

IEEE

# Electromagnetic Compatibility Society



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EDITOR: ROBERT D. GOLDBLUM

## SOME EXERCISES IN *PRACTICAL* ENGINEERING ETHICS JOSEPH H. WUJEK, IEEE SENIOR MEMBER MANAGER-SCIENTIFIC COMPUTING, APPLE COMPUTER, INC.

### Introduction

Ethics in general, and engineering ethics in particular, are subjects not often discussed. One notes a degree of cynicism among the public at large, if reaction to events in Washington and Wall Street, and to the behavior of some television preachers and their associates, is a valid measure. Perhaps the very suggestion of discussion of philosophic principles is sufficient to cause a negative response among many. Philosophy, after all, requires profound thought.

Yet questions of ethics, morality and legality, not at all synonymous labels, are always present. Apart from the application of personal values, one needs to be able to deal with these matters. It has been my belief, and that of several colleagues, that the IEEE must maintain a forum for these matters.

Thus in April 1987, the Santa Clara Valley Chapter of the Electromagnetic Compatibility Society organized a colloquium on engineering ethics. (Details of the meeting, "Integrity in Engineering, The Role of Ethics in Practice," will be found in the Summer 1987 edition of the EMC Society Newsletter, pages 4 and 5.) An edited printed transcript of the presentations (discussions omitted) of the colloquium was prepared by Wujek and Hanttula and is available through the Santa Clara Valley

Chapter of the EMC Society. It is being distributed at cost to IEEE members and students, and copyright has been waived for copying by educational institutions. **To obtain a postpaid copy, send a check (\$5.00 to IEEE Members and students, \$6.00 to nonmembers of IEEE) payable to "SCV EMC" to the Chapter Secretary, Mr. Steve Cabral, Apple Computer, Inc., 20525 Mariani Avenue, M/S 26-A, Cupertino, CA 95014.** The document will be sent by First Class mail.

To stimulate colloquium audience discussion, I prepared hypothetical scenarios and corresponding questions. These were drawn from anecdotes and discussions among the colloquium planners. Although generally fictitious, the scenarios are believed to represent a composite of case histories, hearsay and credible occurrences.

In November 1987, as a result of an invitation by Professor Robert J. Baum of the Department of Philosophy of the University of Florida, these scenarios were presented by me and discussed at a seminar at that institution. Present were faculty members and students from engineering and other departments. It occurred to me that others could benefit from such discussions. Hence the scenarios are reproduced below, **without copyright**, with the intent that others may copy and use them as a seed to discuss-

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## EDUCATION COMMITTEE NEWS

Dave Hanttula, Chairman of the EMC Society's Distinguished Lecturer Program, has announced the selection of the first two of four Distinguished Lecturers. Those selected are: Roger Southwick and Herb Mertel. See the announcement elsewhere in this newsletter. The remaining two Distinguished Lecturers will be selected by June 1, 1988.

The following letter was received from Tony Nasuta, Westinghouse Electric Corporation. It is my feeling that the content is *food for thought* for all of us.

"Upon reading the 1987 EMC Society International Symposium 'Keynote Address' by Rear Admiral R.J. Grich, USN, which was in the Fall 1987 issue of the EMC Society Newsletter, a thought came to me that I would like to pass on to you for consideration by the committee. It struck me that the Admiral was presenting a challenge to the EMC Society as a whole, and the Education Committee in particular, by his suggestion of an ACADEMIC thrust for achieving EMC in the complex weapons systems of today and tomorrow. The following quote from his speech seems to me to express the heart of this challenge:

'EM environment considerations need to be organized and systemized into an engineering discipline, taught in our engineering curricula and applied in design and production to help reduce the unexpected performance penalties.'

This challenge, if taken seriously, obviously extends beyond the EMC Society into the academic community. However, there are some things which the EMC Education Committee *could do* to respond to this challenge. Let me be specific:

1. As a spin-off of the Distinguished Lecture Series, the Committee could offer 'Guest Lecturers' to engineering schools to speak on the EM environment and the need for EMC.
2. Extend the same offer to Student Chapters or groups of the EMC Society.
3. Offer the EMC video tape to this same academic community thru direct mailing contact with these Institutions.
4. Create another tape, or modify a version of the existing tape, to include Admiral Grich stressing the importance of EMC.

Obviously, these ideas require additional thought and discussion; and I have not addressed at all the funding of them. However, if you feel there is any merit to them, perhaps additional discussion among the Education Committee members could help shape them into a workable response to Admiral Grich's challenge."

I think that Mr. Nasuta has raised some interesting points that deserve the Committee's attention. Anyone with comments on the above, or anyone who is willing to work at implementing any of the above suggestions should contact the Education Committee.

Henry Ott  
Chairman, EMC-S Education Committee  
Henry Ott Consultants  
48 Baker Road, Livingston, NJ 07039, (201) 992-1793

## NEWSLETTER STAFF

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Robert D. Goldblum  
R&B Enterprises  
20 Clipper Road  
W. Conshohocken, PA 19428

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sions. (These also appear in the *transcript*, noted above.) Although the materials deal with EMC/Safety, which are often lumped together in corporations, the principles involved are much more general.

It is suggested that organizations such as EMC Chapters hold a meeting with these scenarios as the discussion focus. The materials could be mailed in advance to potential attendees, although this is not necessary. (*Indeed, for spontaneity and "real world" simulation it's probably better to have the participants "think on their feet" about these matters.*) Other professional societies and educators may have application for this material, or it may suggest other ideas. The author will be pleased to help you plan a meeting on engineering ethics. Your comments and questions are welcome and may be directed to the author at Apple Computer, Inc., 20525 Mariani Avenue, 22-Y, Cupertino, CA 95014 or telephone (408) 973-3084.

### The Scenarios

These scenarios are fictitious. However, they are based on a composite of situations which may have occurred in several distinct cases and credible events.

#### SCENARIO A

You are an engineer charged with the responsibility of performing electromagnetic compatibility (EMC) testing of your company's products. You are solely responsible for signing, and thus certifying, that a product is in compliance with U.S. Federal Communications Commission (FCC) Rules, Part 15J. Products cannot be marketed legally unless compliant to the Rules.

A new product, the Gee-Whiz (GW) is to be introduced by your company at a trade show in three months. The factory is poised to begin high-quantity ("volume") production of the GW. The market strategy calls for your company to have "many units" in inventory so as to be able to deliver in quantity as soon as the GW is announced at the trade show.

You have tested five units from the first pilot-production runs. These are known to be within the "QA-spread" of production; that is, they are statistically-representative of what may be expected from high-volume production.

You find that the five units are over the FCC limits for E-field radiated emissions at four different frequencies in the test-spectrum. These were found only by very careful lab technique, each are narrow-band "spikes." These over-limit emissions are within the bands assigned to FM, TV and emergency communications, and range from 3.9dB to 5.8dB (stationary-averages) over-limit. At these measurement narrow-bands the combination of uncertainties in measurements (precision of instruments, site, all known sources of error) results in a Standard Deviation of 1.9dB. This means that 98% of production would be over-limit at one or more narrow-bands, and that 10% of production would be over-limit by at least 8.2dB. You have checked calibrations yourself and independent checks by others agree with your results. Moreover, a check with a calibration-standard verifies the validity of

your measurements. Hence, you must conclude that the test results are correct to within the stated statistical uncertainties.

At a meeting of the GW project team you announce your findings. After discussion, it is clear that everyone accepts the validity of your measurements. It is impossible to make changes in design or production to bring the GW into FCC-compliance to meet the trade-show deadline. If the GW is not announced at the trade show the product will lose an incalculable "competitive edge" in the market, which means lost sales opportunities. Moreover, the company will be embarrassed because of "press leaks" which tout the GW as an outstanding product.

In the meeting, the marketing vice-president, turns to you and says, "You don't want to be the one who causes the company an enormous loss, do you? Do something so that we can market the Gee-Whiz as we planned!" There is a general nodding of heads to this latter statement and the meeting disbands.

After the meeting you receive advice and commiseration privately, in turn, from several people who were in the meeting. Some of their comments:

- "Let it go . . . it's only a few dB . . ." (3dB above limit is 40% above the electric-field limit)
- "Who'll know?"
- "Everybody does it . . . it's not as if there's public safety at stake."
- "It's not as though you'd be doing something criminal."
- "The FCC limits are arbitrary . . . a few dB won't matter that much to TV reception. Television programs are garbage anyway!"

1. What do you do?
2. Suppose your manager submits the data (over the manager's signature) such that it appears the GW is compliant. What do you do?
3. Your manager tells you to ignore the tolerances, ". . . that's only statistics. The 'real numbers' are what count!" What is your response?
4. Your manager orders you to represent the data as compliant, sign the report and submit it to the FCC. What do you do?

#### SCENARIO B

You are an engineer charged with performing safety-testing and obtaining appropriate regulatory agency or outside testing laboratory ("agency") approvals of your company's product. The Gee-Whiz Mark 2 (GWM2) has been tested and found compliant to both voluntary and mandatory safety standards in North America and (non-Soviet bloc) Europe.

Because of a purchase-order error and subsequent oversights in manufacture, 25,000 units of GWM2 ("bad units") were built which are not compliant to any of the

North American or European safety standards. Because of this, a user of bad units would be much more vulnerable to electric shock than would be the user of a compliant unit. Under some combinations of plausible events the bad-unit user could be electrocuted. Retrofitting these products to make them compliant is not feasible because the rework costs would exceed by far the profit margin. All agree that because of this defect the safety labels will not be attached to the bad units, per the requirements of the several agencies. Only two alternatives exist:

- (a) Scrap the units and take the loss.
- (b) Sell the units.

An employee of the company notes that many countries do not have safety standards of any kind for this type of product. It is suggested that the bad units be marketed in these countries. It is pointed out that many of these nations do not have electrical wiring codes of, if codes exist, they are not enforced. The argument is thus advanced that the bad GWM2 units are no worse than the modus operandi of the electrical practice of these countries and their cultural value. Assuming that no treaties or export regulations would be violated:

1. What is your recommendation?
2. Suppose one of the countries under consideration was the country of origin for you or your recent ancestors. Would this affect your recommendation?
3. Now suppose you are not asked for a recommendation, only an opinion. What is your response?
4. Suppose it is suggested that the "bad units" be sold to a third party who would very likely sell these to these countries? Your comment?
5. You are offered gratis one of the bad units for your use at home, provided you sign a release indicating your awareness of the condition of the unit and that it is given to you as a "test unit." (Assume you can't retrofit it and that the product could be very useful to you.) Would you accept the offer?
6. Suppose it is suggested that the offer above (item 5) be made to all employees of the company. Your comment?

#### **ADDITIONAL DISCUSSION**

An EMC consultant operating a test-site installs a new antenna system and finds that it results in E-field measurements consistently higher than those obtained with the "old" antennas. Both "track" within the site-calibration limits and both antenna vendors claim NBS traceability. Which system is the better in absolute calibration is thus unknown. There is not sufficient time to resolve this discrepancy before a client's new product must be tested for FCC Part 15J compliance.

1. Which antenna system should be used to test the product?
2. Is averaging the results ethical, assuming engineering judgement indicates this is valid?
3. Suppose the site was never properly (scientifically/statistically) calibrated. Should this fact be made known (voluntarily) to the FCC?

## **TRAVEL DATES TO SEATTLE EMC SYMPOSIUM EXTENDED**

New extended travel dates added to the EMC Symposium travel arrangements will allow attendees and those traveling with them to stay over in Seattle an additional week and weekend and still use the discounted fares. The Symposium Committee notes that visitors vacationing in the Seattle area in August can take advantage of Seattle's best weather and the Seafair celebration, too.

A special convention airfare has been arranged with United Airlines, the official airlines for the 1988 IEEE International Symposium on Electromagnetic Compatibility. A five percent bonus discount off United's published fares is available when you travel to Seattle for the conference. All conference attendees, exhibitors and their traveling companions are eligible for this exclusive offer.

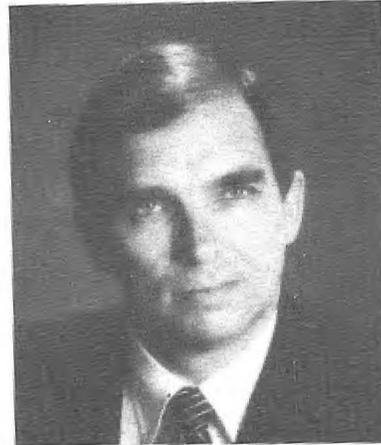
Qualification requires that you fly United round trip to Seattle between July 27 and August 14, 1988 and meet all restrictions of the fare to which the discount is being applied. If you cannot meet the restrictions of the many discount fares United offers, a special forty percent discount from the normal coach (Y) fare will be offered. No minimum stay or advance purchase is necessary for this 40 percent savings.

Travel at these fares is permitted from all points in the United States including Alaska and Hawaii. (Attention international attendees: It is possible for all travel arrangements to be made for your travel to and from the United States.) Reservations and ticketing at these special reductions are available only through Global Express-Southcenter Travel, the official travel coordinator for the IEEE/EMC 1988 Symposium.

Here's what you should do *today* to take advantage of these special travel savings:

- **Call Cathy Gunstone at Global Express-Southcenter Travel, (800) 456-8183 toll-free, between the hours of 8:30 am and 2:00 pm Pacific Time.**
- **Cathy will provide all information and make reservations for all flights and fares. Tickets will be mailed to you upon receipt of payment.**
- **Seats are limited and there are restrictions on some fares, so call early for the best availability. Fares are guaranteed at the time of ticket purchase.**
- **Arrangements for car rental or pre- and post-conference travel is also available. Special packages to Victoria or Vancouver, British Columbia, Alaska or vacation spots in Washington State can be reserved for you and your family.**

# PRESIDENT'S MESSAGE



by Donald E. Clark

It was truly an honor to be elected President of the Society, and I look forward to working with the Board of Directors and you, the members, during 1988. I feel very fortunate to have an experienced and able Board to assist me and to have an outstanding membership to support our activities.

Past-President Len Carlson contributed much over the past two years, and we all owe him a vote of thanks. The new Board plans to continue the programming that Len and other Past-Presidents initiated. Due to their efforts and that of our members and committees, the status of the EMC Society is excellent. The Society's membership continues to increase and the total membership now stands at 3082. During 1987 our Society was one of the top five fastest growing societies in the IEEE. Our finances continue to be sound and our net worth now stands at approximately \$304,000. Our symposia continue to be successful. Each year they have been a financial success and their attendance continues to increase from year to year. The Transactions and newsletters are of high quality and continue to improve every year. The interaction between the Society's Board of Directors and the local Chapters is improving. The ANGEL program has been set up to assist Chapters with problems and with financial support. Each year at the Symposium, a Chapter Chairmen's breakfast is held to provide an opportunity for first-hand exchanges. The Society has been very successful in the number of Fellows awarded to its members. The standards activities in our Society have been outstanding in recent years. The Society's activities in education have been many, including announcements of continuing education short courses, special sessions on education at symposia and the initiation of a Distinguished Lecturers Program. The Technical Advisory Committees have served as technical paper reviewers for the recent symposia, and the quality of the symposia papers is improving each year. We now have in operation a good public relations program and our professional services to the members are improving. Each year our Society is becoming more internationalized and Chapters now exist in Canada, Israel and Japan. The Society is now holding

meetings in conjunction with the IEEE Technical Activities Board (TAB) and our attendance at the TAB meetings has improved. As a result, we are getting more visibility within TAB and among other societies. Overall, we can be pleased and proud of our Society's status.

This past February, a planning workshop was held in San Antonio so that the officers and directors could identify goals, rank priorities, and prepare plans. Plans were prepared for two levels of activities: one for the Board and one for the overall Society. At the Board level, a number of administrative housekeeping items were addressed. At the Society level, a number of needs were identified for Chapter and membership activities. The overall plans will be presented to the Board of Directors in April for further discussion and approval. A written plan will then be prepared to act as a silent witness to our progress.

Thus, in summary, our Society is active, progressive and growing. We are off to a good start in 1988 and with your help and participation, 1988 will be another good year.

Donald E. Clark, President  
Electronics Research Building  
Georgia Tech Research Institute  
Atlanta, GA 30332

## REPORT OF DIVISION IV DIRECTOR

The Board of Directors of the IEEE met in Orlando, Florida, on November 22 and 23. There are a number of items from that meeting I would like to report to you.

The Board, taking note of the members majority vote for the proposed constitutional amendment, debated at length the number of candidates to put up for President-elect and Vice-President in 1988 and how best to do so. As a result of this debate, the Board voted to use approval voting in 1988. In a certain sense, this is a new concept in voting procedure, although it is presently used by a half-dozen or so states. Approval voting means that you can vote for as many, or as few, candidates as you approve of. For example, there will be three candidates for Executive Vice-President in 1988. Under approval voting you could vote for zero, one, two or three candidates. Obviously voting for all three would have the same effect as voting for zero. Thus, the real voter decision is whether to vote for one or two. Either choice is a valid vote (which makes this a friendly change in voting procedure).

After hearing testimony from an outside expert in voting procedures, the Board decided to use approval voting in 1988 since approval voting provides the best way for the majority view to prevail in contests where there are three or more candidates without the need for expensive run-off elections. Additionally, it is a procedural change that will not result in an increase in invalid ballots.

Approval voting will be sort of an experiment in 1988 to see how well it works, how well the members like it and to see if it will generate increased interest in the elections as evidenced by the number of ballots cast. Please give it a try. After you have done so, let us know how you like it.

Next, I would like to follow up on two items I have mentioned in some previous newsletters. As a member of the Board, I am expected to attend at least four Board-related meetings per year. These meetings, which include TAB and TABopCom meetings, extend over 5 or 6 days each time. In addition, each of the 5 societies in Division IV has at least two administrative meetings per year. And further, for 1988 I will be a representative of the Board of Directors on the EAB (Educational Activities Board), which meets at least three times a year. To keep my travel within tolerable limits I have chosen not to routinely attend Society administrative meetings because, in part, most matters that come before the Board are not the same things that come before the Societies at their meetings. There are some disadvantages in this, one of them being reduced communication between the Board and the Societies. Thus, in my second year, fortified by greater familiarity with the directorship and the issues before the board, I will attempt to attend some of the Society ad-



by Gary A. Thiele

ministrative meetings. I was pleased to be able to attend part of the recent EMC administrative meeting in Orlando this past November.

The final item I would like to report on is the progress on the matter of reviewing the operation of the IEEE. This year's President, Henry Bachman, has taken a personal interest in this matter and is off to a significant start in conducting a review. He will be able to spend even more time on the review in 1988 once his Presidential duties are behind him. The Board is quite interested in this issue and will be following it closely, having already participated in the initial phase with President Bachman.

Gary A. Thiele  
Director, Division IV

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## FOURTH ANNUAL AFCEA SYMPOSIUM

The Armed Forces Communications and Electronics Association will hold its Fourth Annual Symposium and Technical Display on August 16-18 at the Franklin Plaza Hotel in Philadelphia, PA. The Symposium theme will be "C<sup>3</sup>I Technology, Information and Security: Protection vs. Dissemination."

Major topic areas will be military operations and C<sup>3</sup>I/CM, security and business, government and C<sup>3</sup>I: changing elements. Program sessions on security topics will include TEMPEST, EMI and RAD. For more information, contact the AFCEA Philadelphia Chapter, c/o Unisys Corporation SDG, P.O. Box 517, Paoli, PA 19301.

## FIRST TWO DISTINGUISHED LECTURERS CHOSEN

At their January 29, 1987 meeting, the Board of Directors approved the following proposal for the establishment of an EMC Distinguished Lecturer Program:

"It is hereby proposed that the Board of Directors authorize the establishment of an EMC Distinguished Lecturer Program, wherein no more than four lecturers will be selected and engaged to present a maximum of four lectures each per year on subjects relating to EMC. Presentation of lectures at other than EMC-S chapters and functions is encouraged. Lecturers shall solicit funds to offset expenses from their affiliation and/or the inviting organization. Non-reimbursed expenses not to exceed \$750 per lecture will be paid by the EMC Society."

"A Program Chairman will be nominated by the Education Committee and approved by the Board of Directors. The Chairman shall have the authority to select lecturers, topics, and approve the expenditure of funds within a budget approved by the Board of Directors. The Chairman must be a member of the EMC-S, will serve a two-year term and cannot also serve as a Distinguished Lecturer. The Chairman shall report annually on the status of the program to the BOD."

"Distinguished Lecturers will be selected by the Program Chairman from written nominations submitted by members of the EMC-S. The Distinguished Lecturer must be a member of the EMC-S. Distinguished lecturers will serve in that capacity for two years, and may not serve two consecutive terms. The lecturers will be selected based on: (1) topic of lectures, (2) lecturer's area of expertise, (3) lecturer's presentation skills and (4) balance of all topics. The topics, abstracts and biographical sketches for each lecturer will be published in the EMC-S Newsletter."

"The lecturers will be responsible for obtaining prior approval for a lecture from the Program Chairman, and for submitting a travel expense statement and receipts to the EMC-S Treasurer for reimbursement. Copies of the expense statement and receipts will also be sent to the Program Chairman."

"The Education Committee will prepare, and the BOD will approve, a set of guidelines to be used by the Program Chairman in administering the program."

David M. Hanttula, Chairman of the Program, announces the first two speakers selected:

Herbert K. Mertel  
Emaco, Inc.  
PO Box 22066  
San Diego, CA 92122  
(619) 578-1480

Roger A. Southwick  
EMC Consulting  
2716 N. Estrella  
Tucson, AZ 85705  
(602) 792-9491

The term of both Lecturers will run from the present to June 30, 1989. The second two Lecturers, whose terms will run from July 1, 1988 to June 30, 1990, have not yet been selected. They will be selected by July 1 as reported in the Program Chairman's last status report.

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## NOMINATIONS FOR BOARD OF DIRECTORS

Nominations are now being accepted for election of the IEEE EMC Society Board of Directors. In accordance with the by-laws, nominations can be by petition or by the Nominating Committee. The petition shown below shall carry a minimum of 15 names of Society members, excluding students. Nominees should possess significant technical and professional stature in electromagnetic compatibility and should have adequate resources and/or backing to be able to attend three BODS meetings per year and be able to actively contribute to the Board of Directors, including committee activities, correspondence, telephone calls, etc. Nominees must be a full member of IEEE and a member of the EMC Society. No member can serve for more than six consecutive years, including partial terms. All nominees are required to submit a biographical summary to the Nominations Chairman. The summary must not exceed one-half typewritten page and must be in the following format:

1st paragraph: Name, title, place of employment, educational background.

2nd paragraph: Technical and professional experience.

3rd paragraph: IEEE service and activities including offices, committees, awards, etc.

Petition forms and information can be obtained from the Nominations Chairman.

Please submit petitions and biographical summaries post-marked no later than June 14, 1988 to:

B. Leonard Carlson  
Nominations Chairman  
516 Snoq. River Road, S.E.  
Carnation, WA 98014  
(206) 773-6297

B. Leonard Carlson,  
Nominations Chairman

# NOMINATION PETITION IEEE ELECTROMAGNETIC COMPATIBILITY SOCIETY BOARD OF DIRECTORS

I. NOMINEE'S NAME: \_\_\_\_\_  
 MEMBERSHIP NO.: \_\_\_\_\_  
 ADDRESS: \_\_\_\_\_  
 \_\_\_\_\_  
 PHONE: \_\_\_\_\_

II. BIOGRAPHICAL SUMMARY: ATTACH TYPED COPY

III. SIGNATURES: (Minimum of 15 names.)

We, the undersigned, all of whom are current IEEE Electromagnetic Compatibility Society (EMC-S) members in good standing, nominate the above mentioned person to serve on the EMC-S BODS for a three-year term beginning January 1, 1989.

	MEMBER'S NAME (PRINT)	SIGNATURE	MEMBERSHIP NO.
1.			
2.			
3.			
4.			
5.			

## 1988 MEMBERSHIP DIRECTORY

Containing over 2000 pages, the paperbound *1988 IEEE Membership Directory* provides quick access to the name, current location and title of over 240,000 IEEE members and Affiliates in over 137 countries (student members are not included). Listings include telephone numbers, when authorized.

In addition to the roster, the *Directory* contains a listing of over 3900 IEEE Fellows, including their citations and other awards; winners of 25 major IEEE Awards for outstanding achievement in science and technology, from their inception; IEEE past presidents and directors. Included, also, is a section on the purposes, organization and history of the IEEE and requirements for the attainment of various membership grades.

Mobility within the fields of electrical/electronics/computer science and engineering is large. In the IEEE it amounts to a 50% change in member addresses over the course of an average 18-month span. As the *Directory* is not reprinted once it goes out of stock, it is recommended that orders be placed in advance of the *Directory's* mid-April publication date in order to assure possession. Also, orders placed now will receive expedited delivery directly from the printer.

The *1988 IEEE Membership Directory* (JH83345) is priced at \$50.00 for IEEE members and \$126.00 for non-members. The Directory may be ordered in advance from the IEEE Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331. Please add \$4.00 for postage and handling charges.

## FUTURE EMC-S SYMPOSIA SCHEDULE

<b>1988</b>	—Seattle WA, August 2-4 Westin Hotel Papers: Tom Herring (206) 463-3567 Registration: Dave Dennis (206) 525-9336
<b>1989</b>	—International Nagoya, Japan; September 8-10 Secretariat: Professor Y. Miyazaki Telephone: 0532-47-0111, ext. 576 Fax: 0532-45-0480
<b>1990</b>	—National Denver, CO; May 23-25 The Radisson John Adams (303) 497-3348
<b>1991</b>	—Washington, DC; August 21-23 Washington Hilton Thomas W. Doepfner (703) 664-3477
<b>1991</b>	—New Jersey; August Cherry Hill Hyatt Cherry Hill, NJ Donald N. Heirman (201) 834-3566

## ISAP '89 JAPAN

The 1989 International Symposium on Antennas and Propagation, Japan (ISAP '89 Japan) will be held at the Nippon Toshi Center in Tokyo, Japan, from August 22 (Tuesday) through August 25 (Friday), 1989. This Symposium, the fourth ISAP in Japan, is sponsored and organized by the Institute of Electronics, Information and Communication Engineers (formerly the Institute of Electronics and Communication Engineers of Japan) and is supported by the International Union of Radio Science, the Antennas and Propagation Society of the Institute of Electrical and Electronics Engineers and the Electronics Division of the Institution of Electrical Engineers.

The topics shown here are suggested; papers concerned with other aspects of antennas and propagation will also be considered. In addition, the Steering Committee has designated five special topics for inclusion in the program to treat these new trends in research and development in antennas and propagation:

- **Antennas and Related Topics**
- **Propagation and Related Topics**
- **Electromagnetic Wave Theory**
- **Special Topics**

Original papers are solicited that have not been presented previously and that describe new contributions in the area suggested in the SCOPE. Each author is requested to submit one English original and two duplicated copies of a 4-page paper, including all text, references, figures and photographs. As papers will be reproduced for the *Proceedings* from author's originals, please request complete specifications for format of papers. The ISAP '89 Japan submission deadlines are:

Final call for papers:	August, 1988
Deadline for submission of papers:	March 1, 1989
Notification of accepted papers:	May 1, 1989
Deadline for advance registration:	July 1, 1989

The working language is English. Poster sessions will also be scheduled.

For further information please write to:

Dr. Takashi Katagi,  
Chairman of ISAP '89 Publicity Committee,  
Mitsubishi Electric Corporation,  
325 Kamimachiya, Kamakura, 247 Japan  
telephone (0467) 44-8862, Fax (0467) 47-2005  
or Telex 3862-165 MELCO J.

## EMP NOTE SERIES

The following EMP-related notes have been published and distributed recently:

- MaN 87 "A Note on an Initial Value Problem Associated with a Distributed Switch for Launching Spherical Waves," Alexander P. Stone, Department of Mathematics and Statistics, University of New Mexico, October 1987.
- SSN 308 "Design of Two-Dimensional EM Lenses Via Differential Geometric Scaling," A.P. Stone, Department of Mathematics, University of New Mexico, Albuquerque, NM 87131 and C.E. Baum, Air Force Weapons Laboratory, Kirtland AFB, NM 87117, October 1987.
- SwN 27 "Breakdown of Uniform Field Pressurized SF<sub>6</sub> Spark Gaps as a Function of Charge Time," Ian Smith, Pulse Sciences, Inc., 600 McCormick Street, San Leandro, CA 94577, June 1987.
- IN 458 "A Study of Overhead Line Responses to High Altitude Electromagnetic Pulse Environments," F.M. Tesche, LuTech, Inc., 3742 Mt. Diablo Blvd., Lafayette, CA 94549, December 1986.
- SSN 298 "Networks for Producing Composite Magnetic Dipole Moments from Various Loops," James D. Quinn and Carl E. Baum, Air Force Weapons Laboratory, January 26, 1987.
- TN 354 "A Nominal Set of High-Altitude EMP Environments," Conrad L. Longmire, Robert M. Hamilton and Jane M. Hahn, Mission Research Corporation, P.O. Drawer 719, Santa Barbara, CA 93102-0719, January 1987.

Copies of these notes may be obtained directly from the author, from the Defense Documentation Center, Cameron Station, Alexandria, VA 22134, or from the note series editor, Dr. Carl Baum, Air Force Weapons Laboratory (NTAAB), Kirtland AFB, NM 87117-6008. Non-U.S. citizens desiring the most recently published notes should request copies directly from the authors or through their embassies. In addition, these notes are available at many universities and companies doing research in EMP and electromagnetic theory. The EMP note series actively solicits contributed papers in this area for publication. For such contributions, contact Dr. Baum.

# INTER-SOCIETY ACTIVITIES



by Walt Mc Kerchar

## **SAE Committee AE-4 On Electromagnetic Compatibility**

The first meeting of the newly-formed SAE Committee AE-4, Aircraft Radiated Environment, was held at the Douglas Aircraft Long Beach facility on December 15, 16 and 17, 1987. The Committee's goal is to draft an advisory circular and attendant User's Manual for guidance and information on how to certify commercial aircraft to the electromagnetic radio frequency environment created by High Energy Radio Frequency emitters. Emitters of interest include radar (ground-based, ship-based and aircraft-based), commercial radio stations, mobile communications systems and any other transmitter or emitter that could illuminate commercial aircraft both on the ground or in the air.

Committee AE-4R is further divided into three Subcommittees. They are the Data Accuracy Subcommittee, which will define the electromagnetic RF environment that commercial aircraft may be subjected to; a Design Approach Subcommittee, that will develop the draft advisory circular and User's Manual and a Test and Analysis Methods Subcommittee, which will document test and analysis techniques that can be used to validate an aircraft design against the electromagnetic RF environment.

A total of 41 technical experts from Sweden, France, England, Canada and the United States were in attendance. A cross-section of expertise from airframe manufacturers, equipment manufacturers, electromagnetics consultants, integrators and governmental agencies were present.

It was a consensus of the Committee that all are dedicated to protecting the flying public against the potential electromagnetic radio frequency threat in an effort to assure safe flight. The Committee must accomplish this effort in a systematic, rational manner to preclude unnecessary burdens to aircraft designers or unnecessary impact on the certification process.

The consensus was that the Committee would focus on protecting aircraft during all aspects of flight, including ramp, taxi, takeoff, cruise, landing and rollout. However, AE-4R would not address protection of cargo, fuel systems, hydraulics or structures. Also, it will be assumed that at the ramp all doors and panels are closed. The FAA has an action item to resolve whether or not the FAA thinks AE-4R should address personnel protection for crew and passengers.

A key issue that needs resolution is whether or not the Committee addresses both flight-critical and flight-essential functions. The FAA was going to have an all-directorate meeting on the electromagnetic radio frequency environment issue in February and will resolve this issue.

Mr. Brian Perry, the head of the Systems and Equipment Department for the British CAA sent a telegram indicating their regret in not attending this meeting. However, their organization is very interested in this work and hopes to attend future meetings. Mr. Perry indicated that liaison with Europe is normally best achieved through EUROCAE.

The Committee is very fortunate to have three very capable and industrious Subcommittee Chairmen: Ron Rogers from the Airline Pilot's Association, Chairman of the Data Accuracy Subcommittee, Chris Kendal of Kendal Associates, Chairman of the Design Approach Subcommittee and Fred Heather from the Navy Air Test Center, Chairman of the Test and Analysis Subcommittee. Noel Sargent is the Secretary for the AE-4R Committee.

The cross section of expertise of the people in attendance at the first meeting, the participation, the willingness of members to take homework assignments and the amount of work accomplished was very impressive. Mr. Nick Rasch from FAA Headquarters was impressed with the productivity of the organization. Mr. Rasch has been the driving force for the FAA to make something happen in this high energy radio frequency environment arena.

## **Discussion Items, December 1987 AE-4R Meeting**

The following items were discussed at the December 1987 AE-4R meeting (Comments from the meeting are also included):

1. Simultaneous AE-4R Subcommittee meetings: The AE-4R Subcommittees will all meet simultaneously. There will not be separate Subcommittee meetings at sites and times other than when the general AE-4R Committee meets. There may be an occasional excep-

tion, however, such as when personnel from the Data Accuracy Subcommittee visit ECAC to review their data and assumptions. Members from that Subcommittee may also meet with the FAA to review their flight test plan for airborne recording of the RF environment.

2. SAE AE-4R members represent themselves, not their companies or agencies.
3. The SAE AE-4R Secretary will maintain a list of active members and members that are unable to attend the meetings, but want to be kept informed.
4. Frequency of meetings: Three to four meetings a year are planned. This activity is to be completed within two years.
5. All meetings and documentation will be unclassified. However, selected members of the Data Accuracy Subcommittee may be involved in review of classified environmental data with ECAC.
6. Brian Perry, the head of the Systems and Equipment Department of the CAA in England, sent a telegram supporting our activity and recommending that liaison with Europe be done through EUROCAE. The Telex was displayed to the Committee and discussed.
7. Coordination with the RTCA 135 Subcommittee activities: RTCA 135 is drafting a proposed test for electronic and electrical equipment to qualify black boxes against a high energy RF environment. Since airframe manufacturers may choose equipment qualified to an RTCA 135 specification, AE-4R will remain closely abreast of this activity. Fortunately, four members of the Committee are also members of the RTCA 135 Committee.
8. Coordination with EUROCAE: This will be done through the FAA and Brian Perry of the CAA.
9. Flight-critical versus minimum equipment lists: The Committee will address flight-critical functions in our draft advisory circular. It has not been resolved whether or not we will also address flight-essential functions. This will be resolved at an FAA all-directorates meeting on the electromagnetic radio frequency environment in February, 1988.
10. Applicable Federal Air Regulations: There are currently no directly applicable Federal Air Regulations. The FAA intends to draft a Notice of Proposed Rule Making in the near future.
11. Schedule of Committee activities: The Committee will meet four times a year. The next meeting will be April 5, 6 and 7 in Fort Worth, TX. The Committee will attempt to meet at the same time as the general SAE AE-4 meeting whenever possible to minimize travel required for people that desire to attend both meetings.
12. The final document will be an SAE Aerospace Recommended Practice document. It will address commercial aircraft, not military. It will be drafted for the FAA. However, the environment will be coordinated with the FAA and the European regulatory agencies. All commercial air vehicles, including transports, civil aviation, charter vehicles and tilt rotor aircraft, will be discussed.
13. Documentation will be restricted to aircraft safety. The Committee will address electrical and electronic equipment functions and not cargo, fuel systems, hydraulics or structures. Whether or not the Committee will address personnel protection for personnel in the aircraft has not been resolved.
14. Digital versus analog: Both will be covered.
15. Upset versus damage: Both will be addressed. However, the terms for upset and damage are yet to be defined.
16. What are existing FAR or European restricted flight areas?
17. Entry into avionic boxes by way of front door and back door: It appears for the higher frequencies that entrance by way of antennas will be the primary concern. However, for lower frequencies, such as HF and VHF, excitation of the airframe and wires must be addressed as well.
18. Threat parameters to consider:
  - modulation
  - peak power
  - average power
  - pulse rate frequency
  - frequency
  - scan rates
  - dwell time
  - energy
  - illumination area
  - antenna physical height
  - "H" field levels for low frequency
  - Antenna size/gain
  - Future threat levels
19. Frequency range of interest: The Committee will address 10 kilohertz to 40 gigahertz.
20. Validation techniques:
  - injection testing of subsystems
  - full vehicle tests (full threat and low energy tests)
  - partial vehicle tests
  - analysis
  - tests and analyses combined
21. Review of ECAC data and assumptions: The Data Accuracy Subcommittee will review ECAC data and assumptions.
22. FAA flight test program to verify field levels: The FAA is contracting with the University of Ohio to use a DC-3 to flight test and record RF fields. The Data Accuracy Subcommittee will review the test plan and ultimately help review the test data. Funding permitting, the FAA hopes to complete these flight tests in February of 1988.

23. Anglo-French in-flight measurement of RF fields: The Data Accuracy Subcommittee will also review the Anglo-French data and assumptions to evaluate their applicability to FAA certification of commercial vehicles.
24. Development of recommended threat definition for certification of civil and commercial aircraft: A draft of an electromagnetic radio frequency environment will be included as an appendix in the advisory circular.
25. Subcommittee Chairmen: Ron Rogers of ALPA for the Data Accuracy Subcommittee, Chris Kendal of Kendal and Associates for the Design Approach Subcommittee and Fred Heather from Naval Air Test Center for the Test and Analysis Subcommittee.

#### **Subcommittee Objectives**

##### **DATA ACCURACY SUBCOMMITTEE:**

1. Review ECAC and Anglo/French data assumptions, results and conclusions.
2. Make recommendation to FAA for type of data desired during FAA in-flight measurement program.
3. Evaluation of FAA flight test data.
4. Develop recommended threat definition for inclusion in FAA draft advisory circular.
5. Develop an approach or philosophy on how to address future increases in the electromagnetic radio frequency environment.
6. Write appendix defining electromagnetic RF environment for draft Advisory Circular.

##### **DESIGN APPROACH SUBCOMMITTEE:**

1. Draft aerospace recommended practice for compliance to FAA and Anglo/French requirements for aircraft protection against the high energy radio frequency threat.
2. Use the draft advisory circular developed by the SAE Lightning Committee as a preliminary format.
3. Define verification safety margins.
4. Draft User's Guide to support the draft advisory circular that includes lessons learned, good design practices, test and validation techniques, etc.

##### **TEST AND ANALYSIS METHODS SUBCOMMITTEE:**

1. Develop recommended test and analysis techniques to be used for proof of compliance to advisory circular requirements developed by the Design Approach Subcommittee and consistent with the environment defined by the Data Accuracy Subcommittee. Draft as section to User's Guide.
2. Provide inputs to the AC and User's Guide on test and analysis techniques.

The next meeting will be held April 5, 6 and the morning of the 7th, 1988 at the FAA facility in Fort Worth, TX.

Mr. Richard Vaughn (telephone (817) 624-5121) will be our host.

#### **Other Committee AE-4 Business**

The next scheduled meeting of the National Committee will be on April 26, 27 and 28 at SAE Headquarters in Warrington, PA. The recommended Hotel is the Hyatt-Pittsburg. A special room rate has been established if you mention the SAE meeting.

Final comments should have been returned in time for this next meeting from official SAE balloting on a proposed Aerospace Recommended Practice (ARP) No 4244, "Recommended Filter Insertion Loss Characteristics Testing." This ARP is an attempt to upgrade MIL-STD-220 (which Steven Caine has been working on), and include some non-50 ohm conditions. Also, at this national meeting the AE-4 review and comments on the new MIL-E-6051 will be presented by its Chairman, Wes Johnson. Aerospace Information Report (AIR) No. 1499, "Commercial EMC Susceptibility," authored by the Business Systems Subcommittee will be finalized. After the April meetings, the AE-4 Committee will meet again on August 1, at the Westin Hotel in Seattle, WA.

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## **HOME VIDEO TUTORIALS**

IEEE's Education Activities Department has introduced a series of home video tutorials. Each tutorial includes a one-to-two-hour course on video cassette (1/2-inch VHS), a workbook with applications-oriented problems, solutions to all the workbook problems and an extensive bibliography. Each course takes between four to eight hours to complete, including solution of the problems. A completed course can be filed away as a handy reference and refresher course. Available for \$49.95, a partial list of courses developed or being developed includes:

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- **Grounding and Lightning Protection**
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# PCs FOR EMC



by Edmund K. Miller

The focus of this column will be the general subject of "visualization" and how computers and computer graphics are revolutionizing this fascinating area. Over the past few years, including the occasion of a course I gave at Kansas University on developing computer-graphics movies for teaching, I have collected a number of books related in one way or another to visualization and graphics. During that collection process I was surprised to find myself perusing the art and medical departments of book stores as I discovered that my evolving interest in visualization naturally led to investigating how artists, who specialize in presenting visual images, deal with that problem from a mental viewpoint. This led to another unexpected topic, that of psychology, and in particular how we interpret what we see. I thought that it might be useful to present summaries of several of the more interesting to me, and I hope to you also. You should be warned that this will be a rather eclectic book collection as all are not directly related to computer graphics, but do relate to visualization in one form or another.

First, a brief definition of visualize/visualization as given by the American College Dictionary whose four definitions include "to call up or form mental images or pictures" and "to make visual or visible". Clearly, visualization involves not only developing a pictorial representation of something, but dealing with that representation mentally. Thus, books like *Psychology of Perception* [W. N. Dember and J. S. Warm (1979), Holt, Rinehart and Winston, ISBN 0-03-006426-0] and *The Logic of Perception* [I. Rock (1983), The MIT Press, ISBN 0-262-18109-6] consider the basic question of "why do things look as they do?" This is a tantalizing question the answer to which was originally formulated by the Greek philosophers according to Dember and Warm in terms of miniature copies of external objects that entered the mind through the senses. Some of the aspects of perception include context and expectation. A common example of the latter is seeing what is expected rather than what's there, one of the reasons why I'm so bad at proof reading.

Two books that make a point for connecting imagination and creativity to visual representations are by Betty Edwards, *Drawing on the Right Side of the Brain* [(1979) J. P. Tarcher, Inc., Los Angeles, ISBN 0-87477-088-2] and *Drawing on the Artist Within* [(1986) Simon and Schuster, New York, ISBN 0-671-49387-8]. Dr. White, a Professor of Art at California State University, Long Beach, believes that "drawing is a skill that can be learned by every normal person with average eyesight and average

eyehand coordination". She also stresses that "drawing ability seems to involve in part at least, an ability to make a shift in brain state to a different mode of seeing/perceiving," or to make "a mental shift to a different mode of information processing." She quotes Helmholtz and Poincare who described four stages of scientific discovery as being: *saturation*, the stage of research; *incubation*, the mulling-over stage; *illumination*, the sudden solution; and *verification*, putting the solution into concrete form while checking it for error and usefulness. Later, the American psychologist Jacob Getzels suggested a stage preceding saturation as being *finding* or *formulation*, a matter of discovering problems that no one else has perceived, i.e., asking a productive question. Dr. White's connecting creativity in a broader sense with the ability to express ideas in visual form through drawing is a fascinating one whose implications in the age of computer graphics is especially provocative. Other sources which develop this basic theme are *Visual Thinking* [R. Arnheim (1969), U. of California Press, Berkeley, ISBN 0-520-01378-6], *Seeing With the Mind's Eye* [M. Samuels (1975), Random House, Inc., ISBN 0-394-73113-1], and *Experiences in Visual Thinking* [R. H. McKim (1980), Brooks/Cole Publishing Co., Monterey, CA].

Professor Moshe F. Rubinstein of the Engineering Systems Department at the University of California, Los Angeles, has written a series of books on the general theme of creative problem solving in a more engineering oriented format. These include *Patterns of Problem Solving* [Prentice Hall (1975)], *Concepts in Problem Solving* (with K. R. Pfeiffer, 1980) [Prentice Hall], and *Tools for Thinking and Problem Solving* [(1986) Prentice Hall, ISBN 0-13-925140-5]. A quotation from Albert Einstein in the latter provides perhaps some sense of content to be found in Professor Rubinstein's approach, as "Imagination is more important that knowledge, for knowledge is limited whereas imagination embraces the entire world, stimulating progress giving birth to evolution." These books have grown from a campus-wide interdisciplinary course "Patterns of Problem Solving"

given by Professor Rubinstein at UCLA. Although not addressed directly to graphics or drawing, Professor Rubinstein's work emphasizes diagrammatic approaches which lead to the relationships upon which correct problem definition, and thus its solution, ultimately depend. Although the word does not appear in any of these titles, the central theme is one of model development and validation, a theme certainly appropriate for electromagnetics and computers.

As further examples of generalizing thought processes and creativity we might also include *The Right Brain* [T. R. Blakeslee (1980), Berkley Publishing Co., ISBN 0-425-08161-3] and *The Society of Mind* [M. Minsky (1985), Simon and Schuster, New York, ISBN 0-671-60740-5]. The former explores the idea that the left brain is better at analysis and the right at synthesis. Or in other words, the left brain handles complexity by sequences of small logical steps, whereas the right brain takes an holistic approach to problem solving. Put still another way, mathematically-oriented people would be expected to use their left brains more of the time whereas the converse would be expected of those who are artistically-oriented. We are probably most productive when we make appropriate use of both brain halves. For example, Blakeslee observes that "creative breakthroughs generally are a result of finding hidden relationships--patterns that are obscured by their context." This appeals to a model I favor which has science developing from the specific to the general in terms of: (1) making observations via collecting data; (2) extracting information from that data to fill in missing observations via interpolation; (3) acquiring underlying knowledge to explain what has been observed and to extrapolate beyond the immediate domain of observation; (4) developing wisdom to apply what has been learned to phenomena outside that domain; and (5) exhibiting the vision to make practical use of what has been learned. Blakeslee describes many interesting experiments and data which support the basic thesis of left brain/right brain thinking.

In *Society of Mind*, motivated by his many years of work in artificial intelligence, Minsky presents a picture of the mind as a "society" of successively smaller units which are themselves mindless. Essentially, he explains intelligence "as a combination of simpler things," and observes that "knowing how is not the same as knowing why." Thus, his model involves three questions: (1) how does each separate part work?; (2) how do these parts interact with those to which it is connected?; and (3) how do these local interactions combine to accomplish what the system does? Appropriately enough, the book is well illustrated with diagrams and drawings.

I'll conclude this column with more thorough descriptions of several books which deal with graphical or visual representations. First is *The Elements of Graphing Data* [W. S. Cleveland (1985), Wadsworth, Inc., Monterey,

CA, ISBN 0-534-03729-1]. As stated in the preface, the book is "about graphing data in science and technology." It is concerned about both data *analysis*, where study of the data is important, and *communication*, where the data is to be communicated to others. The table of contents is as follows:

1) Introduction	3-20
2) Principles of Graph Construction	21-102
3) Graphical Methods	103-228
4) Graphical Perception	229-294
References	295-306

Numerous examples of how clear communication can be enhanced by good graphical design, and counter examples too, are presented. Extensive use of scatter plots is illustrated, a type of graph seen more in the social than the hard sciences. Two interesting perceptual "laws" are presented to make graphical design more effective by anticipating how quantitative interpretation is thereby affected. One of these, Weber's Law, describes perceptual judgement of attributes such as position, length, and area and is given by

$$w_p(x) = k_p x$$

where  $w_p(x)$  is a positive number and  $k_p$  does not depend on  $x$ . Weber's Law states that, for example, a line of length  $x + w_p(x)$  is detected with probability  $p$  to be longer than the line of length  $x$ . An implication of this law is that a fixed percentage increase, rather than a fixed increase, in measure is required for equal probability of perceptual detection.

Another perceptual law is due to Stevens which says that a person's perceived scale is

$$p(x) = cx^b$$

where  $x$  is the magnitude of an attribute. The values of  $b$  found from experiment range from 0.9 to 1.1 for  $x$  being length, from 0.6 to 0.9 for area, and 0.5 to 0.8 for volume. An implication of these results is that bias can be introduced into graphical presentations which depend on an area measure, effectively resulting in smaller areas appearing bigger than they are and conversely for larger areas. Cleveland presents the results of various experiments of perception which support empirical laws like these.

A book somewhat similar to the above, except that a perhaps wider variety of examples are given from economics, geography, etc. is *The Visual Display of Quantitative Information* [E. R. Tufte (1983), Graphics Press, Cheshire, CT 06410]. A systematic approach for developing effective data graphics is described and the principles illustrated with numerous examples. Some of the more interesting were produced interestingly enough a hundred or more years ago, including a display of Napoleon's invasion and retreat from Russia in 1812, and an 1885 Paris-Lyon train schedule. The table of contents is:

1) Graphical Excellence	13-52	B) The Plane	44-59
2) Graphical Integrity	53-78	C) The Retinal Variables	60-98
3) Sources of Graphical Integrity and Sophistication	79-90	3) The Rules of the Graphic System	99-191
4) Data-Ink and Graphical Redesign	91-106	A) The Basic Graphic Problem	100-138
5) Chartjunk: Vibrations, Grids, and Ducks	107-122	B) Image Theory: Efficiency	139-159
6) Data-Ink Maximization and Graphical Design	123-138	C) Three Functions of Graphic Representation	160-170
7) Multifunctioning Graphical Elements	139-160	D) General Rules of Construction	171-191
8) Data Density and Small Multiples	161-176	Part Two: Utilization of the Graphic Sign-System	
9) Aesthetics and Technique in Data Graphical Design	177-190	Classification of Graphic Problems	192

This is an entertaining, yet very informative and worthwhile book to read. Although Tufte, as does Cleveland, deals primarily with pen-and-ink graphics, the guidelines and recommendations presented are entirely relevant to computer graphics as well. Tufte in addition does include a few color examples, an information channel that is becoming more practicable to exploit using computers. Tufte also introduces a quantitative measure of information content which he defines as *data density* given by

$$\text{data density} = \text{number of data entries/area of graphic}$$

and points out that this measure varies enormously in practice. He analyzes a number of publications ranging from scientific to political with *data density* varying from 48 per square inch for *Nature* at a maximum, to a median of 7 for the *New York Times* to a low of 0.2 for *Pravda*.

A much more ambitious book, properly described as a *Tour de Force* is *Semiology of Graphics* [J. Bertain (1983), The University of Wisconsin Press, ISBN 0-299-09060-4], translated by W. J. Berg. This work was originally published in 1967 in France, and so pre-dates much of the computer-graphics revolution that has since, and is continuing, to take place. This is a beautifully produced book with lavish black and white, as well as color, illustrations. My only reservation about it is that translation of some of the French terms resulted in what seems to me awkward terminology, but you may feel differently. The 400+ pages are divided as follows:

Part One: Semiology of the Graphic Sign-System	
General Theory	2-14
1) Analysis of the Information	15-40
A) The Invariant and the Components	16-27
B) The Number of Components	28-32
C) The Length of the Components	33-34
D) The Level of Organization of the Components	34-40
2) The Properties of the Graphic System	41-98
A) The Scope of the Graphic System	42-43

1) Diagrams	193-268
A) Diagrams Involving Two Components	195-216
B) Diagrams Involving Three Components	217-254
C) Problems Involving More Than Three Components	254-268
2) Networks	269-284
A) Construction and Transformation of a Network	271-274
B) Application of Networks to Classifications	275-276
C) Trees	276-281
D) Areas, Inclusive Relationships	282-283
E) Perspective Drawings	282-284
3) Maps	285-412
A) External Geographic Identification	287-297
B) Internal Geographic Identification	298-317
C) Maps Involving One Component	318-320
D) Maps Involving Two Components	321-388
E) Cartographic Problems Involving More Than Two Components	389-412

Bertain develops the basic theory of graphics in the introduction to Part One, where he first establishes graphics in relation to other basic sign-systems such as language, music, mathematics, etc. He then considers perceptual properties of linear and spatial systems using sound or sight. Next considered is the number of dimensions or components in the data to be graphed, how the categories of each component are measured as a generalized "length", and then the level of organization, whether qualitative, ordered, or quantitative. He then points out that a graphic system has eight variables at its disposal, these being the the two dimensions of the plane (i.e., x-y axes), and the size, value (i.e., intensity), texture, color, orientation, and shape of the symbols used in the plotting. Finally, he mentions that the plotting plane can be organized as an ordered relationship into a diagram (among all elements of two components); a network (among all elements of the same component); a geographic map (among all elements of the same geographic component); and symbolism (between a single element and the reader). The introduction concludes with the rules of the graphic system, for example defining efficiency in terms of the required observation time for a correct conclusion to be drawn from the graph. If you are really interested in a systematic development of graphics, I

think you find this to be a worthwhile book.

Finally, I'll conclude by describing two quite different books, each of which in its own way beautifully dramatizes the power of visualization. These are *The Picture Book of Quantum Mechanics* [S. Brandt and H. D. Dahmen (1985), John Wiley & Sons, ISBN 0-471-81776-7], and *An Album of Fluid Motion* [M. Van Dyke (1982), The Parabolic Press, Stanford, CA, ISBN 0-915760-02-9]. *Picture Book* was developed by the authors because "in quantum mechanics, beginners are without any intuition" and "we have no experience of quantum-mechanical phenomena in daily life." Furthermore, "only very few problems can be treated without a computer" which can however offer incredible help in visualizing what the mathematics describes. The table of contents is:

1) Introduction	1-10
2) Light Waves, Photons	11-34
3) Probability Waves of Matter	35-54
4) Solution of the Schroedinger Equation in One Dimension	55-74
5) One-Dimensional Quantum Mechanics: Scattering by a Potential	75-94
6) One-Dimensional Quantum Mechanics: Motion within a Potential and Bound States	95-116
7) Coupled Harmonic Oscillators: Distinguishable Particles	117-132
8) Coupled Harmonic Oscillators: Indistinguishable Particles	133-150
9) Wave Packet in Three Dimensions	151-180
10) Solution of the Schroedinger Equation in Three Dimensions	181-188
11) Three-Dimensional Quantum Mechanics: Scattering by a Potential	189-209
12) Three-Dimensional Quantum Mechanics: Bound States	209-240
13) Three-Dimensional Quantum Mechanics: Resonance Scattering	241-274
14) Examples from Atomic, Molecular, Solid-State, Nuclear, and Particle Physics	275-301

It's almost unnecessary to say that the book is extensively illustrated throughout with drawings and graphs, many of a perspective nature as a function of time in the form of a movie sequence. Not only are physical phenomena displayed, but pictures are also used for the special functions that arise in quantum mechanics such as Legendre, Hermite, and Laguerre polynomials, etc. (shades of Jahnke and Emde!). This book makes a strong case for using graphical aids as a help in visualizing what would otherwise be only a mathematical exercise for most of us.

It, plus another set of books on mathematics which perhaps I'll review at a later date, inspire me to think about doing a similarly motivated book with the working title *Visual Electromagnetics*.

The *Album of Fluid Motion* is an excellent example of visualization with which to conclude this column. In the words of Professor Van Dyke, it was assembled, rather than written, in that it is a collection of hundreds of black and white photographs of fluid mechanics experiments. I bought it initially because I thought that some useful hints might be extracted from it concerning computer-graphical presentation of electromagnetic phenomena. The table of contents is:

0) Introduction	6-7
1) Creeping Flow	8-17
2) Laminar Flow	18-23
3) Separation	24-41
4) Vortices	42-59
5) Instability	60-87
6) Turbulence	88-103
7) Free-surface Flow	104-117
8) Natural Convection	118-127
9) Subsonic Flow	128-135
10) Shock Waves	136-153
11) Supersonic Flow	154-172

Van Dyke says in the introduction that "we who work in fluid mechanics are fortunate . . . that our subject is easily visualized. Flow visualization has from early times played an important part in research, always yielding qualitative insight, and recently also quantitative results". He has collected together in one volume the best photographs from colleagues around the world, and organized them into the logical sequence that might also be found in a text treating fluid mechanics. *Fluid Motion* is not intended to replace a textbook, but it would certainly appear to be a most useful supplement.

While the photographs included in this book are almost uniformly provocative from the viewpoint of stimulating comparisons with electromagnetics and statics, there is one sequence on pages 110 and 111 which I found especially intriguing. Shown there are time exposures over one wave cycle of white particles suspended in a glass-sided water trough as the wave motion is changed in steps from a propagating to a standing-wave field. The motion of the particles thereby changes from essentially circular orbits for a single propagating wave to increasingly flattened and inclined orbits as the reflected-wave amplitude approaches that of the incident wave. Finally, when standing waves are produced at total reflection, the particle trajectories are reduced to streamlines. I think that you will find this to be a most fascinating book.

# EMC CERTIFICATION AND ACCREDITATION

## EMC CERTIFICATION AND ACCREDITATION PROGRESS REPORT

15 February 1988

Since the last issue of this newsletter a couple of significant events have taken place. The first full public meeting on laboratory accreditation was held on 25 January at the National Bureau of Standards in Gaithersburg, MD, and The National Association of Radio and Telecommunication Engineers (NARTE), Salem, OR, has agreed to be the certification agent for EMC technical personnel.

The laboratory accreditation meeting was hampered by a brisk snowfall, but that helped to focus discussion. One of the areas of prime concern centered around the NAVAIR commitment to this requirement. This was felt to be a key issue because the ability to recover costs and the competitive advantage of being accredited or certified all hinge on enforcement of the NAVAIR requirement. The concept has been articulated to senior NAVAIR management and has received a positive response. The instruction codifying the requirement had been drafted and is circulating within the Command for technical comment. Thus far there has not been any opposition.

After resolution of technical comments, the instruction will proceed through a meticulous management review leading to signature. The target for signature of 1 October 1988 is on track and remains a practical objective. It should be noted that the text of the instruction calls for accreditation of test laboratories and certification of EMC technical personnel in responsible charge within six months after signature, allowing time for orderly implementation.

In addition, the concept has been embraced by the Office of the Chief of Naval Operations, which will lead to Navy-wide application. Further Navy application will be held back pending the results of implementation at NAVAIR. It is not yet known when the requirement for accreditation and certification will be imposed by other services but it is reasonable to assume that it may happen.

A synopsis of the NBS accreditation meeting is available. Copies can be obtained by contacting Ms. Merri Sutor at (703) 685-7110.

Certification of engineering and technical personnel must be accomplished through a totally objective process. To remove any potential for conflict, NAVAIR has elected to use a nonprofit technical association for this function. In February, NARTE agreed to act as the certification agent. NARTE has been certifying engineers and technicians in



by Russell V. Carstensen, P.E.

the telecommunications field since 1983. They have over 7000 members. NAVAIR will set the requirements for acceptable education, work experience and examination, and pass these to NARTE. NARTE will in turn administer the process. NARTE will issue applications, schedule examinations and award certificates. Complaints or clarifications will be addressed by NARTE in the context of the criteria set by NAVAIR.

The examination will be open book. It will cover essentials in 26 areas of EMC-related technology such as bonding, grounding, prediction analysis, etc. Examination questions will be on three levels of difficulty; basic, intermediate and challenging. Questions will be in multiple choice format. Separate examinations will be given for engineers and technicians.

It is recognized that there are a large number of competent practitioners currently in the field. There is a provision in the NAVAIR certification implementation for "grandfathering" those who are currently practicing. To grandfather, a candidate must meet the qualifications for EMC engineer or technician, must have been practicing for the 12 months immediately prior to the application and must be practicing at the time of application. Otherwise, application by conventional means is necessary.

NARTE will have a handbook describing the process and the requirements by June of this year. NARTE is receiving requests for applications and is holding them until the application forms are complete. Their address is:

The National Association of Radio  
and Telecommunication Engineers, Inc.  
P.O. Box 15029  
Salem, OR 97309  
telephone: (503) 581-3336

In April I will be presenting the NAVAIR accreditation and certification approach to the NATO Air Electrical

Working Party, SAE and EIA, and soliciting their comments on the critical elements for MIL-STD-462 test procedures. In June we will be loading the initial examination set on the NARTE computer and conducting another community workshop at NBS.

## **CPEM '88**

The 1988 Conference on Precision Electromagnetic Measurements (CPEM '88) will be held this year from June 7-10 at Tsukuba Research Center, Tsukuba Science City, the technopolis located 60 kilometers northeast of Tokyo. Organized by the Society of Instrument and Control Engineers and permanently sponsored by URSI, NBS and the IEEE Instrumentation and Measurement Society, CPEM '88 is sponsored by the Agency of Industrial Science and Technology, the Ministry of International Trade and Industry, the Science Council of Japan and the International Union of Pure and Applied Physics.

All papers will be concerned with electromagnetic measurements and related fundamental constants. Recent progress in measuring techniques now offer various new approaches to the measurements of ultra-high speed phenomena and ultra-fine material structures, as well as highly sensitive and stable measurements. Papers concerned with basic ideas or fundamental technologies of novel precision EM measurement methods were also invited:

### **PRECISION MEASUREMENTS AND STANDARDS OF ELECTROMAGNETIC QUANTITIES**

- **Antenna and field measurements**
- **EMC/EMI measurements**
- **Direct current and low frequency**
- **Radio frequencies, microwaves and millimeter waves**
- **Time and frequency**
- **Light waves (frequency, wavelength, power, etc.)**
- **Fiber optics**
- **Fundamental constants and fifth force experiments**
- **Cryo-electronics**
- **Measurements of material constants (or characteristics)**
- **Time domain wave form measurements**

### **ADVANCED APPLIED MEASUREMENTS**

- **Sensors and transducers**
- **Scanning tunneling microscope**
- **Lasers and optical fibers (spectroscopy, interferometry, etc.)**
- **Global positioning system (GPS)**
- **Very long baseline interferometer (VLBI)**

The program will include special lectures by leading

authorities, invited presentations of highly evaluated works, poster sessions and panel discussions.

Registration fees are 40,000 yen before May 5 and 50,000 yen afterwards. All payment must be in Japanese yen and no personal checks are accepted. For additional hotel and registration information, contact:

CPEM '88 Secretariat  
c/o Business Center for Academic Societies Japan  
Conference Department  
2-40-14, Hongo, Bunkyo-ku,  
Tokyo 113, Japan

## **MORE ON ENGINEERING SPECIALTY CERTIFICATION**

The United States Activities Board recently endorsed a guidance document for IEEE delegates to the upcoming National Conference on Engineering Specialty Certification, which will be held in Atlanta, GA, on April 12-13. Attendees of the Conference, which is being sponsored by 18 engineering societies, will examine several issues, including granting specialty certification before or after registration, determining qualifications, maintaining certification, legal issues and benefits and disadvantages of certification.

IEEE is participating in the Conference to represent the needs and interests of electrical, electronics and computer engineers who are U.S. members of IEEE. The guidance document includes the following:

- **IEEE has not perceived a clear need for engineering specialty certification (ESC) or encountered a problem within the profession that it feels a comprehensive certification program would solve. Therefore, IEEE has no active ESC programs and questions the need for any.**
- **IEEE has an interest and concern about ESC in those interdisciplinary fields that involve electrical, electronics or computer engineering.**
- **IEEE feels that most employers of electrical, electronics and computer engineers do not seek and would not support mandatory ESC for their employees.**
- **IEEE will not support any ESC program that would tend to bar engineers from practicing their profession.**

Engineers and engineering societies are encouraged to participate in the Conference, as are members of the public. For information on attending, contact Arthur Schwartz at the National Society of Professional Engineers at (703) 684-2845.

# CHAPTER CHATTER



by Charles F.W. Anderson

## CENTRAL NEW ENGLAND

On November 17, the Chapter met at the Apollo Computer facility in Chelmsford. Don Heirman was the speaker and the topic was "Constructing, Operating and Maintaining an All-Weather Open-Area Test Site (OATS)." There were 28 attendees, of whom about half were EMC-S affiliates. In addition, changes in recommended test procedures for computer equipment were discussed, including the recent (July '87) FCC MP-4. It was noted that further changes are under consideration. Important aspects of radiated emission test sites were discussed. There was also a tour of Apollo's new test site.

Planning for the February and April meetings is well in hand. These are to include a talk on EM effects on aircraft engine controls, and a student night.

## DALLAS/FORT WORTH

On November 18, the Chapter held a meeting at which the speaker was Myron Crawford (NBS-Boulder). His paper was titled "TEM Cells/Resistive-Loaded Antennas." There were eight attendees. The January 20 meeting had Wade Selph (IRT-San Diego) as the speaker. His topic was "High-Altitude EMP Simulation." Thirteen were in attendance. Thanks to Scott Sullivan for the inputs.

## NEW JERSEY COAST

This joint AP/EMC/VT Chapter held its annual Holiday Party/Membership Drive on December 15. (No word yet on who won the door prize—a digital amp probe meter.) The January 16 meeting had as its speaker Dr. George Zysman (Bell Labs Cellular Telecommunications Lab). He discussed the design of the new narrow-band digital cellular system which is under development at the Labs. He pointed out that in many areas of the U.S., cellular systems are nearing full capacity and, therefore, a more spectrally efficient system is needed. The new system will incorporate an integral ISDN signaling channel and has been designed to provide immunity over a wide range of delay spread conditions.

(Your Column Editor needs to make his apologies. I misinterpreted something and jumped to the conclusion that Bob Davis was giving up the editorship of the New Jersey Coast newsletter. He is still going strong in that capacity!)

## SANTA CLARA VALLEY

The December 8 meeting featured J.P. Neil (Consulting Engineer), who spoke on the topic "Part 68 Overview." He addressed the background and history of Part 68, as well as legal, administrative, documentation, testing, reporting and application aspects thereof. On February 8, Evangelos Tonas (ESL, Inc.) presented a talk on a cost-

effective approach to shielding of new or existing buildings for EMI control and/or TEMPEST security. His presentation covered construction techniques, materials and associated costs.

## TOKYO

Six papers were given at the November 20 meeting of the Chapter. Topics included TV receiver design to alleviate the effects of Sporadic E interference, an X-band absorber with better than 20% bandwidth and use of "X Y condensers"\* for power mains filtering.

A total of 12 papers were given at the December 18 meeting. There were three papers devoted to power line EMI problems, two of which dealt with lightning matters. The others covered a range of topics which included evaluations of coax-connector shielding effectiveness, electronic controls in autos and differences between EMI radiation of TTL and CMOS digital ICs with emphasis on the additional design measures necessary with the latter type. Thanks to Prof. Echigo for his inputs.

## TWIN CITIES

The Chapter held its first meeting of the year on February 10. Garrett Lysiak (Owl Engineering) was the speaker, with the topic "Airborne Leakage Measurements for Cable TV Systems." Thanks to Program Chair Dan Hoolihan (Amador) for the information.

## WASHINGTON/NORTHERN VIRGINIA

On January 21, the Chapter's meeting was addressed by Russ Carstensen (Naval Air Systems Command). His topic was "Navy Accreditation of Personnel and Laboratories." There were about 50 attendees (including your Column Editor). For a good rundown on Russ's presentation, see his article in the Winter Newsletter issue.\*\* The annual social event for the Chapter was the Valentine Dinner, held February 12 at the Bethesda Naval Hospital Officer's Club. (Hope to have more on this for the next issue.)

\*Can any of our readers shed light on the identity of "X Y condensers?"

\*\*Based on Russ's presentation and a chat with him afterwards, this program is going to do things we have needed for a long time!

# TECHNICAL COMMITTEES OF THE IEEE EMC SOCIETY

## INTRODUCTION

The purpose of each of the seven Technical Committees (TC) of the EMC-S is to promote activities in its area of technical competence by: 1) receiving, generating and reviewing papers in cooperation with the *Transactions* Editor and Symposium Committee, 2) organizing and operating sessions and workshops at meetings of the EMC-S and the IEEE at all levels, 3) arranging through appropriate editors for publishing pertinent papers in IEEE publications, 4) generating and developing appropriate standards in its field for processing by the EMC-S Standards Committee and 5) evaluating the "state of the art" of its field.

## AREAS OF TECHNICAL COMPETENCE

### TC-1 EMC MANAGEMENT

Concerned with the need for an EMC program and the management tools by which EMC requirements are integrated into the various phases of system development. Applicable standards (commercial and military), control plans, test plans, design guides, personnel training, etc. are typical areas of concern for this committee.

### TC-2 EMC MEASUREMENTS

Concerned with the measurement and instrumentation requirements in EMC standards with procedures and how they are interpreted. Also concerned with the adequacy of measurement procedures and measurement instrumentation specifications for radiated and conducted emissions and susceptibility tests and the rationale for performance limits for both of these tests.

### TC-3 ELECTROMAGNETIC ENVIRONMENTS

Concerned with natural noise (lightning, magnetospheric discharges, solar activity and atmospheric noise) and man-made interference (coherent radiations from signal sources such as sidebands and harmonics and incoherent

radiation from automotive ignition systems, power generation and transmission facilities and industrial processing equipment).

### TC-4 INTERFERENCE CONTROL

Concerned with design, analysis and modeling techniques useful in suppressing interference or eliminating it at its source. Bonding, grounding, shielding and filtering are within the jurisdiction of this committee. These activities span efforts at the system, subsystem and unit levels.

### TC-5 EMP

Concerned with the nonlinear effects of EMP and hardening protection. Lightning processes, interaction with aircraft and the effects of transient electrical discharges on equipment are also within the jurisdiction of this committee.

### TC-6 SPECTRUM MANAGEMENT

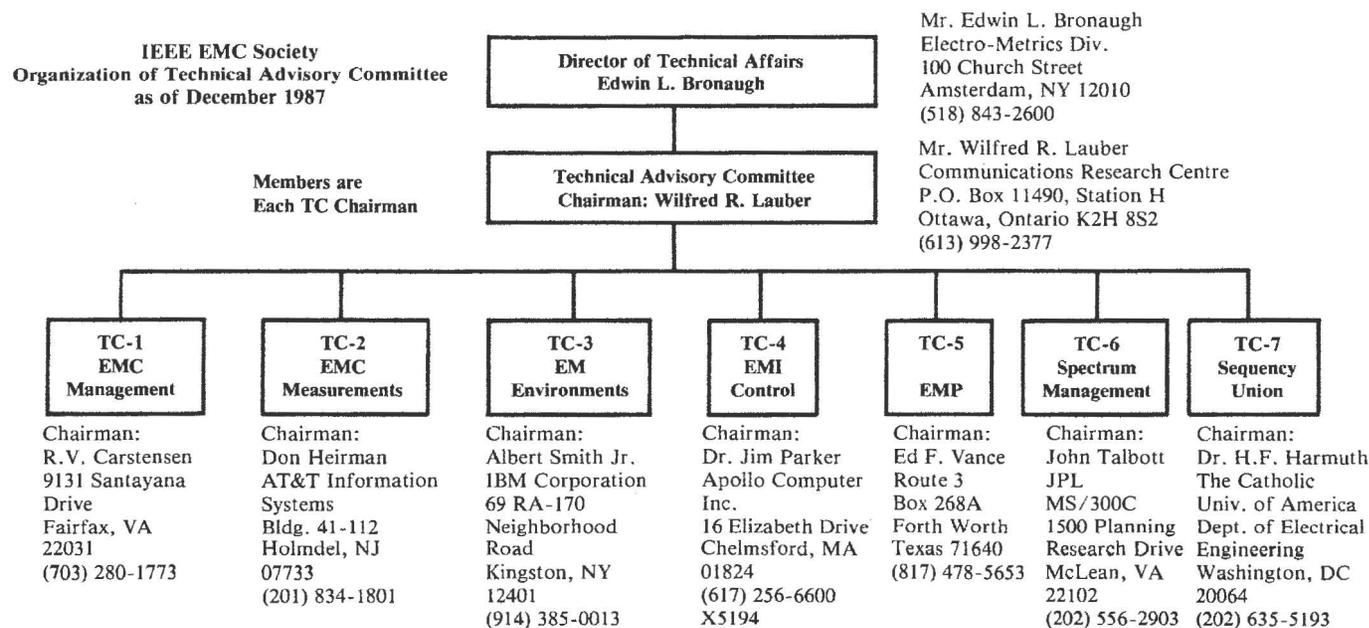
Concerned with frequency coordination, management procedures for efficient spectrum use, band occupancy and congestion and federal regulations and their adequacy.

### TC-7 SEQUENCY UNION

Concerned with the application of electromagnetic signals with large relative bandwidth, commonly referred to as nonsinusoidal waves.

## SUMMARY

The figure below shows the organization of the Technical Advisory Committee. The major contributions of the TCs to the EMC-S over the past few years have been: 1) providing a technical review of Symposium papers, 2) organizing and running workshops and tutorials at EMC Symposiums and 3) generating standards. If you are interested in this work, please contact the appropriate TC Chairman.



# EMC PERSONALITY PROFILE



**BERNHARD E. KEISER**

Bernie Keiser is a consulting engineer in telecommunications and related EMC problems. His company, Keiser Engineering, Inc., has been in operation since 1975. His work in EMC began in 1972 while working as Director, Analysis, on the ATS-6 spacecraft program at Fairchild in Germantown, MD. The numerous RF experiments and projects from 40 MHz to 30 GHz carried within the small confines of the spacecraft made the design a real EMC challenge.

Since 1975, in addition to consulting, he has been teaching continuing engineering education courses in *Electromagnetic Interference and Control*, *Grounding, Bonding and Shielding*, *Hazardous Electromagnetic Radiation and Lightning Protection*. In 1979, Bernie's book, *Principles of Electromagnetic Compatibility*, was published by Artech House, Inc. This book, now in its third edition (1987), is based on his consulting and teaching experience.

One of his recent EMC projects has been the development of a means of limiting wave diffraction over a barrier wall, for which he has received a U.S. patent. This technique is being used successfully by the Fanwall Corporation in allowing satellite earth stations to operate in the presence of strong terrestrial microwave signals. In a recent project, he helped the Irish telecommunications authority in planning for minimum interference to the public telephone system from a new long wave broadcasting station. He has also assisted television stations experiencing interference from co-located AM stations.

Bernie was born in Richmond Heights (St. Louis), Missouri, and earned his BSEE, MSEE and DScEE from Washington University in St. Louis. His work toward the



by William G. Duff

doctorate was done under an RCA Fellowship in Electronics. Following several engineering positions in the St. Louis area after graduation, Bernie went to work for RCA Laboratories, Princeton, NJ, in 1959. There he designed what, at the time, was the world's longest radio antenna (160 km), for the ELF program, then known as Project Pangloss. This preliminary work led to the system now being operated by the Navy in northern Wisconsin and the upper Michigan peninsula.

Bernie's work for RCA also included management of the communications planning activity at the Merritt Island Launch Area (Florida) in preparation for the Manned Lunar Landing Program, plus two years at the RCA Radar Division in Moorestown, NJ.

In 1969, Bernie moved to the Washington, DC, area where he became Vice President and Technical Director at Page Communications Engineers. Subsequently, he became Director of Advanced Engineering at Atlantic Research.

Bernie joined the IRE as a student member while in college and became a Fellow of the IEEE in 1980. He was Technical Program Chairman for the IEEE-EMC Symposium in Baltimore in 1980, Chairman of the Washington, DC, EMC chapter in 1979-1980, and Chairman of the IEEE Northern Virginia Section in 1980-1981. He was a recipient of the IEEE Centennial Medal in 1984. He is a member of IEEE Committee P 626 on grounding standards for digital systems. In addition to his IEEE activities, he is a Fellow of the Radio Club of America and the Washington Academy of Sciences. He is a Registered Professional Engineer in Virginia, Maryland and the District of Columbia.

Bernie and his wife, Evelyn, have four daughters and one son. His hobby is amateur radio, in which he holds an extra class license, and he is active in amateur fast-scan television.

# BOOK REVIEWS



by Jim Hill, The EMXX Corp.

Preston E. Law, Jr. is well qualified to write a book about shipboard electromagnetics. He is currently Head of the Ship Topside Electromagnetics Design Branch of the Naval Sea Systems Command, where he is responsible for ensuring EMC in Shipboard Command Systems. His previous experience includes employment as a communications systems engineer in Thailand, with the Voice of America in Washington, DC, and the FAA in Anchorage, Alaska. *Shipboard Electromagnetics* is not his first book. He has also written *Shipboard Antennas* which came out in its second edition in 1986.

Our reviewer is Robert J. Haislmaier who, as Navy EMC Coordinator of the Office of the Chief of Naval Operations, is exceptionally well qualified to evaluate and review a book on shipboard electromagnetics.

## SHIPBOARD ELECTROMAGNETICS

by Preston E. Law, Jr., 1987

ARTECH House, Inc.  
685 Canton Street  
Norwood, MA 02062

262 pages, hardbound, illustrated, \$60.00

How can one cram all those complex, sensitive and high-powered electronic eyes, ears, fingers and nerves onto one ship with any hope of its being able to carry out its mission? The answer this book convinces us of is: "very carefully."

To be sure we understand the problem, the first chapter is a brisk journey through a most fascinating history of EMI in ships. Like the proverbial mule being hit between the eyes with a two-by-four to get his attention, we are confronted immediately with the ultimate disaster—a modern warship lost in combat because it was disabled by EMI. The chapter then moves from the simultaneous birth of naval radio communications and naval EMI on October 26, 1899 through 88 years of the U.S. Navy's struggle to assert control over EMI so its fleet can prevail. One leaves the chapter amazed that such an insidious problem could ever be brought under control. The rest of the book explains how it is done, and ends each chapter with references.

Chapter Two discusses the formidable electromagnetic environment in which ship's electronics, ordnance and personnel must successfully and safely function. Contributions from onboard systems produce field levels as great as 30,000 volts per meter; external sources, including electronic jammers, can raise the environment to 850,000 volts per meter.

Chapter Three defines shipboard electromagnetic compatibility and management measures to assure it is achieved in ship design and construction: EMC program planning, EMC advisory boards, EMI control plan, EMC test and evaluation, configuration management and awareness training.

Chapter Four on shipboard electromagnetic interference constitutes the major portion of the book. It presents the technology used for EMI control in integrating electronics into the construction and maintenance of ships: shielding, grounding, bonding, filtering, blanking and system arrangement and integration. Technology presented includes shielding with non-metals coated by vacuum metalizing, electroless plating and wire-arc and flame spray deposition.

Chapter Five broadens the focus from electronics to include people, ordnance and fuel as victims of the shipboard electromagnetic environment.

Chapter Six introduces another source into the ship electromagnetic environment—nuclear electromagnetic pulse (EMP). The principle of EMP hardening is to prevent EMP generated currents from penetrating to the equipment level. Control measures include grounding, shielding and bypassing, together with analyses and testing methods and facilities for both scale model and full size ships.

The seventh and final chapter on shipboard electromagnetic assessment is the transition into the future. Several programs are discussed which use the computer to sort, compare and evaluate the interference and effectiveness levels of system arrangements on ships. Examples are given of use of the Topside Design Model (TDM), "a computer-aided systems engineering program, currently used in all major ship designs, modernizations and overhauls affecting shipboard electromagnetic performance."

The fact is that shipboard EMI control is too complex even for a committee of experts. They need an engineering

## CALENDAR 1988

- April 12-13                      Engineering Specialty Certification  
Conference  
Atlanta, GA  
Contact:     Mr. Arthur Schwartz  
                 National Society of Professional  
                 Engineers  
                 Telephone: (703) 684-2845  
                 or  
                 NSPE Legal Department  
                 1420 King Street  
                 Alexandria, VA 22314
- April 12-14                      ASME/IEEE Joint Railroad Conference  
William Penn Hotel  
Pittsburgh, PA  
Contact:     Dr. Tristan Kneschke  
                 Meeting Chairman, VTS Land  
                 Transportation Division  
                 Traction Electrification Systems Department  
                 Parsons Brinckerhoff/De Leuw Cather-  
                 1701 North Market Street  
                 Dallas, TX 75202  
                 Telephone: (214) 573-8944
- April 18-21                      1988 International Symposium on  
Radio Propagation (ISRP '88)  
Beijing, China  
Contact:     Professor Sha Zong (Z. Sha)  
                 China Research Institute of  
                 Radiowave Propagation  
                 P.O. Box 138/88  
                 Xinxiang, Henan, People's Republic of China
- April 19-21                      International Conference on Lightning and  
Static Electricity  
Sheraton Century Hotel  
Oklahoma City, OK  
Contact:     Donald R. MacGorman  
                 Conference Chairman, 1988 ICLSE  
                 NOAA/ERL/National Severe Storms Laboratory  
                 1313 Halley Circle  
                 Norman, OK 73069  
                 Telephone: (405) 366-0405  
                 or  
                 G.A.M. Odam  
                 European Coordinator, 1988 ICLSE  
                 Royal Aircraft Establishment  
                 Farnborough, Hants  
                 GU14 6TD United Kingdom  
                 Telephone: 252 24461, ext. 2662

tool which combines ship architecture and marine engineering with electromagnetic engineering and an expert system carrying design guidance from demonstrated experts like the author. That is the direction in which the Navy has started moving since this book was published.

For many years I have observed and respected the author's quiet and efficient competence in EMI control in ship design. I am delighted that he has chosen to document some of his expertise in this book before he, like so many others, leaves the active ship design community. I compliment him on a job well done.

Reviewed by  
Robert J. Haislmaier

## ANTENNA MEASUREMENT ERRORS STUDIED

When antennas are measured or calibrated in anechoic chambers, a misalignment of the receiving and source antennas will lead to errors. In the case of near-field measurements, uncertainty about the location of the probe with respect to the antenna will cause relatively large errors. Two recently published reports from NBS rigorously examine these errors to quantify their effects on measurement accuracy. *Evaluation of Off-Axis Measurements Performed in an Anechoic Chamber* (TN 1305) and *Displacement Errors in Antenna Near-Field Measurements and Their Effect on the Far Field* (TN 1306) are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. TN 1305 may be ordered for \$2.25 prepaid (order by stock no. 003-003-02779-1) and TN 1306 costs \$2.00 prepaid (order by stock no. 003-003-02776-6).

## EMCABS

In this issue we continue publishing abstracts of papers from previous EMC Symposia, other conferences, meetings and publications. The EMCABS committee is composed of the members listed below. By way of introduction to the community, they are listed with their company affiliations:

L.F. Babcock, Ford Aerospace Textron  
E.L. Bronaugh, Electro-Metrics/Penril Corporation  
R.N. Hokkanen, Harris Corporation  
R. Jacobson, Sperry Flight System  
S. Kuniyoshi, Naval Sea Systems Command  
D.R. Kerns, Southwest Research Institute  
R.B. Schulz, Consultant  
R.M. Showers, University of Pennsylvania



by William H. McGinnis

**“HOW CAN I GET A COPY OF AN ABSTRACTED ARTICLE?”** The answer to this frequently asked question follows.

Most large public libraries, some small public libraries, all engineering school libraries and most other college or university libraries have copies of publications in which articles appear. If they happen not to have the desired publication, such libraries usually can obtain it or a copy of the article from other libraries or sources. Many company libraries, both large and small, also have such arrangements. Many articles also are available from the National Technical Information Service (NTIS) and/or the Defense Technical Information Center (DTIC). To retrieve an article or publication containing an article abstracted in EMCABS, it is suggested that you contact your company library, a nearby engineering school library, a university library or your municipal public library. If the library does not have the publication, go to the librarian, explain what you need and he or she will help you get the publication on loan, perhaps from another library or, for a nominal charge, from NTIS. If you have a Department of Defense contract, the contracting officer or your company librarian can help you get publications from DTIC. The information needed is contained in the EMC abstract heading.

<p><b>Out-of-Band Response of Antenna Arrays</b> David A. Hill and Michael H. Francis National Bureau of Standards, Electromagnetic Fields Division, Boulder, CO 80303 1987 IEEE International Symposium on Electromagnetic Compatibility IEEE Catalog Number 87CH2487-7, August 25-27, 1987, pp. 435-438</p> <p><b>ABSTRACT:</b> The response of antenna arrays to out-of-band frequencies has been analyzed using the effective aperture approach. An average value of effective aperture can be obtained by averaging the incidence angle and the polarization of the incident field. Far-field patterns have also been calculated by treating the array element excitations as random variables. The randomness in the element excitations causes a decrease in directivity and an increase in sidelobe level.</p> <p><b>INDEX TERMS:</b> Antenna arrays, effective aperture, far-field patterns</p>	<p><b>EMCABS: 01-03-88</b></p>	<p><b>Measured Electromagnetic Performance of Hardening Elements for Aircraft Windows and Doors</b> L.O. Hoeft,* C. Herrmann,** and William D. Prather*** *BDM Corporation, Albuquerque, NM 87016, **TRW Defense Systems Group, Albuquerque, NM 87106 and ***Air Force Weapons Laboratory, Kirtland AFB, NM 87117 1987 IEEE International Symposium on Electromagnetic Compatibility IEEE Catalog Number 87CH2487-7, August 25-27, 1987, pp. 168-171 <b>ABSTRACT:</b> The electromagnetic coupling through the doors and windows of a Boeing 707 was determined by measuring the open circuit voltage developed in a resistively-terminated wire placed across the inside of the aperture when a transverse electromagnetic (TEM) wave was injected on the outside surface of the aircraft using a special test fixture. Window screens reduced the coupling by about 20dB and metal window blanks with circumferential conductive gaskets by 45dB. Conductive gaskets reduced the coupling through the cargo door by about 28dB. The performance of a personnel door was only 10dB due to differences in construction of the door and its latching mechanism. However, when the aircraft was pressurized, the shielding increased to 22dB.</p> <p><b>INDEX TERMS:</b> Electromagnetic coupling, aircraft, transverse electromagnetic (TEM) wave, conductive gaskets, shielding</p>	<p><b>EMCABS: 04-03-88</b></p>
<p><b>Antenna Factor Anomalies and Their Effects on EMC Measurements</b> Colin E. Brench Digital Equipment Corporation, Maynard, MA 01754 1987 IEEE International Symposium on Electromagnetic Compatibility IEEE Catalog Number 87CH2487-7, August 25-27, 1987, pp. 342-346</p> <p><b>ABSTRACT:</b> When using broadband antennas in EMC work, the conditions in which they are used are significantly different from those for which they were calibrated. The errors caused by this during compliance testing have been shown to exceed 10dB. This paper details measurements made to evaluate these effects by using a modified version of the calibration by substitution method for a biconical antenna.</p> <p><b>INDEX TERMS:</b> Broadband antennas, EMC, calibration, biconical antenna</p>	<p><b>EMCABS: 02-03-88</b></p>	<p><b>Definitive Open Area Test Site Qualifications</b> Donald N. Heirman AT&amp;T Information Systems, Holmdel, NJ 07733 1987 IEEE International Symposium on Electromagnetic Compatibility IEEE Catalog Number 87CH2487-7, August 25-27, 1987, pp. 127-134</p> <p><b>ABSTRACT:</b> This paper summarizes recent efforts of the voluntary standards community to standardize adequate site qualification measurements. This work is being considered primarily by the American National Standards Institute Accredited Standards Committee C63 (EMC) and the Special International Committee on Radio Interference (CISPR). Present methods for determining open area as well as other test site qualifications to measure radiated emissions for compliance with FCC and other regulatory requirements depend on comparing horizontal polarization site attenuation measurements to a theoretical model. Horizontal polarization measurements are generally inadequate to identify site anomalies which may actually cause significant errors when equipment emission compliance is subsequently measured. Both vertical and horizontal site attenuation measurements are necessary as well as adequate theoretical models to use in the comparisons.</p> <p><b>INDEX TERMS:</b> FCC, site attenuation, open area test site</p>	<p><b>EMCABS: 05-03-88</b></p>
<p><b>Monitoring Measuring Repeatability at Radiated Emissions Testing Facilities</b> Scott Roleson Hewlett-Packard Company, San Diego, CA 92127 1987 IEEE International Symposium on Electromagnetic Compatibility IEEE Catalog Number 87CH2487-7, August 25-27, 1987, pp. 231-235</p> <p><b>ABSTRACT:</b> Maintaining adequate measuring accuracy and repeatability at radiated emissions testing facilities (e.g., open field sites and semi-anechoic chambers) is necessary to maintain credibility. Although catastrophic failures are usually readily apparent, slow changes to measurement accuracy or minor failures are difficult to detect. Annual or semi-annual preventative maintenance is necessary to insure accuracy, but cannot insure repeatability (i.e., continued accuracy) between maintenance periods. A method is described applying statistical quality control to weekly measurements of a standard, multifrequency source to produce a running control chart of EMI measuring system repeatability.</p> <p><b>INDEX TERMS:</b> Measuring accuracy, radiated emissions testing facilities, preventative maintenance</p>	<p><b>EMCABS: 03-03-88</b></p>	<p><b>A Simple Test Fixture for Quickly Measuring Surface Transfer Impedance of Cables</b> L.O. Hoeft and J.S. Hofstra BDM Corporation, Albuquerque, NM 87106 1987 IEEE International Symposium on Electromagnetic Compatibility IEEE Catalog Number 87CH2487-7, August 25-27, 1987, pp. 72-74</p> <p><b>ABSTRACT:</b> A quadraxial test fixture has been developed that allows the surface transfer impedance of a cable sample to be measured with a minimum of preparation. Measurements show that this fixture is capable of measurements to almost 100 MHz with an accuracy that is comparable to a conventional quadraxial fixture. Its principal limitation is that fixture crosstalk limits the minimum transfer impedance that can be measured.</p> <p><b>INDEX TERMS:</b> Quadraxial test fixture, surface transfer impedance</p>	<p><b>EMCABS: 06-03-88</b></p>

<p><b>Characteristics of Electromagnetic Field Emitting From Overhead Cable</b> Nobuo Kuwabara, Tsuyoshi Ideguchi NTT Electrical Communications Laboratories EMC-S Tokyo Chapter Meeting, June 26, 1987 (EMCJ87-17)</p> <p><b>ABSTRACT:</b> An analytic model of field emission from a telecommunications line is driven to obtain the relation between a terminal voltage and an emitting field. In the analysis, the current on the line is calculated by the wave equation and then the emitting field is calculated from this current. The validity of the theory is tested in the experiment using a small-sized line model and an overhead cable. It is obtained on the investigation that the tendency of an emitting field can be approximately calculated by this theory and a maximum conversion factor between terminal voltage and emitting field is -20dB in the frequency range of 0.1-30 MHz.</p> <p><b>INDEX TERMS:</b> EMI, emitting noise, terminal voltage, telecommunications line</p>	<p><b>EMCABS: 07-03-88</b></p>	<p><b>Calculation of Site Attenuation in Anechoic Chamber</b> T. Takahasi, N. Schibuya, K. Ito, A. Kato and T. Masuda Cannon Co., Takushoku University, Tokin Noise Technical Center, JAPAN EMC-S Tokyo Chapter Meeting, July 30, 1987 (EMCJ87-30)</p> <p><b>ABSTRACT:</b> The site attenuation in the anechoic chamber was calculated using the following methods and compared with the measured data. 1) The characteristics of the absorber was calculated from the multiple reflection of the absorber layers, the <math>\epsilon_s</math> of which were averaged layer by layer into the effective permittivity <math>\epsilon_{eff}</math> from absorber and vacuum one. 2) The 12 reflection paths were counted instead of six, because the floor was seemed to be the perfect reflector. The reflections through floor one time were counted up. 3) The multiple reflections (different from 1) from the floor, ceiling or walls were taken into account, because of the low absorption of the material. 4) The near field effect was taken into account through intrinsic impedance. The consideration of the multi-path reflections results in the agreement of the detailed peaks and dips of the attenuation curve. The measured and calculated curves by taking the near field effect into account agreed qualitatively.</p> <p><b>INDEX TERMS:</b> Site attenuation, anechoic chamber, absorber, near field effect</p>	<p><b>EMCABS: 10-03-88</b></p>
<p><b>Contact-Free Detection of Current Fluctuation—Multicarrier Method</b> Sumihisa Hashiguchi and Naofumi Hoshi Faculty of Engineering, Yamanashi University, JAPAN EMC-S Tokyo Chapter Meeting, May 22, 1987 (EMCJ87-11)</p> <p><b>ABSTRACT:</b> We discussed a new version of the contact-free detection of the current fluctuation. In this method two carriers are applied to the sample and they are detected with two separate detecting systems. The threshold sensitivity is remarkably improved and the restrictions on both C/N of the carrier and the noise of the detecting systems are relaxed.</p> <p><b>INDEX TERMS:</b> Contact-free detection, current fluctuation</p>	<p><b>EMCABS: 08-03-88</b></p>	<p><b>Radiation Characteristics of Printed Circuit Boards By the Difference of Digital IC Structures</b> Nobuo Murota Industrial Research of Aichi Prefectural Government, JAPAN EMC-S Tokyo Chapter Meeting, December 18, 1987 (EMCJ87-75)</p> <p><b>ABSTRACT:</b> Manufacturing technology of IC improves its ability. The switching speed of the new type of CMOS digital IC is faster than before. Electromagnetic radiation from printed circuit boards is increased. This paper describes the difference of radiation characteristics between CMOS and TTL digital ICs, and among shapes of circuit patterns. When radiation is considered, more care is required when we make use of CMOS ICs than when TTL ICs are used. The measurement was done by using a TEM cell.</p> <p><b>INDEX TERMS:</b> Electromagnetic radiation, printed circuit, CMOS, TEM cell</p>	<p><b>EMCABS: 11-03-88</b></p>
<p><b>A Method of Visualizing Two-Dimensional Distribution of Static Electricity for ESD Primary Countermeasure</b> Takesi Kondoh, Osamu Fujiara, Kazuo Kotoh and Takasi Azakami Faculty of Engineering, Nagoya Institute of Technology, JAPAN EMC-S Tokyo Chapter Meeting, June 26, 1987 (EMCJ87-23)</p> <p><b>ABSTRACT:</b> In recent years, many investigations have been done on the subject of electrostatic discharge (ESD) and the influences of these charges on electronic equipment. For the purpose of ESD primary countermeasure, we present a method of visualizing the two-dimensional distribution of static electricity, which is based on the principle of the X-Ray CT. To confirm the validity of this method, we performed a computer computation and a preliminary experiment on the focusing images of a simple model.</p> <p><b>INDEX TERMS:</b> ESD, charge distribution, visualization, computation, experiment</p>	<p><b>EMCABS: 09-03-88</b></p>	<p><b>On the Possibility of a Very Wide-Band and Thin EM Absorber</b> Yoshiyuki Haitoh and Hajime Seki Faculty of Engineering, Tokyo Institute of Technology, JAPAN EMC-S Tokyo Chapter Meeting, December 18, 1987 (EMCJ87-71)</p> <p><b>ABSTRACT:</b> The thinnest configuration of separated multiferrite absorber is determined by a nonlinear optimization technique SUMT in order to reduce TV ghosts in both VHF and UHF bands. Solutions suggests that a thin absorber with a much wider bandwidth than before may be obtained, without the necessity of using multilayer, by reducing the permittivity of the ferrite material.</p> <p><b>INDEX TERMS:</b> Electromagnetic absorber, ferrite, TV ghost, wide band, optimization, permittivity</p>	<p><b>EMCABS: 12-03-88</b></p>

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November 8-10

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