# IEEE ELECTROMAGNETIC COMPATIBILITY SOCIETY NEWSLETTER

ISSUE NO. 165 SPRING 1995 (ISSN 0164-7644) ROBERT D. GOLDBLUM, *Editor*


## MESSAGE FROM THE PRESIDENT

WARREN KESSELMAN
PRESIDENT, EMC SOCIETY

Globalization, corporate downsizing, rapid technological change, information highway and wireless society are some of the buzz words often associated with twenty-first century challenges. By year's end, your Board of Directors should have adopted a strategic plan to take our Society from the "old" to the "new" way of doing business. The focus of the plan will be to better serve the needs of our worldwide membership. What is your personal strategy to keep up with the rapid changes that are occurring?

Last year, the IEEE Educational Activities Board sponsored a workshop entitled "Industry 2000 — Technical Vitality Through Continuing Education." Over 100 participants from large and small companies debated such questions as: "How do successful engineers and their employers prepare themselves to face the challenges of advancing technology?"; "What are the barriers to using the resources that are already in place, such as the programs offered by universities?"; and "Why does industry have a technical vitality problem?"

In his plenary address, Dr. Ray O. Waddoups, Motorola University West, made a comparison between computer technology advancement and university training obsolescence. It caught my attention because it related directly to me. His analysis was that an engineering education received 45 years ago is now a million times obsolete. One of his key remarks was that "Our people are the most important thing we have. We've got to learn how to upgrade more than our computers if we are going to be successful. We must learn how to upgrade our people." Dr. Waddoups stated that Mororola has a corporate goal "that everyone (CEO on down to maintenance people) is to receive a minimum of 40 hours of training each year." You might consider that a guide for your yearly upgrading.

A large part of that objective for this year could be accomplished at your Society's Symposium in Atlanta, Georgia in August. A full week of workshops and technical sessions are on the agenda. You also will have an opportunity to visit our Education Committee's demonstration booth and discuss ways in which your Society might encourage knowledge dissemination. One of the conclusions of Industry 2000 was "Unfortunately, professionals do not maintain their technical knowledge base as well as they care for their home." That statement was prompted by the observation that training an engineer costs about the same as your first house.

A number of recommendations resulted from Industry 2000. Our Society's strategic planning will include implementation of a number of those actions. Copies of the Proceedings of Industry 2000 may be purchased from the IEEE. Also, a 15-minute video entitled "Professional Development: Where Do You Stand?" may be purchased. It's described as "a fast-paced video report on the need for technical vitality through continuing education." It contains interviews with a cross section of engineering professionals discussing current conditions and future trends.

EMC engineering crosses all electro-technology boundaries. Your continuing education development, therefore, must have a broad horizon.

## In this issue

# EDITORIAL

ROBERT D. GOLDBLUM
EDITOR

I didn't realize that writing a meaningful editorial every few months would be such a challenge. It seems as though we just finished the last Newsletter and now the editorial for the next one is due. Before I open a new topic, perhaps it is best that I receive some feedback relative to the proposition of a worldwide accepted EMC standard, the subject of my last editorial. Thank you, Bob Rothenberg, for the cheer. I would certainly like to receive additional views and opinions on the subject and especially learn of some ways this may be achieved. I can't promise that I will publish whatever you send, but I can promise that if you don't send anything, it won't be published.

This is an unveiled attempt to make the EMCS Newsletter a more open forum. I look forward to hearing from you.




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### IEEE EMC SOCIETY NEWSLETTER PUBLICATION SCHEDULE

| PUBLICATION DATES | EDITORIAL DEADLINES |
|---|---|
| August | June 15 |
| November | September 15 |
| February | December 15 |
| May | March 15 |

Editorial Contributions for the August issue should be received by June 15.

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# CHAPTER CHATTER

**TODD HUBING**
**ASSOCIATE EDITOR**

"Knock knock."
"Who's there?"
"Gelegenheit!"
"Who? What do you want?""
"Knock knock."
"Who's there?"
"Occasione!"
"Who? Listen, I'm working on a very tricky EMC problem in here. Speak up!"
"Knock knock."
"Who's there?"
"Oportunidad!"
"I can't understand a word you're saying. Come back tomorrow. I'm very busy."

Are you so overwhelmed with your own engineering problems that you find it difficult to keep up with what it going on outside your laboratory? The electronics industry is rapidly changing. As EMC engineers, we are constantly presented with new challenges. How do you keep yourself up-to-date? Do you read the IEEE EMC *Transactions*? Trade magazines? Do you move from crisis to crisis relying on first-hand experience to hone your EMC problem solving skills?

How do you keep up with changes in EMC regulations, new device technologies, new materials, new test equipment, new measurement procedures, new design methodologies and new computer design tools? How does the best decoupling strategy for a 4-layer board differ from that of a 10-layer board? What EMC regulations must a product comply with if it will be shipped to Europe in 1996? What test equipment is available for FCC EMI testing up to 5 GHz? What impact do ball-grid arrays have on radiated EMI? Are there any computer modeling tools that could help you to be more efficient? The answer to each of these questions is likely to be different today than it was just a year ago.

To be highly effective as an EMC engineer, you need access to the latest information. It's good to keep up with the EMC *Transactions*, but journal papers usually describe work that was done one or two years ago. Trade magazine articles are more current and they are a valuable source of information for the EMC engineer, but the material presented may be incomplete or biased. In general, publications are an important resource for the EMC engineer, but publications alone cannot keep pace with the rapidly evolving electronics industry.

The best way to keep yourself up-to-date and enhance your value to your company and your profession is to communicate regularly with other EMC engineers (preferably not just other engineers within your own company). One of the best ways to communicate with other engineers is to regularly attend your local EMC chapter meetings. In one chapter meeting, you can learn more about the latest tools, tricks, and techniques that are relevant to your own work than you are likely to learn from a whole year's worth of any one publication.

Are chapter meetings out of the question for you? Too far to travel? Inconvenient? Don't give up on communication. There is another tool available. You've heard of it. It's the Internet. You can become connected through your company, through a local university, or through one of dozens of commercial access providers.

My 11-year old son uses the Internet to keep up with the latest information on X-men and other comic book super heroes. He gets the latest pricing information, downloads pictures, and discusses plots and characters with other aficionados. My 14-year old daughter has downloaded sounds, pictures, text, and videos relating to her interest in gymnastics and her current plans to become a veterinarian. As an EMC engineer, you can find information on the latest products and components, EMC test sites, EM modeling software, EMC regulations, and almost anything relevant to your profession that you might want to investigate. You can communicate directly with other EMC engineers via electronic mail, post general questions to the electronic news groups, download software, and visit other companies and laboratories via the worldwide web.

The IEEE EMC Society is on the Internet. You can find us via the IEEE's web page at

www.ieee.org

or link to us directly at

www.emclab.umr.edu/ieee_emcs

The EMC Society web page contains information about the society and links to other web pages with EMC-related information.

Our value as EMC engineers is defined by our knowledge and our ability to apply that knowledge to solve real problems. We can't be completely effective if we remain isolated in our own laboratories solving today's problems using yesterday's techniques. Communication is the key. If you're not taking advantage of the opportunities presented by your local EMC Society chapter and the Internet, then you're not being as efficient or as effective as you can be. Attend the meetings! Get connected to the Internet! When opportunity knocks, open the door!

**CENTRAL NEW ENGLAND**

John Clarke, secretary of the Central New England chapter reports that Henry Ott was the featured speaker at their February meeting. Henry's talk was titled "The Changing

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Regulatory Environment" and described changes pending or made to various EMC standards both in Europe and the United States. The presentation covered the rationale behind these changes and their impact on industry. The talk ended with comments on future regulatory trends in the United States and Europe.

**CENTRAL TEXAS**

Bob Hunter, "Sometime Acting Secretary/Treasurer of the Central Texas Chapter," reports that Mr. Scott Roleson of Hewlett-Packard was the featured speaker at their January meeting. The title of his presentation was "Perspectives and Techniques for Bench-Top EMC Testing." Mr. Roleson is a Distinguished Lecturer for the EMC Society.

In February, the chapter met at a San Antonio restaurant, then went to the University of Texas Health Science Center - Center for Radiation Toxicology and Radiation Oncology for a presentation by Dr. Martin Meltz. Dr. Meltz's presentation was titled "Topics in the Study of Ionizing and Nonionizing Radiation." His research includes the development of a facility where test specimens may simultaneously be exposed to X-radiation and EM fields. William H. (Bill) Parker was the featured speaker at the March 23rd meeting. Bill spoke on the specification and selection of EMI line filters for both emissions and immunity.

On March 31st, the chapter met jointly with the Electronics in Medicine and Biology Society (EMBS) chapter. This meeting, also attended by many of the EMCS Board members was a panel discussion on the EMI susceptibility of medical equipment. Dan Hoolihan moderated the panel, which included EMCS members Ed Bronaugh, Joe Butler and EMBS member David Kilpatrick.

**CHICAGO**

Ray Klouda submitted the following report on the activities of the Chicago chapter: New officer elections were held at the January meeting. Congratulations to all those elected. We welcome Jack Black as our new membership chairman. He replaced Lance Dekker who had resigned from this position. A special thanks was extended to Lance for his years of outstanding service to the chapter. Don Sweeney will continue as Chairman; Roger Swanberg, Vice Chair; Bill Bumbliss, Treasurer; Ray Klouda, Secretary; Dale Sventanoff, Programs Chair.

Don Weber of Electromagnetic Engineering Technology was the guest lecturer for the January meeting. His presentation, "Real World EMC Problems and Practical Solutions," offered an interesting sample and view of typical EMC problems. Don shared several personal experiences with the chapter, including a story about a farmer that was convinced that EMI was affecting his cows.

Our technical program has continued to supply enlightening and interesting topics. Last fall, our program included the latest developments in RF absorbers and chamber design. This topic was again considered during the Spring program with another view of a test chamber design.

**LOS ANGELES**

Janet O'Neil sent in the following report on the activities of the Los Angeles chapter. Thank you, Janet.

After a December holiday break, Los Angeles chapter members reconvened in January to host Don Heirman. Don spoke on the topic "How Proposed International Emission/Immunity Limits and Measurement Methods Will Affect Product Compliance." For added spice, Don included a brief update on the use of commercial EMC standards instead of the usual MIL-STD-462/461 standards per "The Secretary of Defense Perry Memo." Mr. Heirman is uniquely qualified to speak on these topics as he manages the Global Product Compliance Laboratory of AT&T Bell Laboratories in Holmdel, New Jersey. In addition, he is a past President and member of the EMC Society Board of Directors (he also served as Director for Technical Services), he is the current chairman of the EMC Society Standards Committee, and he is a U.S. technical expert and delegate to various basic and product committees within the IEC/CISPR. Also, Don was the IEEE EMC Society representative at the December 8, 1994 Tri-Service meeting in Washington DC so he was especially well prepared to speak about "The Perry Memo." Some 40 Chapter members attended this meeting to learn if Don could provide the magic standard, or an "overarching template," of limits and measurement methods which, if met and used, could ensure that a product can be marketed worldwide. Since many manufacturers are committed to marketing products internationally, this was a pertinent subject to chapter members. From his work with the IEEE EMC Society, Don also stressed the need and importance of the U.S. being more involved in assisting various international bodies in developing their respective EMC standards. He also provided ways for the attendees to participate. (For more information, call Janet O'Neil at (310)973-8757.)

***Don Heirman (left), Ray Adams and their furry pal discuss the cellular phone and EMI debate.***

Photos courtesy of Janet Nichols O'Neil

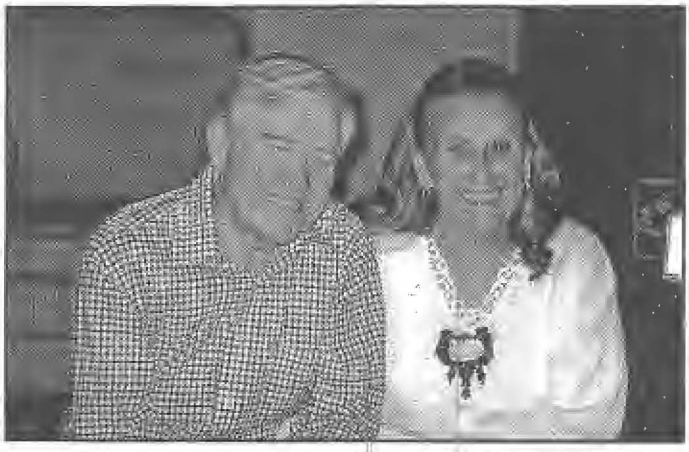
In February, chapter members were treated to the first

meeting of a two-part series on grounding. Dennis Shebel of JPL spoke on Spacecraft Grounding. This drew a near record attendance of 60 members! Dennis discussed some of the unique EMC challenges for planetary spacecraft, especially the Cassini. He passed around an attendee sign-in sheet which will be reduced and mounted on the Cassini spacecraft, which is due to rendezvous with Saturn on July 1, 2004. Dennis noted that spacecraft grounding is solely driven by the payload performance requirements. There are no FCC or NEC requirements; however, all spacecraft subsystems must be mutually compatible. The spacecraft instruments must measure faint electromagnetic signals from the planets and plasma. If the spacecraft platform is not quiet enough, the intended signals will be masked by the system noise. Dennis also stated that the most sensitive subsystem usually drives the EMC design and careful consideration must be given to mitigate EMI from the noisiest subsystems. This must all be accomplished with minimal impact to the system weight budget. It is a challenging EMC task, especially as related to grounding and bonding. A discussion on bonding per MIL-B-5087 elicited some very excited comments from the audience. Overall, it was a fascinating presentation and Chapter Chairman Ray Adams extended special thanks to chapter member Al Whittlesey for suggesting Mr. Shebel as a speaker on this topic.

In March, Hugh Denny of Georgia Tech Research Institute spoke on "Grounding for Facilities and Equipment." This was the second meeting of the two-part series on grounding. Some 50 chapter members attended, which shows the importance placed on the topic of grounding. Hugh outlined the reasons that we ground facilities and equipment and spoke of the folklore and black magic often associated with grounding. He compared the evolution of modern medicine from home remedies to its current state with those of grounding problems and their associated "home remedies." Hugh emphasized that while medicine has evolved into a scientific discipline, grounding is just starting to be approached in a scientific manner. This led to a discussion of grounding "experts," their theories and techniques (some of which were quite humorous, and why "grounds" are often not what we think they are. For example, there is a finite impedance associated with grounds which is usually inductive at high frequencies. This fact is often overlooked and must be taken into account. Hugh closed his enlightening presentation with two "Denny" axioms and their corresponding corollaries: Axiom One: Grounding is a system design parameter. Corollary: "If grounding is not designed in," your system is likely to have grounding problems. Axiom Two: Grounding alone will not solve system/EMI noise nor prevent lightning damage. Corollary: Poor grounds and improper grounding techniques can make the problem worse.

### SANTA CLARA VALLEY

The February meeting of the Santa Clara Valley chapter featured Howard Bassen, Chief of the Electrophysics Branch of the FDA Center for Devices and Radiological



***Joe and Virginia Fischer cozy up after a dinner in Los Angeles honoring the LA chapter guest speaker Don Heirman.***

***Brian Kuhlman (left) discovers a grounding "secret" in the notes of speaker Hugh Denny after his presentation to the Los Angeles chapter.***

Health. Mr. Bassen's presentation was titled "Test Requirements and Methods for Evaluating the Radiated RF Immunity of Medical Devices." He presented technical information on the test methods and the EMI requirements used at the center to evaluate the electromagnetic immunity of medical devices. He also discussed case studies of EMI problems with critical medical devices. Hugh Hyatt, of Hyger Physics, was the featured speaker at the March meeting. Mr. Hyatt presented recent advances in characterizing and understanding ESD phenomena which help to explain the current lack of repeatability in ESD simulation. He also discussed the development of non-ambiguous ESD calibration and measurement techniques.

### SEATTLE

Steve Stegner sent in an e-mail message reporting that Art Brockschmidt was the featured speaker at the December meeting of the Seattle chapter. The title of Art's presentation was "Circuit Design Problems and Solutions Typical of Military, Space, and Commercial Switching Power Supplies." At a meeting on March 2nd, Howard Smith of Eldec gave a presentation titled "Power Supply Design War Stories." March 16th was the chapter's "Milwaukee Night." Steve Stegner gave a presentation titled "The 'CE' mark -What Is It?"

# EMCS BoD ACTIVITIES

DICK FORD
ASSOCIATE EDITOR

The first EMCS Board of Directors (BoD) meeting of 1995 was held in Austin, Texas on March 31 and April 1. On the 1st, the meeting was held at the Austin Convention Center, the planned site of the 1997 IEEE EMCS International Symposium. The Central Texas chapter and the convention center staff hosted a tour of the facility. On the 31st, the meeting was held at one of the planned symposium hotels, the Hyatt Regency.

The following directors were in attendance at the two-day meeting: **Warren Kesselman** (presiding), **Joe Butler, Len Carlson, Bill Duff, Bob Hofmann, Dan Hoolihan, Todd Hubing, Bill Gjertson, Bill McGinnis, Henry Ott, Dave Staggs, Don Sweeney, Norm Violette, Kimball Williams,** and me. Other attendees included: **Don Heirman, John Rohrbaugh, Bob Wangemann, Scott Davies, Ed Bronaugh, John Osborn, and Bob Hunter.**

Highlights of the meeting and Director's reports are as follows:

## FINANCIAL

A motion was approved for the EMCS Treasurer, **Andy Podgorski**, to prepare an article for the next issue of the EMCS Newsletter which will summarize budget plans for 1996. After the article I wrote a couple years ago (a retrospective of financial issues from the previous decade) several members asked for more financial information to be published in the newsletter. Next, **Bob Wangemann**, who replaced Irv Engelson as IEEE TAB Director a couple years ago, gave a report on the new proposed TAB financial policy (basically how societies are "taxed" to pay for the support received from headquarters TAB).

## MEMBER SERVICES

Director **Dan Hoolihan** informed the BoD that he planned an ambitious mail survey of EMCS membership, working in cooperation with the PROFESSIONAL SERVICES' survey/employment analysis committee. He has already talked with IEEE experts on survey techniques and plans fairly quick action. He moved to allow an overrun of his budget, not to exceed $5K (if necessary). It was approved. (See also survey article page 19.)

## CHAPTERS AND MEMBERSHIP

**Dave Staggs** reported that we're up from 40 to 41 chapters now. The latest chapter is a joint EMCS/ Antennas & Propagation (APS)/ Microwave Theory and Techniques (MTTS) Chapter in Beijing, China. Troubles continue to plague the new IEEE headquarters computer system and hence membership statistics continue to be unavailable (however, Bob Wangemann insists progress is being made). The EMCS booth was in operation at EMC/Zurich. The BoD extended special thanks to **Dr. Ferdy Mayer** for exemplary booth service (seven new members).

## DISTINGUISHED LECTURERS (DL)

**Dave Hanttula** reported considerable activity by the DLs (thirteen presentations between September '94 and March '95). **Hugh Denny** and Norm Violette were elected as new DLs, effective immediately (succeeding **Mike Crawford** and **Bill Parker). Todd Hubing** and **Franz Gisin** were also elected DLs, but will begin their two-year DL term effective January 1, 1996, succeeding **Andy Podgorski** and **Scott Roleson.** Finally, Dave would like to retire (recall that Dave temporarily assumed the DL chair after the death of John Adams). Dan Hoolihan is soliciting nominations to succeed Dave.

## COMMUNICATIONS SERVICES

### History

**Chet Smith** recently submitted to **Len Carlson**, the EMCS Communications Director, a sample CD-ROM produced by **Royce White's** Data Disc, Inc. Engineers at Boeing who evaluated it were enthused about the benefits of CD-ROM technology over the traditional methods. Now that costs for this technology have dropped significantly, Chet proposes putting much of our historical material (symposium records, newsletters, etc.) on CD-ROM. He estimates costs at about $15 to $20K. With expected sales of around 5000, a break-even cost of significantly less than $10 per disk would be expected.

### Symposia

**Henry Ott**, Symposium Committee Chair, submitted a letter clarifying the relationship and scope of his committee vs. the international committee. He then submitted the following motions:

1) That the Santa Clara 1996 symposium budget be approved.
2) That the Twin Cities chapter (Minneapolis/St. Paul, USA) be authorized to host the 2002 International Symposium. After **Dan Hoolihan's** second, there was considerable discussion. Much of this discussion centered around the still pending status of the Israeli request to host an International Symposium. It was expected that after 2001 was assigned to Montreal, Israel would actively pursue its request. Director Hoolihan was asked his opinion concerning 2003 for the Twin Cities (holding open 2002). After additional discussion,

*NEWS FLASH...* Our own Bill Duff has been nominated as IEEE Division IV Director!!! Don't forget to vote. We're not a large Society. It's vital that we rally behind Bill just as we successfully did behind Len Carlson a few years ago.

the "question was called."
3) That EMCS be a co-sponsor of AMEREM '96 to be held May 21, 1996 in Albuquerque, NM.
4) That symposium sponsoring chapters be authorized to define fees for EMCS life members attending their symposiums.

All these motions were approved.

**John Rohrbaugh** then gave a presentation on the status of the '95 Atlanta symposium. Fifty-nine companies have booked 93 booths (170 available) as of March 30. Subscriptions are on track with 1994 activity levels. Unlike the last two symposiums, Marriott is making a substantial number of rooms available (about 20%) for government attendees at $79.00. As well, the symposium committee bargained hard and got about a 40% discount from the standard "rack rate" for other attendees.

**Bob Hofmann,** Past President/Past Symposium Chair, presented a check to EMCS President **Warren Kesselman** for $112,039. This represents the surplus from the symposium in Chicago. In addition to this amount, over $12,000 was provided to the Chicago section in thanks for their assistance with the Symposium. (Some of this money covered the cost of our IEEE required formal symposium budget audit. Our symposium has now grown to the point that the informal audits are no longer allowed. This audit cost exceeded $2,000.)

Lastly on symposium issues, as a result of exhibitor concern at the Chicago Symposium over endorsement availability and credit, Henry Ott moved and the BoD approved the following policy:
1) Solicitation of donations from exhibitors to offset symposium expenses is allowed and encouraged.
2) All exhibitors must be given an equal opportunity to participate. Requests for solicitation of donations must be mailed or communicated to all exhibitors.
3) All signage recognizing such support shall be produced by the symposium committee, and not be banners or signage provided by the exhibitor.
4) The following, or similarly worded text, shall be placed in the symposium program: *"Financial support provided by organizations to offset symposium expenses does not constitute sponsorship of the symposium and/or endorsement of such organizations by the IEEE EMC Society."*

**PROFESSIONAL SERVICES**
**Norm Violette** reported that **Al Mills** has agreed to remain on as PACE coordinator despite his retirement status. **Herb Zajac** (PUBLIC RELATIONS COMMITTEE) has endorsed efforts to produce updated/new EMCS videos. He has shown the existing video to public forums such as local high schools. Response has been very good, but the video is now over five years old. Norm also reported that the international committee agrees with the policy reported under Symposia, but also recommended that the two committees be combined.

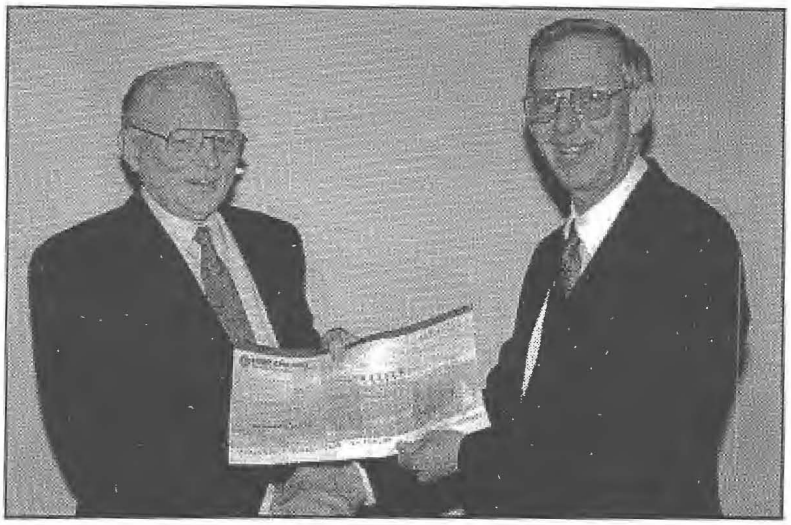


Photo courtesy of Dick Ford

***EMCS President Warren Kesselman (left) receives a check from Past Symposium Chair Bob Hofmann for the surplus revenues from the Chicago symposium.***

**TECHNICAL SERVICES**
**Leo Makowski**, Representative Advisory Committee (RAC) chair, reported that the RAC desires to sponsor **David Imeson** to speak at the Atlanta symposium. Mr. Imeson is the Chairman for the Association of European EMC Competent Bodies (ACB). Leo moved (by letter request) that the BoD authorize up to $2500 to defray Mr. Imeson's expenses. BoD discussion addressed: the amount of this request relative to amounts typically authorized ($1000); the fact that since the '95 budget reserve has already been committed, no budget line is available to cover this expense; and where future desirable efforts such as this should be budgeted. The motion was approved. COMAR representative **Dan Hoolihan** reported major news from the November COMAR meeting. The IEEE Engineering in Medicine and Biology Society (EMBS) has voted to accept COMAR as a technical committee effective January 1, 1995.

For the Education Committee, **John Howard** reported a reassessment of the University Grant Program. Subcommittee members are worried that the present plan simply "throws" money at a university. Without the presence of an on-site "champion" our hopes that this "seed" grant might create an EMC curriculum would be unfulfilled. **Jim Muccioli** reported that plans for the student paper contest for 1996 are going well and that connection efforts with

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student chapters are also going very well. **Todd Hubing** reports that he's getting about twelve "hits" a day on his new World Wide Web EMC "Home Page." There are now plans for an actual NARTE exam after **Jim Whalen's** 3rd (annual?) NARTE examination symposium workshop at the Atlanta Symposium. There's also consideration for using the NARTE question pool for an IEEE EMC Engineering Self-Appraisement Program (ESAP).

Technical Activities Committee **Todd Hubing**, Chair, reports that he has received the files of **Wilf Lauber** (past Chair) and is fast coming up to speed on the TCs. He has asked **Scott Davies** to be Chair of TC-1, EMC Management. Scott has reviewed the status of TC-1 and recommends that it be continued with a slight change in scope.

**OTHER BUSINESS**

**Len Carlson** moved, and **Don Sweeney** seconded a motion to raise from $850 to $1500 the amount available to reimburse BoD members for costs to attend BoD meetings if they have lost corporate support. There was considerable discussion on this motion. It was pointed out that the fastest growing portion of the budget seems to be the money the BoD spends on itself. There was also a question as to the motion's actual words changing the scope from just those directors whose status changed **after** they were elected (had support when elected but lost it subsequently) to any director claiming hardship. After it was clarified that only the amount was to be changed, but not the scope of application, the motion was voted and approved.

As usual, **Janet O'Neil**, EMCS Secretary, will be happy to provide additional details on the happenings at this (or any other) BoD meeting. The BoD's next meeting is planned for the Atlanta Symposium, Sunday August 13 from 10:00 a.m. to 5:00 p.m. and continuing on Thursday evening August 17 from 6:00 p.m. to 9:00 p.m.

# *DIVISION IV REPORT*

**ROLF LARSEN, DIVISION IV DIRECTOR**

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

In early March I participated in the TAB meetings and BoD meetings in Calgary, Canada. These meetings and the many enjoyable contacts I made gave me a first idea of which IEEE activities I should concentrate on during the next two years. In particular, I had the chance to meet most of the presidents of the societies within Division IV and got the impression that we can make a very good team.

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

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

All of these have been society presidents and all are IEEE Fellows. The one to be elected will serve in 1996 as Delegate Director Elect overlapping with my second year in office to create the desired continuity in Division IV. The Elect will automatically become the Division IV Director for the two years 1997/1998 following my term of office. With Ken Dawson's strong support (he acted as the Division IV nominating Committee Chairman), the plan of our societies regarding the Director Elect position has now been set on a regular path for the future.

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

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

KIMBALL WILLIAMS
ASSOCIATE EDITOR

## ENGINEERING EDUCATION: HOW LONG SHOULD IT TAKE?

The traditional university curricula in most of the civilized world comprises a standard four years of study, during which, it is tacitly assumed, the student will encompass the fundamentals of their discipline. Now why are four years the standard, especially for such divergent disciplines as nuclear physics, English literature and psychology? Should different disciplines require different periods of introduction to their basics? Or can all of the rudiments of a study be covered conveniently in a four-year cycle of classes? Who decided on four?

The four-year study period seems to have been established some time in the middle ages as the proper period for a young noble to spend away from his father's table, sowing wild oats and learning the ways of the world. Then he was expected to return to the estate and begin preparing to ease the work of, and eventually to take over from, his father. So, the four year standard may have begun as a social convention.

A debate within the academic community has been raging about just this subject for several years, with no significant progress in sight. Is four years enough to cover the basics of most subjects? Barely, and only if you cut corners. Would six years be a better choice? Yes, but who decides which materials are included in an expanded curriculum?

Educators would like to see more emphasis on fundamentals, most of which are given only introductory treatment in the current courses. (Can you imagine what a single semester E-mag field theory course must be like?) It is also astonishing what some academic administrations are proposing dropping from the current curricula to make room!

Engineering managers would like to see the extra time used to provide more practical skills for the new engineers. The problem is that what is considered practical varies from one business to another, sometimes from one engineering manager to another. Most would like to find a new engineer who can sit down at a desk and be fully productive on the first day of the new job.

Students are so focused on getting a degree so that they can get a "real job" that, for the most part, they let the schools, or the business they wish to enter dictate their educational options for them. This is not just being bored with school, or wanting to have a way to pay for a new car. A growing number of students of my acquaintance are putting themselves through college and working one (or more) jobs in addition to attending school. For them, and in some cases their families as well, a degree and the increase in income it promises is a hard financial goal with tangible benefits.

## PILOTS LICENSE

Several years ago I got my private pilots license. This was a goal that I had been working toward, off and on, for about fifteen years. The criteria was simple: acquire the skills, log sufficient hours of practice time, pass a written test and then pass a flight test supervised by an independent examiner. There is no prescribed length of time it takes to acquire the skills. You are not considered a brain if you do it all in one week. You are not held up as a dunce if it takes you fifteen years. The limits are only your available time and resources.

When I took my flight test for the license I made several errors, which I pointed out to the examiner when I realized that I had made them. He concurred with my assessment and the flight continued. At the conclusion of the flight, he surprised me by signing my log and recommending that I be issued a license! (I assumed that I would be coming back to try again sometime in the future.) He told me "Son, we don't consider this a license to fly, we consider it a license to continue learning." I have come to the conclusion that he was more right than perhaps he knew.

How many of us are so well-grounded in our basics that a review wouldn't do some good? How many of us are so up-to-date with the latest technological developments that we are not surprised or delighted by some article in one of the technical publications? For that matter, how many of us completed our degree requirements and then went on to take several more courses that we just didn't have time for in the regular curriculum?

## BEYOND THE BASICS

If we assume that the most we will have time for in a university curriculum is a grounding in the basics, we are left with whole classes of subjects which cannot be covered in school. The non-technical aspects of an engineering job can sometimes be a bit overwhelming for a new engineer. Planning, organizing, tracking and controlling a project is usually learned by way of on-the-job-training (OJT). So is threading your way through the mine fields of office politics. I never had a course in technical standards in school. Nor was "How to Run an Effective Meeting" ever a course offering in my university catalog.

Coupled with the non-technical complications is the ever present problem of technical diversity and obsolescence. How do I select the "best" component for a function? You mean that I have to learn

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another computer language? (I now "speak" four computer languages, five operating systems and nine 'editors'... and I am not a computer jock!) The new release of my spreadsheet doesn't look anything like the old one! And what the heck is EMC?

**"POST" GRADUATE STUDY**

After school comes....school! For must of us, What we can't learn that we need to know as part of OJT is provided by night classes or seminars and conferences to help us pick up new skills, keep abreast of new developments in our fields, acquaint us with new products, and so on. The IEEE EMC Symposium is one of these media. The tutorials at each symposium are always well-attended, from the fundamentals through particular applications.

Several of our associates in the EMC Society devote at least part of their time to teaching seminars to industry groups to help them make the transition from "What the heck is EMC?" to an awareness of the technical aspects of the field and its challenges. A small number of university professors have managed to integrate EMC into their courses, or convince their administrations to permit an elective course on EMC to be offered at the junior or senior level.

With all this going on, is there more that we can, or should do? YES! If we accept the likelihood that there will be no major changes in the educational system next year, we need a horde of EMC engineers speaking to IEEE student chapters across this country making these future engineers aware of the issues of EMC so they have a fighting chance when they enter the workplace.

If semiconductor manufacturers continue introducing new 'pin-for-pin compatible' replacement chips that require complete EMC reworks on older products because they made improvements, we need EMC engineers working with the chip manufactures to make them aware of what it is that they just did to us. If we have manufacturers who insist on producing equipment using new operating modes in the presence of strong RF fields, we need more participation on our standards committees, and more enforcement of those standards. If we have a public that continues to believe that it should be able to play a 1/4 dBμV sensitivity radio receiver next to a personal computer without interference, and a legal system that supports their belief by acting against the manufacturers of both the radio and the computer, we need EMC engineers out speaking to public groups at every available opportunity!

All of this is education in one form or another, and contributes either to the total sum of human knowledge or to its dissemination. With the tremendous range of opportunity, there is no reason why *all* of us can not be engaged in this activity in one way or another. For instance...

Is there a university with an IEEE student chapter near you? I bet they would welcome you as a speaker on the subject of EMC at least once a year.

Does your company have a co-op program which brings students into the workplace on alternate semesters or employs students during the summer? What better experience for an engineering student than working in an EMC laboratory?

Is there a standard that affects your work that has an active committee? Then there is strong rationale for you to be a contributing member of that committee so that you will have a say in the development of a document that you will have to live with for years to come.

Do you know of a Rotary, Elks, Knights of Columbus, Ladies Garden Club, PTA, or Toastmasters? Chances are that they would be fascinated by a talk on EMC from a professional in the field if the talk is tailored to their technical level.

With all this opportunity, the only step remaining is to get out there and get started!

**GRADUATION**

After several years of study, the student expects to receive some verification of acceptance into the ranks of those qualified to practice the new profession. After several years of work in the field, the new engineer should be looking for some verification that enough of the 'other' material needed for the profession has been learned.

For many, that verification comes as a Professional Engineer certification for his state. For those of us that practice EMC engineering, that verification comes as certification by the National Association of Radio and Telecommunication Engineers (NARTE).

At the 1995 EMC Symposium, for the first time, there will be an opportunity to take the NARTE examination immediately after the symposium. If you have yet to take the examination, Dr. Jim Whalen of the State University of New York at Buffalo will be conducting a NARTE workshop during the symposium to help new applicants prepare for the exam. Watch for an announcement of the date and time of the workshop in the advance program for the symposium.

**HOW LONG?**

We began this discussion with the question of how long is enough time for an engineering education. While we didn't answer the question directly, I believe that a partial answer is in front of us. As a formal student, practicing engineer or educator, the work once begun continues for the rest of your life.

The only question that remains is: "Is one lifetime enough?"

J.L. NORMAN VIOLETTE
ASSOCIATE EDITOR

**INTRODUCTION TO THE CONTROL OF ELECTROMAGNETIC INTERFERENCE**
**A GUIDE TO UNDERSTANDING, APPLYING, AND TAILORING EMI LIMITS AND TEST METHODS**
**by KEN JAVOR**
**EMC Compliance**
**Huntsville, Alabama**
**April, 1994 (Second Printing)**
**List Price: $85.00**

The main orientation of this voluminous and unique book is military-aerospace, with commercial EMC considerations also included. The details provide a background on the evolution of military EMI/EMC and commercial standards up to the development of the current MIL-STD-461D/462D and FCC Rules & Regulations Part 15. A unique feature of the book is the presentation of rationale for the limits and test procedures of military and commercial standards. Also, several historical and current military and commercial standards are provided in the appendices. The mathematical details are on a moderate level to support the illustrative examples.

This hardcover 700-page plus book measures a full 8.5" x 11.5" and is 1.75" thick. It starts with a comprehensive table of contents and includes a detailed index within the first 200 pages. The remainder of the book (the last two-thirds or so) comprises the aforementioned appendices.

## INTRODUCTION

This front section sets a useful stage for what follows.The Purpose and Scope gives a picture of the author's twofold purpose: "... to foster an *engineering issues oriented* understanding of EMI requirements as a *tool* for achieving the *goal* of electromagnetic compatibility." It is also intended to serve as a reference for questions concerning rationale behind EMI limits and test methods. The author has accomplished both objectives. The Outline, wherein each of the 12 chapters are briefly described, follows the introduction.

## INTRODUCTION TO ELECTROMAGNETIC COMPATIBILITY: CONCEPTS, TERMS, AND DEFINITIONS

This chapter addresses basic EMI problems and introduces EMC terminology. The impact of EMI on radio receivers and transmitters is presented in a historical context. The applicability of EMI in product development for military/aerospace and commercial systems is presented, including the applications of waivers and tailoring of the specifications. The impact and realities of economic factors on EMC are discussed.

## EMI SPECIFICATIONS AND STANDARDS, A HISTORICAL PERSPECTIVE

This presentation of where we (the EMC community) once were, and how we arrived where we are with respect to EMI specifications and standards contributes to a better understanding of why things developed to the point of present requirements. The Tri-Service activities are outlined from 1945 to the 1990s, including the development of the current MIL-STD-461 and MIL-STD-462.

## OVERVIEW OF EMC ISSUES: EMI INTERACTIONS AND THE QUANTIZATION THEREOF

The author introduces the four categorizations of EMI per the MIL-STD-461/462 nomenclature — conducted emissions (CE), conducted susceptibility (CS), radiated emissions (RE), and radiated susceptibility (RS). A brief overview and description for each of these four EMI categories plus the rationale for this categorization and their interrelationships are given. The emission and coupling mechanisms involved are illustrated.

The quantization of EMI parameters is presented, including an introduction of time and frequency domain concepts and Fourier envelope approximations. Standard units encountered in EMC are presented, including the motivation for using the logarithm and decibel format. Transducer (antenna-to-receiver) characterization and parameters (gain, antenna factor, effective antenna height and aperture area) are defined. Sample problems are presented in the use of logarithms and decibels.

## RADIO RECEIVER SYSTEM FUNDAMENTALS

The importance of understanding radio frequency (RF) communications in EMC measurements is discussed. The applications of receiver noise figure, bandwidth, gain, and sensitivity are described and their use in making meaningful EMI measurements is demonstrated. Included is a basic functional description of a typical heterodyne radio receiver along with the function of a preselector. Peak, quasi-peak, and average detector characteristics are presented. Differences and similarities between radio receivers and spectrum analyzers are presented in terms of their respective applicability. Antenna port susceptibility and emission measurements and controls are described briefly. This addresses MIL-STD-461C/462 requirements and tests CS03, CS04, CS05, CS08, CE06, RE03.

## TECHNICAL RATIONALE FOR CONDUCTED EMI MEASUREMENTS

The need to control power and signal line conducted EMI, emissions and susceptibility is described. The effects of power bus impedance and

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voltage variations with frequency are discussed. The characteristics of electric and magnetic field radiations from the power bus are described as functions of frequency. Conducted emission measurement procedures, along with the use of the 10-microfarad capacitor are presented. The characteristics and use of the line impedance stabilization network (LISN) for line voltage measurements are described, along with the differentiation between common mode (CM) and differential mode (DM) basic noise types. Conducted susceptibility concepts, test methods, and limits are described. Bulk current injection (BCI) techniques and limits and field-to-cable concepts are presented and illustrated. The rationale for using current injection techniques and limits, such as for CS114 of MIL-STD-461D, is provided.

**HISTORICAL MILITARY CONDUCTED EMI CONTROL**
This chapter depicts the evolution of the requirements for conducted EMI suppression and the military requirement and measurement standards which followed. The chapter contains basic concepts which are valuable for developing an understanding of why it became necessary to control EMI and how the problems became more complex with time and the evolution of high performance technology.

**HISTORICAL COMMERCIAL CONTROL OF CONDUCTED EMI**
This chapter describes the control of EMI from intentional emitters (RF transmitters) to any device switching at frequencies above 9 kHz (FCC Part 15 Subpart J). The development of the FCC conducted limits and test procedures is discussed. The techniques and equipment test setups are illustrated. Also included is a presentation of the control of conducted EMI for automobile and medical electronics. The details for the specification and measurement of transient conducted emissions, including inrush current, are also described.

**TECHNICAL RATIONALE FOR RADIATED EMI CONTROL**
Basic radiation concepts are introduced in terms of the basic physics. An illustration of the radiated field pattern of an elementary dipole and the definition of antenna parameters are included. The concepts used for making radiated field measurements are described, followed by a description of the application of antenna parameters. Requirements and techniques for making repeatable radiated field measurements in an open area test site (OATS) are discussed and illustrated. The determination of site attenuation is also illustrated. Typical tabulated antenna factors are presented in terms of frequency and measurement distance for a biconical and a log-periodic antenna. The use of electric field pickup devices is illustrated.

**HISTORICAL MILITARY RADIATED EMI REQUIREMENTS**
Traditional military concerns with radiation involve the need to protect sensitive receiver systems from unintentional radiating sources, and the protection of other electronic equipment from high power intentional transmitters. The development of radiated electric and magnetic field emission measurements (including some equipment) are described and illustrated graphically and pictorially. The use of shielded rooms is described as well as alternative methods for establishing and measuring radiated field intensity. The need for absorber and/or mode-stirring applications in shielded rooms is presented. The lack of safety margins between radiated emission and susceptibility limits is discussed.

**HISTORICAL COMMERCIAL RADIATED EMI CONTROL**
This chapter describes the development of requirements for controlling radiated emissions from unintentional emitters. The establishment of limits and OATS test procedures are described to satisfy the requirements established by the FCC. The control of EMI for medical electronics and automobiles, including radiated susceptibility, is described. The use of test sites, including anechoic chambers, parallel plates, and TEM cells, is discussed.

**ELECTRICAL BONDING: BONDING FOR THE CONTROL OF EMI AND OTHER EXCUSES; INCLUDING NECESSARY SUPPORTING DISCUSSIONS OF FILTERING AND SHIELDING FOR THE CONTROL OF EMI**
The importance of electrical bonding is developed in this chapter. Bond classes are described for different applications according to MIL-B-5087. Bonding-related topics discussed include current carrying wires, fault current paths, RF performance, filter bonding, the containment of radiated emissions, protection against radiated susceptibility, and proper cable shield termination. Several illustrations are provided for measuring shielding effectiveness, evaluating transfer impedance, coaxial cable installation, modeling coaxial shield performance, and coaxial line performance. Terminations for radar antenna cables are illustrated as well as bonding for static protection. Measurement setups for determining gasket shielding effectiveness are illustrated.

**A LOOK TOWARDS THE FUTURE: IMPROVING THE QUALITY OF THE EMC CONTROL PROCESS**
The author presents practical considerations for cost-effective EMC programs. He provides ideas regarding post-cold-war changes (threat as well as economics), and where the future emphasis might be in terms of engineering design and standards for optimal allocation of protection against EMI.

The index is comprehensive. The appendices which make up the last two-thirds of the book include the following:

**Appendix A** Parker, A.T. A Brief History of EMI Specifications. Delivered at the 1992 IEEE EMC Symposium in Anaheim, CA.

**Appendix B** Pearlston, C.B., Jr. Historical Analysis of Electromagnetic Interference Limits. April, 1967.

**Appendix C** Final Report, Evaluation of Radio Interference Pick-Up Devices and Explanation of the Methods and Limits of Specification No. MIL-I-6181B. 10 August 1955.

**Appendix D** Early Specifications. AN-I-27, 26 October 1944; JAN-I-225, 14 June, 1945; AN-I-40, 6 August, 1947; MIL-I-6181B, 29 May, 1953.

**Appendix E** Rationale for MIL-STD-461 and MIL-STD-462.

**Appendix F** CBEMA ESC5/77/29. Limits and Methods of Measurement of Electromagnetic Emanations from Electronic Data Processing and Office Equipment.

**Appendix G** MDS-201-0004. Electromagnetic Compatibility Standard for Medical Devices. 20 May, 1977.

**Appendix H** MIL-E-6051D. Electromagnetic Compatibility Requirements, System. 7 September, 1967.

**Appendix I** MIL-STD-1818. Electromagnetic Effects Requirements for Systems. 2 May, 1992.

*Recommendation:* This book is recommended as a comprehensive reference for practicing EMC engineers and technicians involved in military and commercial EMC design and testing who desire a deeper insight into EMC standards. It can also serve as a supplementary reference for courses in EMC as an avenue toward practical applications of EMC design, measurements, and test procedures.

# *WIRELESS INTERFERENCE: A PROBLEM FOR MEDICAL DEVICES*

**KENNETH R. FOSTER, IEEE Fellow, Philadelphia, PA**

(*Source:* The Institute, December, 1994)
Electrical interference with medical devices is a longstanding problem, but one that is receiving new attention due to the explosive growth of the wireless communications industry.

The number of medical-equipment malfunctions attributable to electromagnetic interference (EMI) is relatively small — less than 50 reported in the United States in a recent one-year period. But the consequences can be life-threatening, and news reports, such as a June 15 [1984] article in the *Wall Street Journal*, have heightened public awareness.

The issue is serious enough that the subject attracted nearly 400 professionals from the communications, medical device and health care industries to an industry-sponsored conference last September in Dallas, Texas, USA. The University of Oklahoma, with the support of the Health Industry Manufacturers Association, and the Cellular Telecommunications Industry Association sponsored the meeting. Among the speakers were John T. Stupka, president and chief executive of the Southwestern Bell Mobile Systems, Robert W. Galvin, chairman of the executive committee of the board of Motorola, and Wolfgang Krull, research and development manager of Hewlett-Packard.

The EMI problem has two aspects. One is that some medical equipment in service is highly susceptible to interference. Such incidents can be sporadic, and difficult to identify and reproduce. Howard Bassen, chief of the Electrophysics Branch, Office of Science and Technology at the U.S. Food and Drug Administration, has documented cases in which some apnea monitors failed to operate properly when exposed to rather weak radio frequency fields — below 0.1 volts/meter. Some patients have reportedly died as a result of these equipment failures. Radio frequency fields of this strength are very common in the environment.

This very unfortunate situation has arisen in part because the lack of mandatory federal standards for immunity has allowed the market to accept some medical equipment that is poorly designed for electromagnetic compatibility. The U.S. medical device industry is fragmented, with some 13,000 companies, many of which are too small to develop expertise in electromagnetic compatibility or are unwilling to devote the resources needed for adequate testing.

The second aspect of the problem is that electric fields close (within tens of centimeters) to handheld cellular phones and portable transceivers can be strong — above 10 volts/meter — and can interfere with even well-designed equipment. Bassen has documented cases of patients losing control of electric wheelchairs when communications transceivers were placed close to the wheelchairs' control boxes. It is easy to interfere with medical instruments by operating cellular phones very close to them.

## FEW INCIDENTS

Truly harmful incidents are apparently quite rare, although no one knows their exact numbers. From September 1993 to August 1994, the FDA received 96,000 reports to potentially serious malfunctions with medical devices. Of these, only 48 were associated with electromagnetic interference. Those incidents had diverse causes, only a few of which were associated with

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wireless communications. Certainly, many other incidents have occurred, but were unreported.

Interference does not necessarily compromise patient care, particularly when it is recognized by medical staff. Nevertheless, there exists a potential for injury, with a resulting exposure to litigation.

"What to do" was a question that constantly arose at the Dallas conference, mostly by hospital representatives asking for guidance. Some action is needed, but it is also important to avoid over-reacting to what is, by all appearances, an infrequent and often benign problem. This happened, for example, in the scare during the 1970s about "microshock" in hospitals, where the problem was grossly overstated by the lay media. Banning wireless communications from hospitals would prevent interference, but it would surely bring opportunity costs that could adversely affect patient care.

There was little sense at the conference that such drastic steps are needed. The speakers repeatedly emphasized that the solutions to electromagnetic compatibility problems lie in careful design and testing and in educating users about possible risks of the technology.

The danger is that the communications and medical device industries may each try to shift the burden onto the other, leaving health-care givers — who are ill-equipped to deal with the issue — to fend for themselves.

In the long run, better standards will help reduce the problem. The FDA is developing immunity standards for medical equipment, and standards have been in place in Europe for some time. But hospitals have large stocks of equipment of uncertain immunity, which might take decades to replace. There is a need to identify and recall or modify excessively susceptible equipment.

### GUIDELINES NEEDED

There remains the problem of strong fields close to handheld transceivers, against which no reasonable standard can guarantee immunity. Hospitals must develop guidelines for safe use of wireless communications and educate users about the possible hazards of the technology. In the earliest days of power distribution, customers had to learn not to touch live conductors. Present users of cellular phones will have to learn not to use the devices too close to electronic equipment. The trend in the wireless communications industry is toward lower-power devices. This will reduce the problem in the long run.

As one of the conference participants pointed out, there are no magic bullets. That representatives from three different industries could get together at this meeting to discuss the issue indicates a welcome sense of responsibility.

## *EMC SOCIETY MEETING ON MEDICAL EQUIPMENT*

An EMC Society Special Meeting was held jointly with the IEEE Engineering in Medicine and Biology Society (EMBS) Chapter and the EMC Society BoD on Friday, March 31, 1995 in Austin TX. The meeting included a panel discussion on the problems of EMI susceptibility in medical equipment and was moderated by Dan Hoolihan (EMCS). The panel included Edwin L. Bronaugh, Joe Butler and David Kilpatrick.

The meeting was in response to public attention to the issue of susceptibility of medical equipment to interference sources in the hospital and other environments. Of special concern are the emissions of cellular phones in close proximity to such devices. The Food and Drug Administration (FDA) is actively reviewing the issue and a special center has been established at the University of Oklahoma to address the issue. Dan Hoolihan is a prominent figure in the area and represents the EMC Society on these issues.

Photo courtesy of Dick Ford

***Panel participants ( left to right): Dan Hoolihan, Joe Butler, David Kilpatrick, and Edwin Bronaugh.***

# IEC IMMUNITY STANDARDS — AN UPDATE ON A MOVING TARGET

**LEO MAKOWSKI, Chairman,**
**EMCS Representative Advisory Committee**

The EMC Directive, which is the set of harmonized EMC requirements for all of Europe, is scheduled to become law throughout the European Union (EU) at the beginning of next year. However, many of the International Electrotechnical Commission (IEC) basic standards that render the directive enforceable are presently in draft form or are being revised. One example is the requirement for EMC immunity standards. Not only are many of the older standards being revised, but the numbering system change for the IEC 801-X series to the 1000-4-X has taken place as well. Widespread use of the old IEC 801-X numbering system has caused a lot of confusion as to what are the latest requirements and how they are converted when changed into the IEC 1000-4-X series.

One reason for the numbering change for the IEC basic immunity standards is due to the change in responsibility for the development of these standards from the IEC Technical Committee (TC) 65 (responsible for developing standards for industrial process measurement and control equipment) to the IEC Technical Committee 77B (responsible for developing basic immunity EMC standards for all electrical and electronic equipment). Table 1 was updated after the meeting of IEC TC 65 held in Paris during the week of March 12, 1995 and depicts the status of the new 1000-4 series of standards and how these tie into the old 801 standards.

All of the published basic immunity standards have been ratified and adopted by CENELEC and will become Euronorms with the exception of IEC 1000-4-3. This standard was not ratified by CENELEC and is being revised by TC 110 WG 2.

In addition to the changes in these basic immunity standards, the harmonized Euronorm generic standards that reference these tests are also being updated. These new generic standards are particularly important to companies getting ready to export to Europe. An example of this updating is prEN 50082-1, the generic standard for residential, commercial and light industrial environments, which was released in August 1994. In this new document, an insertion of the informative annex from the 1992 edition was completed. This information annex was only used in the 1992 edition to show what could be expected in a later version. Tables 2 and 3 compare EN 50082-1992 and the new prEN 50082-1 August 1994: It is important to keep in mind that most standards are revised in a cyclical manner. In the case of IEC standards, revisions may occur as frequently as every five years. This has become evident with the IEC 1000-4-X series of standards about to published.

Within the EU, CENELEC is responsible for harmonizing the EMC standards. CENELEC will

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| IEC 1000-4-X Standard | TITLE | EMC PHENOMENA | IEC 801-X & STATUS |
|---|---|---|---|
| **IEC 1000-4-1** | Overview of EMC Immunity Tests<br>Basic EMC publication | All | Total **revision of IEC 801-1**<br>Finished & Published |
| **IEC 1000-4-2**<br>Approved Nov. 1994 | ESD Immunity Test<br>Basic EMC publication | Direct and indirect human body ESD | IEC approval based on **IEC 801-2 1991** - New Work Item for furniture discharge as an addendum to 1000-4-2 |
| **IEC 1000-4-3**<br>Published March 1995 | Radiated, Radiofrequency Electromagnetic Fields<br>Basic EMC publication | RFI from 80 MHz to 1 GHz - 80% ampl. modulated with a 1 kHz sine wave | DIS (Draft Int'l Std.) 65A/77B (CO) 40/24 94/08 was approved by IEC as the **revision** to IEC 801-3-1984 |
| **IEC 1000-4-4**<br>Approved Nov. 1994 | Electrical Fast Transients/ Bursts<br>Basic EMC publication | Electrical switching transients | IEC approval based on **IEC 801-4, 1988. Revision** being worked on. Secretariat Document (SEC) to be released in 1995 |
| **IEC 1000-4-5**<br>Published March 1995 | Surge Immunity Tests<br>Basic EMC publication | High energy surge transients from switching and lightning | **Based on Draft Int'l Standard 77B(Central Office) 25 A new standard** |
| **IEC 1000-4-6**<br>Scheduled Mid-1995 | Conducted Disturbances Induced by RF Fields<br>Basic EMC publication | RFI from 9 kHz to 80 MHz induced into equipment via power & I/O lines | Committee draft **77B (Sec) 110 93/04** in circulation. This is a **new standard** |
| **IEC 1000-4-7** | Guide on Harmonics & Interharmonics Measurements & Instr. for Power Supply Systems | Not an immunity standard; only deals with measurements | Finished and Published |
| **IEC 1000-4-8** | Power Frequency Magnetic Fields<br>Basic EMC publication | Magnetic fields originating from power distribution networks (50-60 Hz) | **A new standard**<br>Finished and Published |
| **IEC 1000-4-9** | Pulse Magnetic Field<br>Basic EMC publication | Magnetic fields from lightning in power distribution networks | **A new standard**<br>Finished and Published |
| **IEC 1000-4-10** | Damped Oscillatory Magnetic Field<br>Basic EMC publication | Magnetic fields from switching of HV bus-bars | **A new standard**<br>Finished and Published |
| **IEC 1000-4-11** | Voltage Dips, Short Interrupts and Voltage Variations<br>Basic EMC publication | Perturbations in line voltage due to equipment using the same power supply | **A new standard**<br>Finished and Published |
| **Future IEC 1000-4-12** | Oscillatory Waveshapes<br>Basic EMC publication | | Committee draft 77B (Sec) 141 94/11<br>**A new standard** |
| **Future IEC 1000-4-13**<br>Scheduled Mid-1995 | Harmonics, Interharmonics<br>Basic EMC publication | | Committee draft 77B (Sec) 99 93/09<br>**A new standard** |
| **Future IEC 1000-4-16**<br>Scheduled 1996/97 | Conducted Disturbances in the Range of DC to 150 kHz<br>Basic EMC publication | | Committee draft 77A (Sec) 120<br>**A new standard** |
| **IEC 1000-4-Y**<br>Scheduled ??? 1995 | RFI from Digital Radio Telephones | | Committee draft 77B (Sec) 136 94/02 |

***Table 1. Latest draft or finished version of IEC 1000-4-1 to 1000-4-11.***

*Continued*

| NORMATIVE SECTION | INFORMATIVE ANNEX |
|---|---|
| IEC 801-2-1984 | IEC 801-2-1991 |
| IEC 801-3-1984 | IEC 801-3-draft 2nd edition |
| IEC 801-4-1988 | IEC 801-5 draft<br>IEC 801-6 draft<br>IEC 1000-4-8 draft<br>IEC 1000-4-11 draft |

***Table 2. The IEC 801-X series that are used in the generic standard EN 50082-1: 1992-EMC generic immunity standard for residential, commercial and light industrial.***

| NORMATIVE SECTION | INFORMATIVE ANNEX |
|---|---|
| IEC 1000-4-2-1991 | No Informative |
| IEC 1000-4-3-1995 (ENV 50140) | Annex |
| IEC 1000-4-4-1988 | |
| IEC 1000-4-5-1995 (ENV 50142) | |
| IEC 1000-4-6-1995 (ENV 50141) | |
| IEC 1000-4-8-1993 | |
| IEC 1000-4-11-1994 | |

***Table 3. The IEC 801-X series that are used in the generic standard prEN 50082-1: August 1994-EMC generic immunity standard for residential, commercial and light industrial.***

ratify the IEC immunity standards into legally enforceable Euronorms. In some cases, these or other standards will be used by the product standards committees for testing specific family groups of products. Whether used in the generic or product standards, these new IEC 1000-4-X series of immunity standards will become the mandatory requirements to meet the EMC directive.

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303 494 7381 - Home/Work
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001 81 22 222 1800 - Work
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2205 Kramer Ln
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# THE SYMPOSIUM SURVEY

## (TRADITIONALLY CALLED THE EMPLOYMENT ANALYSIS SURVEY)

DICK FORD, ASSOCIATE EDITOR

The EMC Society is run by the 18 to 24 voting members of the Board of Directors (BoD). Eighteen are elected "at-large" by the members. Four are directors who run the Communications Services, Professional Services, Membership Services and Technical Services Directorships. Two are the BoD President and Secretary. These latter six are elected by the BoD itself *but* may already be on the BoD. In any case, the core power rests with the 18 at-large directors. At-large elections with disparate voting blocks always favor the largest block, an effect magnified further in the absence of active, issue-focused, election campaigns. The biggest EMCS voting block is the U.S. (Canada and Japan are next in line.) As a result, the BoD has been, and remains, dominated by folks from the U.S. This may or may not be seen as good news. Fortunately, these directors really try their best. (My eight years as Treasurer qualifies me to speak on this issue). The problem is that they can only bring to bear their own experiences and knowledge base. They can't speak well to the fastest growing portion of our membership (which is non-U.S.). What to do? My answer is to get the BoD better data. Will this solve all the problems? No. But it's something that might help.

About four years ago I asked for, and the BoD granted, permission to attempt a scientific mail survey to supplement the normal symposium survey. After many volunteer hours of effort, it was "beta tested" with reasonable success. But alas, the mailing dollar costs and volunteer labor hour costs were about four times what I projected. The problems associated with international mailing were significantly more than I expected. I had to put the effort on hold.

Last year Bill Johnson stepped down as subcommittee Chair of what has traditionally been called the Employment Analysis Committee. I volunteered to take his place. This committee sponsors the symposium survey. As best I know, this yearly survey is the only survey this committee does or has done. The survey subcommittee is under Norm Violette's Professional Services Directorate. The EMCS survey probably began when IEEE corporate started restricting access to information about its very comprehensive Annual U.S. Salary and Fringe Benefit Survey. I first took an active interest in the symposium survey in 1983, when, as an exhibitor, I made some recommendations to try to implement better sample techniques. Though most folks would agree that my techniques worked, the politics involved prevented them from being used after 1983. So each year questionnaires get "put out there" at the symposium. Depending on the particular symposium, folks involved, and other accidents of fate, we've gotten sample sizes of between 70 and 280. Are the samples biased? Yes. Are their sizes usually too small to produce confident answers to the type questions we have asked? Yes. My main purpose in volunteering for this committee, beginning with this article, is to begin to put all that behind us. I'm further encouraged because Dan Hoolihan, Member Services Director, has strongly endorsed the value of member surveys (see BoD report on page 6).

Thanks to Bob Hofmann, Chicago may have produced one of our best surveys, i.e., a reasonably large size, and low sample bias. We had 152 respondents out of the 726 full registrants (21% participation). Of the 152 respondents, 115 were IEEE members, of which over 90% were also EMCS members. Age, education and membership profiles are shown in Figure 1. Note that this survey analysis also includes profile data from the 1993 IEEE survey on U.S. Salaries and Fringe Benefits (the latest report available at this time). I received permission from headquarters to excerpt selected material appropriate to our Society.

Comparing data: The EMCS education percentages are all within about 30% of the IEEE data. The age differences reflect the fact that simply attending a symposium introduces a bias compared with a mail survey. Our symposium survey had 16 percentage points less response in the three age groups from 20 to 50 (6%, 6%, and 4%, respectively, and hence, 16% more in the over-50 groups as compared with the IEEE survey. Simply said, folks with "clout" are more likely to attend.

It might be asked just how representative the IEEE mail survey is. A clue is provided in their report. They compare total IEEE aggregate membership statistics with those reported in the mail survey. There is a 5% bias toward Senior and Fellow grade as compared with Associate and Member grades, i.e., more Senior/Fellows send back the mail survey. This results in a 10% unbalance, which is significant. And surprisingly, there is apparently no effort to correct for this bias. A similar bias should also be expected for our survey (only 2.8% of IEEE members are Fellows, yet we had 6% Fellow participation in our survey). An additional bias is also present in our sample as concerns EMCS member vs. nonmember survey responses. Of the 726 symposium attendees, 313 were not EMCS members, i.e., 43%. Yet, as previously noted, only 37 of the 152 survey respondents (24%) were

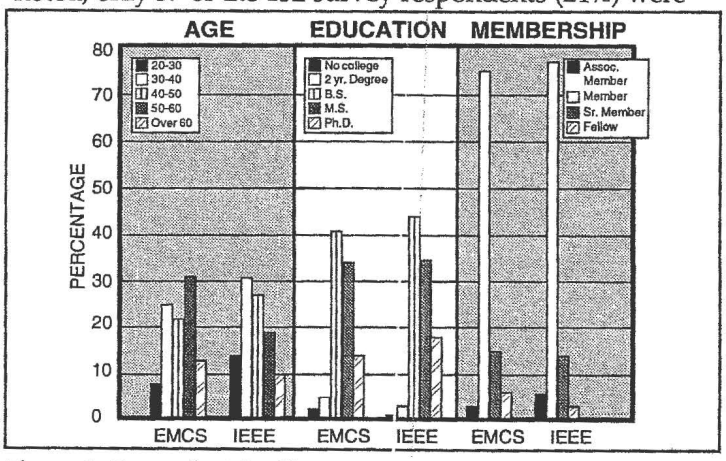


***Figure 1. Respondent Profile.***

*Continued*

*Continued*

nonmembers. This is a serious bias for any issues addressing the overall symposium. As well, it left us with a sample size too small to realistically compare things like pay vs. experience between members and nonmembers. But there's still much to be gleaned.

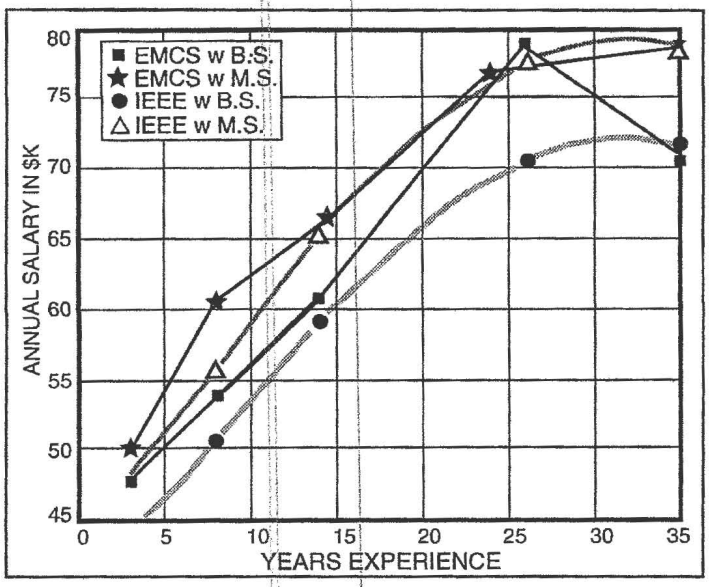


***Figure 2. Salary vs. Experience.***

Figure 2 shows salary vs. experience for Bachelors of Science and Masters of Science for both our symposium survey and for IEEE's mail survey. Now the EMCS data is for members only, but including the nonmember responses doesn't make much difference (and since IEEE data is for members, including non-IEEE members might distort the comparison). Since the IEEE data is basically from 1992, I normalized it to 1994 with a 7% inflation factor. The IEEE data comes from page 4-2 of their report. Actually it is not data. It is a formula that has over thirty coefficients! That's why I drew them as curves rather than line-connected data points. Location, size of company, area of specialty etc, etc, etc... all impact salary. Obviously I'm using a very simplified form. Our society's situation is even more complicated. The technical area coefficient that IEEE uses for our technical discipline reflects Division IV as a whole. Yet, in the detailed discussion on page 3-5, one finds that EMC deviates significantly from all the rest of Division IV in the upper quartile and upper decile. We make significantly less money (15% and 25% respectively). This fact and the quality of our data for EMCS BSers convinces me that the turn down ("age discrimination") in salaries shown in Figure 2 at 25 years experience is real but that its impact is masked by the upward bias of the "clout" factor mentioned earlier. The IEEE formula turns down gradually at 35 years experience. Note that for MS folks the agreement between EMCS and IEEE is excellent (the weak agreement at the lower salaries probably reflects a poor sample size on our part. Another question might be why doesn't the clout factor affect MS folks? Perhaps statistically more of them stay technical, and hence don't "go for the big bucks." Well, what does this all mean? To me it means we don't need to focus on salary issues for our symposium survey. IEEE does a fine job, and although we are restricted from comprehensively publishing their results (it's copyrighted; they sell it for $75), we are allowed to publish narrow extracts such as data specifically applied to our society.

So on what should we focus? My view is that our primary effort should be to survey symposium attendees about symposium issues; perhaps even more to the point... about issues on which their at-the-time views matter most. Next, I would list other society issues, and lastly I'd consider larger issues, such as professionalism, the role of IEEE, etc.

NARTE certification is by far the most popular registration. Thirty-four percent of the EMCS respondents are NARTE certified engineers. Among EMCS government members the percent is nearly identical, 35%. Twenty-three percent of the EMCS respondents had PEs. Among non-EMCS members, NARTE certification was only 12%, and PE licenses only 6%.

Figure 3 depicts data on member activity. It relates good news about chapter activity and reading our EMCS Newsletter. But of course folks attending their own symposium are likely to have high activity levels. I think the main concern should be the high percentage of members who only sometimes, or who never, read our *Transactions*.

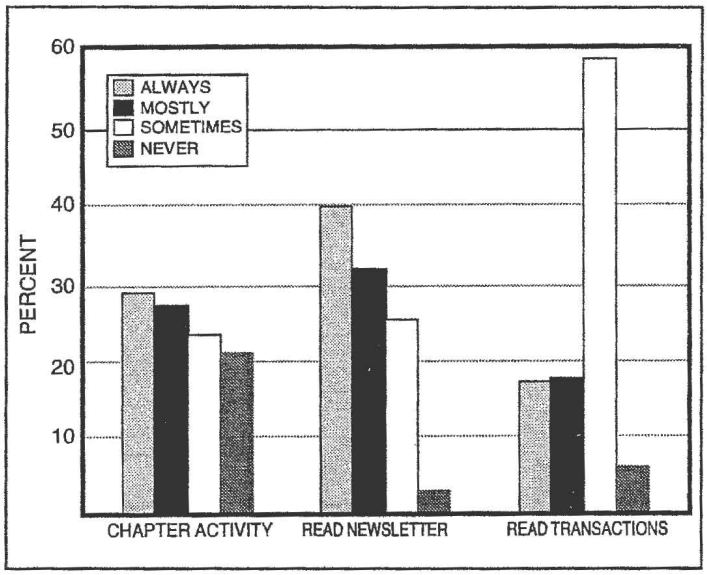


***Figure 3. EMCS Member Activity Level.***

One interesting question is "Who are the nonmembers?" They tend to be slightly more government (18% nonmembers, 16% members), more non-U.S. (17% nonmembers, 8% members), more full-time in non-EMC jobs (16% nonmembers, 6% members) more non-college graduates (15% nonmembers, 3% members), and clearly most significantly, they are younger (see Figures 4A and 4B). To me, this highlights the value of reaching out to students and young engineers to emphasize the value of EMCS membership (of course the problem is that we have to convince them of the value of IEEE membership first).

Figure 5 shows how attendees feel about the future. Note that the most optimistic group are the government EMCS members (GEM). Yet the most (only) pessimistic group is the government non-EMCS members (GNEM). This is

puzzling. As concerns GEMS, maybe things have been so bad that they feel that there's no where to go but up. For the GNEMs I looked at in detail, all are full-time in military EMC and look middle-of-the-pack normal. Maybe the sample was too small (only 6 folks!)

Concerning work specialization, the state of TEMPEST and EMP continues to languish. Figure 6 shows two aspects for members and for nonmembers. One aspect is percentage of them having some (any) involvement in a specialization (these percentages will total more than 100%). The other aspect is the percentage of time each of the two communities spends on each specialization. It's interesting that the nonmembers spend more time in more of the areas. Perhaps it reflects their youth. They haven't yet become specialized. Overall it has to be a bit disappointing that we had no one in our survey specializing in HERO, frequency management, biological hazards, civilian aircraft EMC or TEMPEST. There were just a few folks working in those areas, each spread thinly over several areas. Most folks in these areas apparently don't participate in our symposium.

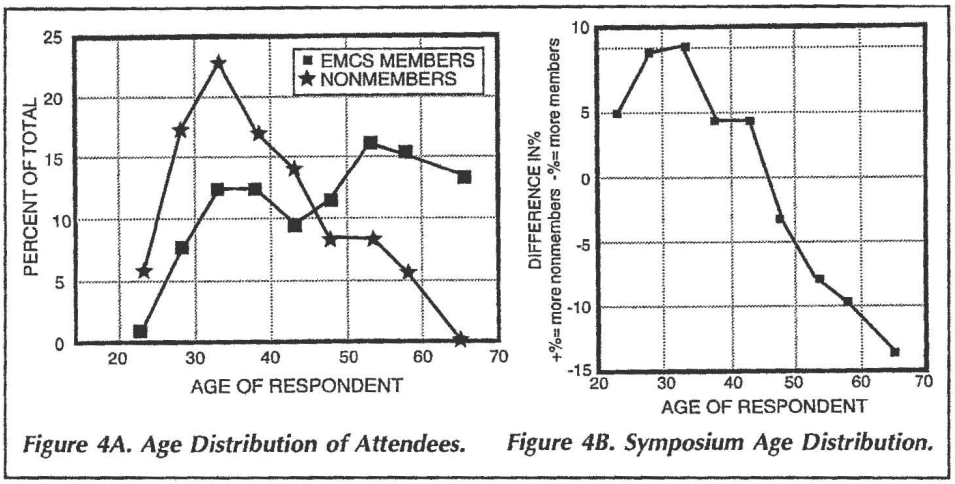


*Figure 4A. Age Distribution of Attendees.* *Figure 4B. Symposium Age Distribution.*

*Figure 4.*

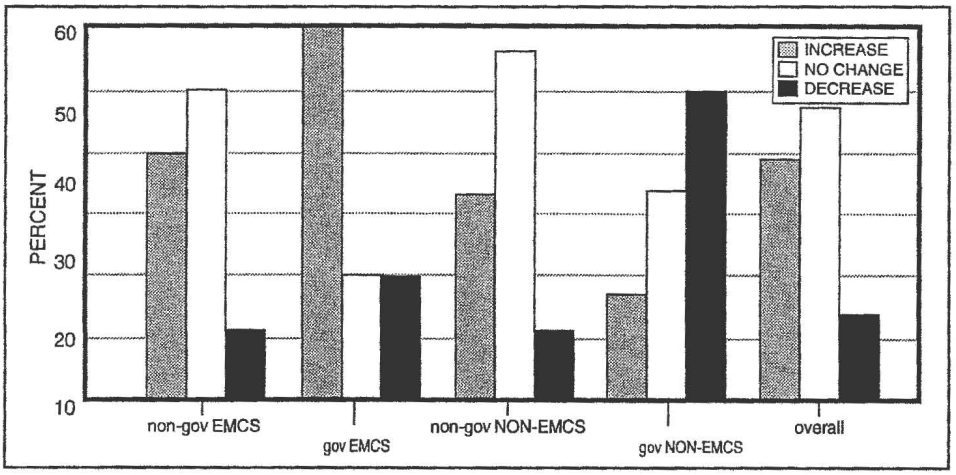


*Figure 5. Outlook — Future Prospects.*

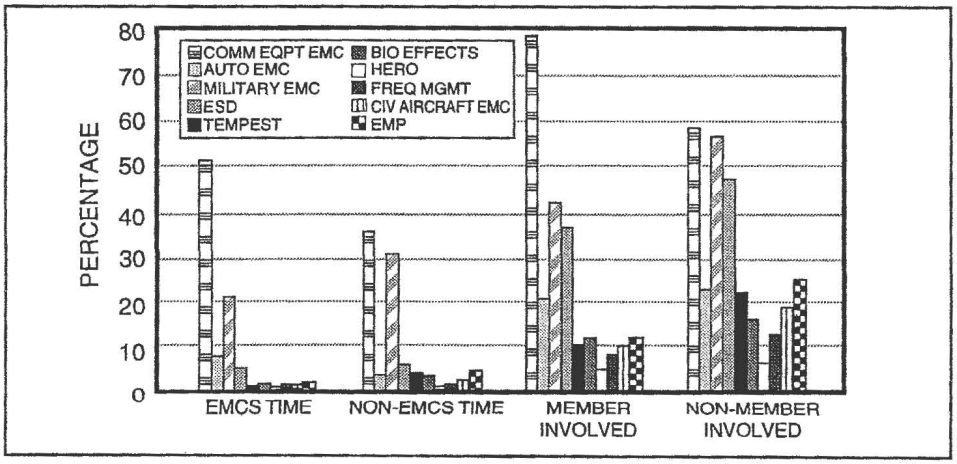


*Figure 6. Specialty Areas.*

Of the 152 respondents, 125 took time to provide written commentary. There were 523 written comments. These have been entered into a computer data base as well as categorized and sent to appropriate EMCS volunteers (*Transactions* editor, etc.). There is a lot of good feedback in these responses, but to hold down the size of this article, I'll limit coverage herein to comments expressed by at least 10% of those who wrote comments (12 folks). The main reason listed for not attending chapter meetings was that no local chapter exists. On the question of how to improve the chapter meetings, many good suggestions were offered but the dominant response was that folks thought the chapters were doing fine. The only central theme on comments about the newsletter was that "it wasn't broke" (so don't fix it!). More interactiveness was a part of a number of comments. In fact it was clear that many folks thought that we get letters to the editor but don't bother to publish them! (Sorry... not the case, we don't get letters!). Beyond that, folks want the news, the gossip, the "juice" about what's on-going. Members' comments on the *Transactions* were deafening. "Only read the practical articles!" "Want more practical articles." "Keep down the math!" Over and over again.

With regard to how the Society can help with career goals, there were again many good suggestions, but the main theme was "Keep up the good work." Responses to our call for "gripes" and issues for BoD action, as might be expected, had no central focus, but again a lot of good ideas were expressed. I hope to list the keys ones in next year's questionnaire so members can focus on them.

# 1995 DISTINGUISHED LECTURERS PROGRAM

The EMCS Distinguished Lecturer Program (DLP) provides speakers to lecture on various aspects of electromagnetic compatibility. These speakers, who are members of the IEEE EMC Society, are knowledgeable professionals who are willing to share their expertise and knowledge on this vast subject. Presentations to groups outside the IEEE and EMCS are encouraged to educate the public on electromagnetic compatibility. Presentations to educational institutions such as engineering schools are especially encouraged. The program is not intended for trade shows or similar commercial functions. Speakers represent the IEEE EMC Society and no other entity, including their employer.

The program consists of several Distinguished Lecturers, each of whom may present four expense-shared lectures each year. The lecturers are selected by the program chairman and the EMCS Board of Directors from written nominations or application from members of the EMCS. Distinguished Lecturers serve for two years. Selection of lecturers is based on: (1) professional competence and recognition (EMC expertise), (2) lecturer's communication and presentation skills, (3) EMC topics, (4) contribution to a balanced program, and (5) recommendations of peer EMCS members.

The EMCS provides Distinguished Lecturer travel expenses for approved speaking engagements, although in instances where costs are significant, the EMCS will share expenses with the benefitting organization.

Speaking engagements are arranged directly by the benefitting organization and the Distinguished Lecturer. Schedules and minimum audience size are at the discretion of the lecturer.

For more information contact: David M. Hanttula, Program Chairman, Silicon Graphics, Inc., ISD MS 946, P.O. Box 7311, Mountain View, CA 94039. Tel: 415-390-1071; Fax: 415-962-9439; e-mail: hanttula@emcengr.esd.sgi.com

## 1995 DISTINGUISHED LECTURER PROGRAM SPEAKER LIST

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e-mail: hugh.denny@gtri.gatech.edu
*IEEE Fellow. Electromagnetic environmental effects, grounding, lightning protection, VHSIC/VLSIC susceptibility, high-power microwave effects, EMI gasket techniques.*

Lee Hill
Silent Solutions
25 River Road
Pepperell, MA 01463-1621
Tel: 508-433-0515
Fax: 508-433-0525
*EM Theory, PCB layout, high frequency common and differential mode filtering, ferrites, EMC design techniques, introduction to EMC.*

Dr. A. S. Podgorski
ASR Technologies
332 Crestview Road
Ottawa, Ontario, K1H 5G6 Canada
Tel: 613-737-2026; Fax: 613-737-3098
*Limits of EMI/EMC shielding; standards for protection and testing of lightning, EMP and ESD; 3D modeling of ultrafast EM interactions; human effects of EM fields generated by stun guns.*

Scott Roleson, Hewlett Packard Co. MS 60U22
16399 W. Bernardo Drive, San Diego, CA 92127-1899
Tel: 619-592-4809; Fax: 619-592-4979
e-mail: scott%hpsdde@SDD.HP.COM
*"Perspectives and Techniques for Benchtop EMC Testing." "Gaining Insight From EMC Radiation Patterns." Benchtop and radiated test site techniques can give valuable insight into emission problems. Discusses rationale and techniques.*

Dr. J. L. Norman Violette
Violette Engineering
120 E. Broad Street, P.O. Box 639
Falls Church, VA 22040-0639
Tel: 703-532-1355; Fax: 703-538-3810
*Lightning and transient protection, electrical noise control, intro to EMI/EMC, high performance electronic design for EMC, EMC standards, immunity testing.*

**The following Distinguished Lecturers begin January 1, 1996, and serve to December, 1998.**

Franz Gisin
1325 Garthwick Drive
Los Altos, CA 94024
Tel: 408-492-3548
*Site attenuation and antenna calibration per ANSI C63.4/5, semi-anechoic chambers, numerical techniques for solving EMC problems, statistical immunity testing techniques, using Fourier transforms to solve EMC problems.*

Todd Hubing
718 Oak Knoll Road
Rolla, MO 65401
Tel: 314-341-6069; Fax: 314-341-4532
*"Overview of Computer Modeling Techniques for EMC," "Avoiding the 200 MHz Cat and 30 pF Pelican: What Every Engineer Should Know About EMC." EMI/EMC tutorial, numerical EM modeling, computer techniques.*

# WROCLAW SYMPOSIUM CALL FOR PAPERS

A first announcement and call for papers has been issued for the 13th Annual Wroclaw Symposium and Exhibition on EMC scheduled for June 25-28, 1996 in Wroclaw, Poland. Prospective authors are invited to submit original, unpublished papers concerning all aspects of EMC. Acceptance of papers will be based on the following criteria: importance of topic, technical sophistication and accuracy, clarity and readability of the summary, presentation of results, novelty and originality. Promotional and commercial presentations are not acceptable.

For immediate information contact: Symposium Organizing Chairman Mr. W. Moron, or Dr. W. Sega (for program information), phone +4871 728812, fax: +4871 728878 or 729375. For exhibition information contact Dr. R.J. Zielinski, phone +4871 214998, fax: +4871 223473. Postal address: EMC Symposium, Box 2141, 51-645 Wroclaw 12, Poland. E-mail: EMC @ITA.PWR.WROC.PL.

# NEW MEMBERS

IEEE personnel have recently compiled a list of members who joined the Society from August 1994 to the present. The unusually long time period is a result of programing challenges faced by the IEEE during a transition to a new membership system. Now that the problems have been rectified, we hope to once again publish theses lists in the newsletter on a timely basis. However, we will not present the current update due to its length. Copies are available from R&B Enterprises, 20 Clipper Road, West Conshohocken, PA 19428. Tel: 610-825-1960, ext. 239.

# EMCS SYMPOSIA SCHEDULE

**1995** Atlanta, GA: August 14-18
Marriott Marquis Hotel
John Rohbaugh
(404)894-8235

*Please note:* The date of the 1995 EMC Symposia was incorrectly lsited in recent issues. The actual dates are August 14-18.

**1996** Santa Clara, CA: August 19-23
Santa Clara Convention Center
Doubletree Hotel
David Hanttula
(415)390-1071
FAX: (415)962-9439

**1997** Austin, TX: August 18-22
Austin Convention Center
Hyatt Hotel
John Osburn
(512)835-4684

**1998** Denver: August 9-14
Radisson Hotel

**1999** Seattle, WA: August 2-6
Westin Hotel
Bill Gjertson
(404)793-0680

**2000** Washington, DC
Bill Duff
(703)914-8450

# EMCS COOPERATING SYMPOSIA

**1997** Shenzhen, China: May 21-23
**1999** Japan: May 15-17
**U.K:** Biannually, even years, in Sept.
**Wroclaw:** Biannually, even years, in June.
**Zurich:** Biannually, odd years, in March.

# ADMINISTRATIVE MEETINGS

August 12-19
**IEEE EXCOM MEETINGS**
To be announced
Australia & New Zealand
Julie Cozin: (908)562-3984

December 10-11
**STANDARDS BOARD COMMITTEE**
and December 12
**STANDARDS BOARD MEETING**
Fiesta Americana
Monterrey, Mexico
Terry deCourcelle: (908) 562-3807

December 11
**IEEE INFORMATION SESSION**
Fiesta Americana
Monterrey, Mexico
Julie Cozin: (908) 562-3984

December 12
**USAB MEETING**
Fiesta Americana
Monterrey, Mexico
Linda Hall: (202) 785-0017

December 12
**IEEE ASSEMBLY**
Fiesta Americana
Monterrey, Mexico
Julie Cozin: (908) 562-3984

December 13
**IEEE SOCIAL**
Fiesta Americana
Monterrey, Mexico
Georgina Crane: (908) 562-3979

December 13-14
IEEE BOD
and December 14
**IEEE EXCOM MEETING**
Fiesta Americana
Monterrey, Mexico
Julie Cozin: (908) 562-3984

# INCEMIC

The Fourth International Conference on Electromagnetic Interference and Compatibility (INCEMIC) will be held from December 6 to 8, 1995, in Madras, India. For information, contact Mr. K.R. Kini, SAMEER Center for Electromagnetics, CIT Campus, 2nd Cross Road, Taramani, Madras 600 113 India. Fax: (91-44) 2352938.

**BACK ISSUES OF THE EMC SOCIETY NEWSLETTERS ON MICROFICHE**

We still have a few sets of the uFiche copies of the back issues of the IEEE EMC Society Newsletters from the present to 1955 when it was called "Quasies and Peaks." The price is $25.00 postpaid. Sets can be ordered from: Dr. Chester L. Smith, EMC Society Historian, 2 Jonathan Lane, Bedford, MA 01730.