/ST
The Pentagon, Room 4E320
Washington, DC 20330-5040
Phone: (703) 697-7842

Dr. Allen Schell
Chief Scientist, Air Force Systems Command
HQ AFSC/XT
Andrews Air Force Base, DC 20334-5000
Phone: (301) 981-4215

Lt. Con. L. Wagenhals
USAF Science Advisory Board
AF/NB
The Pentagon, Room 5D982
Washington, DC 20330

Dr. J.H. Richter
Head, Ocean and Atmospheric Science Division
Code 54
Naval Command Control Ocean Surveillance Center
RDTE Division
San Diego, CA 92152-5000

Dr. Imre Gyuk
Program Manager, Electromagnetics Research
Department of Energy
10000 Independent Avenue

Dr. E. Kutchma
Director of Weapons Systems Evaluation Directorate
Naval Air Warfare Center, Code 1000
Weapons Division
Point Mugu, CA 93041

Dr. Horst Wittmann
Director, Electrical and Material Science
AFOSR
Building 410, Room 223
Bolling Air Force Base, DC 20332-6448

Dr. C. H. Krueger Jr.
Director
WL/AAA
Wright- Patterson Air Force Base, OH 45433-6543

HQ USAF / RD-1/US National Coordinator for AGARD
The Pentagon, Room 4D-260
Washington, DC 20330-5040

Dr. H. Soicher
Center for Comm/ADP
USA Communications Electronics Command
ATTN: AMSEL- COM-TA-1
Ft. Monmouth, NJ 07703-5202

Dr. David Bodde, Executive Director
Commission on Engineering and Technical System
National Research Council
2101 Constitution Avenue, NW
Washington, DC 20418

Lt. Col Richard M. Maddox
HQ AFSPACECOM/LKNW
Peterson Air Force Base, CO 80914-5001

Dr. John Heckscher
Phillips Lab/LID
Hanscom Air Force Base, MA 01731-5000

Dr. John Ello
Executive Director, Defense Science Board
The Pentagon, Rm. 3D-65
Washington, DC 20301-3140

Dr. Peter Franchi
RL/ERAS
Hanscom Air Force Base, MA 01731-5000

Mr. Ronald Chase
Harry Diamond Laboratories
SLCHD-NW-EP
2800 Powder Mill Road
Adelphi, MD 20783-1197

Dr. Robert Dinger
Chief Electronics Engineer
Code 7324
NCCOSC/Radar Division
San Diego, CA 92152-5000

Dr. J.W. Mink
US Army Research Office
PO Box 12211
4300 S. Miami Blvd
Research Triangle Park, NC 27709-2211

Dr. Richard G. Brandt
Scientific Officer, Physics Division
Office of Naval Research
800 North Quincy Street
Arlington, VA 22217-5000

Dr. James G. Smith
Applied Technology Division
Office of Naval Research
800 North Quincy Street
Arlington, VA 22217-5000

Edward Kennedy
Branch Head, Code 5550
Naval Research Laboratory
4555 Overlook Avenue, SW
Washington, DC 20375-5000

US AGENCIES (Cont).

Dr. Irvin D. Olin
Associate Superintendent/Code 5348
Polarimetric Radar Section, Radar Division
Naval Research Laboratory
4555 Overlook Ave, SW
Washington, DC 20375

Dr. Robert J. Serafin, Director
Atmospheric technology Division
NCAR
P.O Box 3000
Boulder, CO 80307-3000

Dr. Jacob J. van Zyl
Radar Sciences and Engineering Section
Jet Propulsion Laboratory, MS/300-233
4800 Oak Grove Dr.
Pasadena, CA 91109

Otto Kessler
Manager
NADC, AS/F, Code 50B
Naval Air Warfare Center
Warminster, PA 18974-5000

Brenda L. Matkin, Head
Advanced sensor Division/RF and MM Guidance
ATTN:AMSMI-RD-AS-RF/Bldg. 5400
US Army Missile Command
Redstone Arsenal, AL 35898-5253

INTERNATIONAL AGENCIES

Director
NATO Scientific Affairs Division
ASI-ARW Programs
B-1110 Bruxelles. BEGIUM

Dr. Ing. Maruice Borgeaud
Wave Interaction and Propagation Section/Em Div.
ESA/ESTEC
P.O Box 299, Keppler Laan
NL-2000 AG Noordwijk, NETHERLANDS

Dr. Paul Rambout, Executive Director
Scientific and Environmental Affairs Division
NATO Headquarters
B-1110 Bruxelles, BELGIUM

Dr. Gert Brussard
Principal Propagation Engineer
ESTEC-ESA/ RF, System Division
NL-2201 AD, NOORDWIJK., NETHERLANDS

Dr. Alois Sieber, Director
Remote Sensing Program, Joint Research center
ISPRA Establishment
I-21020 ISPRA, Lago Maggiore
Varese, ITALY

Dr. Owen R. Cote
Chief, Geophysics and Space Electronics
Edison House
223 Old Marylebone Road
London, NWI-5th U.K.

Dr. Melvin D. Townsend
Director, Aerospace Electronics
AFOSR, European Branch Office
Edison House
223 Old Marylebone Road
London, NWI-5TH. U.K

D. Brammer / Adrian Britton
Royal Signals and Radar Establishment
St. Andrews Road
Gt. Malvern, Worcestershire, WR14 3PS U.K.

Dipl. Phys. Hans & Lotte Dolezalek
ONR-European Branch Office
Oceanography Division
223 Old Marylebone Road
London, NWI-5TH U.K

Dr. Donald H. Sinnott / Dr. Stuart J. Anderson
Microwave and HF Radar Divisions
Surveillance Science and Technology Organization
Australia Department of Defense
GPO Box 1650
Salisbury, SA 5108, AUSTRALIA

Director, radar Division
ONERA
29 Avenue de la Division Leclerc
F-92320 Chatillon/Bagneux, FRANCE

Dr. Edgard Clemens(*)
DLR, NE-HF
Munchener Strasse 20
Oberpfaffeenhofen-DLR
D-8031 Postamt Wessling, GERMANY
(*) Other names under the same address
Dipl. Ing. Karl-Heinz Bethke
Dr.-Ing. Herwing Ottl
Dr. Mahhu Chandra
Dr. Erns Luneburg
Dipl.-Ing. Karl Tragl
Dr.-Ing. Volker Stein
Dr. Fred Ritenberg
Dr. Wolfgang Keydel

Dr. John Gallagher
Microwave Signal Analysis
Royal Signals and Radar Establishment
St. Andrews Road
Gt/ Malvern, Worcestershire, WR14 3PS U.K.

Director
Royal Aerospace Establishment
Farnborough, Hampshire GU14 6TD U.K.

Jacques Dorey, Director
Electroncis Division, ONERA
29 Avenue da la Division Leclerc
F-92320 Chatillon/Bagneux, FRANCE

Director
Centro Ricerche Experienze Studi Applicazioni Militari
I-56010 San Piero a Grado, Pisa, ITALY

Professor J.D. van Wyk
Foundation for Research and Development
P.O. Box 395
0001 Pretoria, SOUTH AFRICA

1994 ACES Conference

10th Anniversary

Annual Review of Progress
in Applied Computational Electromagnetics
March 21-26, 1994

Doubletree Hotel and Convention Center at Fisherman's Wharf
Monterey, California

Plan on joining our 10th Anniversary Celebration scheduled for the beautiful Doubletree Hotel and Convention Center at Fisherman's Wharf in Monterey, California. All aspects of electromagnetic computational analysis are represented but particular emphasis will be placed on the following techniques and applications:

THEORY AND ALGORITHMS	APPLICATIONS
Electromagnetic Compatibility	EMC/EMI/EMP
Finite Difference Time Domain	Materials
Transmission Line Method	Specific Code Applications
High Frequency Theory	(e.g., NEC, GEMACS, TLM, FDTD)
(inc Aperture Antennas/GTD)	High Frequency Applications
Low Frequency Theory	(inc Aperture Antennas/GTD)
Inverse Problem Solutions	Microwave Circuits
Asymptotic Solutions	Antennas
Moment Method Theory	CAEME
Hybrid Methods	Super Computing
Multipole Techniques	Validation

Other topics of interest will include sessions addressing Input/Output Issues and Recent Impacts of Mathematics on Computational Electromagnetics. If you are interested in submitting a paper and did not make the October deadline, contact either Andy Terzuoli (513-255-3636, x4717) or Jodi Nix (513-476-3550) and arrangements might be available.

In addition to the technical sessions, the symposium features other areas of interest to the EM analysis enthusiast: short courses; demonstrations; invited speakers; poster sessions; and vendor exhibits. Special activities include an exhibit reception, 10th Anniversary Banquet, private tour of the Monterey Aquarium, Wine Appreciation Seminar and much more.

1994 ACES Conference Chairman:
Andy Terzuoli
Air Force Institute of Technology
2950 P Street, Bldg. 640, Rm. 210
Wright-Patterson AFB, OH 45433
Tel (513) 255-3636 X4717

Conference Advisor
Dick Adler
ECE Dept. Code ECAB
Naval Postgraduate School
833 Dyer Rd., Room 437
Monterey, CA 93943
Tel (408) 656-2352/Fax: 2955

Conference/Vendor Facilitator
Jodi Nix
Veda Incorporated
5200 Springfield Pike,
Suite 200
Dayton, OH 45431
Tel (513) 476-3550/Fax: 3577

Co-Chairmen:
Jeff Fath
SM-ALC/QL
3200 Peace Keeper Way, Suite 9
McClellan AFB, CA 95652-1034
Tel (916) 643-6935/Fax: 1053

Short Course Chair
Robert Lee
Ohio State University, EE Dept.
2015 Neil Ave.
Columbus, OH 43210-1272
Tel (614) 292-1433/Fax: 7596

Short Course Co-Chair
Jin-Fa Lee
Worcester Polytechnic Inst.
100 Institute Rd., EE Dept.
Worcester, MA 01609
Tel (508) 831-5778

1995 ACES Conference Chairman
Ray Luebbers
Penn-State University
320 Electrical Engineering East
University Park, PA 16802
Tel (814) 865-2362

VENDOR EXHIBITS

The types of companies which will be represented include: electromagnetic and microwave design software; super-computing and parallel computing hardware and software; workstations and their graphical computational tools; MMICAD products; CAE tool developers; modeling, data analysis, graphical computational tools; technical books and journal publishers, and technical magazines; identification and classification software system tools; instrumentation validation tools; antenna measurement and testing tools; antenna calibration systems; radar imagers; wave guide assemblies and sub-systems; and microwave components.

Exhibit dates will be March 22-24, 1994. The exhibits will commence at 4:00 p.m. March 22 with a complimentary wine/appetizer reception within the exhibit hall. March 23 will be a full day of exhibiting (8:00 a.m. until 5:00 p.m.) with complimentary continental breakfast held in the same area as the exhibits. The last day, March 24, will begin again during breakfast at 8:00 a.m. and will run until 1:30 p.m. We have structured the show to allow for great visibility of the companies present. Contact Jodi Nix, conference facilitator, if you are interested in obtaining more information and securing exhibit space.

SYMPOSIUM PRE-REGISTRATION

If you would like to pre-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.

Name: _____

Organization: _____

Address: _____

_____

Phone/Fax: _____

Enclosed is a check for: _____

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. $$); Bank Checks, (Only if: (a) drawn on a U.S. bank (b) have bank address; (c) contain a series of (9) digit routing numbers put on check when originated.

REGISTRATION

Registration fees include: attendance at all technical sessions (excluding short courses), vendor exhibits and poster sessions; conference proceedings; daily continental breakfast; break refreshments; and California wine reception (large assortment of appetizers).

	Before 1/14/94	1/15/94 to 3/1/94	After 3/1/94
Member Price	$235.00	$250.00	$265.00
Non-Member Price	$260.00	$275.00	$290.00
Full-Time Student*	$150.00	$160.00	$170.00
Retired/Unemployed	$150.00	$160.00	$170.00
* Proof of Full-Time Student Status is Required			

ACCOMMODATIONS

The Doubletree Hotel at Fisherman's Wharf. A block of rooms has been reserved at the beautiful Doubletree Hotel in Monterey. The Doubletree overlooks scenic Monterey Bay, where Fisherman's Wharf and historic Cannery Row are just a short stroll away and many of the guest rooms offer spectacular views of the bay. Hotel amenities include a heated pool, spa, elegant lounge, and delicious dining (conference attendees who stay at the Doubletree will also receive reduced rate lunches). There are non-smoking and handicapped accessible rooms available upon request. All meeting rooms and public outlets are wheelchair accessible. These rooms will be assigned on a space available basis.

Rates. A limited amount of the room block are offered at the Government rate. These rooms are available on a first come, first serve basis. Government attendees should make their reservations early. A special conference rate has been arranged with the Doubletree Hotel: Standard Rooms are available for $110.00 (single/double) and Superior rooms for $120.00 (single/double) with a 10% sales and city tax. The conference room rates will be available three days prior to, and three days after the dates of the conference, based on availability.

Reservations. Hotel reservations will be the responsibility of each attendee. Please call 1-800-222-TREE or 408-649-4511 to make your reservation. **When calling for your reservation, it is important to specify that you are with the ACES conference in order to receive the best room rates.** We encourage early reservations to ensure attendees are able to stay in the host hotel and take advantage of the many conveniences the Doubletree offers. All reservations must be received by February 27, 1994 in order to receive the conference room rates. Any reservations received after this date will be honored on a space and rate availability basis only.

Parking. A special self-parking rate of $5.00 has been arranged for conference attendees. This rate includes "in" and "out" privileges. Valet parking has been arranged for $7.00 per 24 hour stay.

SOCIAL EVENTS

The final registration packet will include information on the following: Tenth Anniversary Banquet; Monterey Bay Aquarium party; Wine tasting seminar; submarine tour of the Monterey Bay; Health Club pass; and Hot Air Ballooning by the Sea.

Sponsored by: ACES, DOD and DOE
In cooperation with: IEEE, URSI, ASEE, SIAM and AMTA

SHORT COURSE INFORMATION

The following descriptions delineate the short courses which are being offered at the ACES 1994 Symposium. Half of the courses will be given on Monday, March 21, 1994 and the remainder will be given on Saturday, March 26, 1994. {Note: Tues.-Fri. will be the technical sessions, vendor exhibits, and interactive poster sessions.} 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 94). If you are attending another short course which conflicts with the schedule of a course you would like to take, you may purchase the notes for half of the registration fee. If you have any questions please call Rob Lee at (614) 292-1433, or Jin-Fa Lee at (508) 831-5778.

WAVELET ELECTRODYNAMICS

Gerald Kaiser, Dept. of Mathematical Sciences, UMass-Lowell.
Maxwell's equations are symmetric under space-time translations and dilations. This is used to write an arbitrary solution as a superposition of *electromagnetic wavelets* $W^{k}_{\mathbf{b}\,s}(x,t)$, where $\mathbf{b}$ is a point in space representing the center of the wavelet, $s \neq 0$ is its scale, and $k \neq 1,2,3$ is its polarization index. Possible applications include: *(a) Designing electromagnetic waves with initial data specified locally and by scale. (b) An economic description of electromagnetic pulses emanating from moving or accelerating objects.* 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. Reference: G. Kaiser, *A Friendly Guide to Wavelets*, Birkhauser, available 1/94. **(FULL DAY-MARCH 21)**

TIME-FREQUENCY ANALYSIS

Leon Cohen, Hunter College and Graduate Center of CUNY.
There are many signals for which the spectral content changes in time. Among such signals are sonar, radar, communication, biological, speech, and geophysical signals. 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. **(FULL DAY-MARCH 21)**

FDTD FOR ANTENNAS AND SCATTERING

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. **(HALF DAY-MARCH 21, a.m.)**

VOLUME-INTEGRAL EQUATIONS IN EDDY-CURRENT NONDESTRUCTIVE EVALUATION

Hal Sabbagh, Sabbagh Associates.
This course will illustrate how computational EM can be used for modeling both forward and inverse problems. Sabbagh Associates code, VIC3D (a volume integral equation code which uses conjugate gradient and FFTs to solve problems, with 25,000 to 50,000 unknowns, on PCs), will be used. Applicable to realistic and practical direct and inverse problems. **(HALF DAY-MARCH 26, a.m.)**

USING MODEL-BASED PARAMETER ESTIMATION TO INCREASE EFFICIENCY AND EFFECTIVENESS OF COMPUTATIONAL ELECTROMAGNETICS

Ed Miller, Los Alamos National Lab.
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 models can be helpful in ways ranging from reducing the computer cost of achieving desired solutions to developing more compact representations of observables. The approach is to estimate unknown parameters of the models from sampled data, a process called "model-based parameter estimation" (MBPE). This lecture will survey applications of MBPE in electromagnetic modeling and demonstrate some of our benefits that results. **(HALF DAY-MARCH 21, p.m.)**

FINITE ELEMENT METHODS FOR ELECTROMAGNETICS

Jin-Fa Lee, Worcester Polytechnic Institute;
Robert Lee, Ohio State University;
Tom Cwik, Jet Propulsion Laboratory;
John Brauer, MacNeal-Schwendler Corporation.

The 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. **(FULL DAY-MARCH 26)**

GEMACS FROM A-Z

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 EM problems, such as antenna radiation, structure coupling, scattering, etc. Emphasis is 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. **(FULL DAY-MARCH 26)**

WIRE ANTENNA MODELING USING NEC

Richard Adler, Naval Postgraduate School;
James Breakall, Penn State University;
Gerald 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. **(FULL DAY-MARCH 26)**

GENERAL APPLICATION OF PHYSICAL OPTICS TO CURVED SURFACE SCATTERING (QSP)

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. **(HALF DAY-MARCH 21, a.m.)**

ELECTROMAGNETIC CHARACTERIZATION OF ELECTRONIC PACKAGES

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 element, finite difference and integral equation techniques used to extract package parasitics, predict electromagnetic performance, to assist design will be discussed. The intention is to discuss the advantages and disadvantage of the various methods in the context of the geometric and material complexity of the electronic/opto-electronic packaging structures, and comment on advances required for the development of a realistic electromagnetic CAD environment for electronic package design. **(HALF DAY-MARCH 26, a.m.)**

MEASUREMENT VALIDATION FOR COMPUTATIONAL ELECTROMAGNETICS

Al Dominek, Ohio State University.

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-MARCH 21)**

SHORT COURSE REGISTRATION INFORMATION

The price for a full day course is $140.00 before 3/1/94, and $160.00 after 3/1/94. The price for a half day course is $90.00 before 3/1/94, and $110.00 after 3/1/94. 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 94). If you are attending another short course which conflicts with the schedule of a 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 full refund.* Return the form and payment to: Jodi Nix, Veda Inc., 5200 Springfield Pike, Suite 200, Dayton, OH 45431.

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

Short Course Fees Do Not Include Attendance At The Symposium.
Short Courses Can Be Taken Without Attendance At Symposium, If Desired.

For information regarding ACES or to become a member in the Applied Computational Electromagnetics Society, contact Dr. Richard W. Adler, ECE Department, Code EC/AB, 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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