

# IEEE EMC SOCIETY

## NEWSLETTER

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JANET O'NEIL

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### 1999 IEEE International Symposium on Electromagnetic Compatibility August 2 - 6, Seattle, Washington



Symposium Steering Committee members enjoy the Tuesday evening reception held during the symposium week at the Pacific Science Center, site of the famed Seattle Space Needle. The private IMAX showing of "In the Deep" was a real hit for (L-R) Bill Hall, Exhibits Co-Chair, Dave Walen, Technical Program Chair, his wife Anna, and Rob Steinle, Treasurer. For more photos of symposium activities, see pages 20-23.



EMCS Board Member, Warren Kessleman (L), enjoys the boat ride to Kiana Lodge, the unique site of the Wednesday evening gala held during the symposium week. Captain Jim Oakley even let him steer the boat! The boat ride home was a different story as the skies turned from sunny and clear to dark and cloudy. The lightning show from the returning boats provided a spectacular ending to a memorable evening. For more information about Board activities during the symposium, see page 36.



Moto Kanda (L) received the Laurence G. Cumming Award, one of the EMC Society's highest awards, at the Awards Luncheon during the Seattle Symposium. EMC Society President Dan Hoolihan presented the award. For a complete list of the awards presented during the Symposium, see page 34.



Arlene Carstensen, Russ Carstensen, the new Executive Director of NARTE, and Don Sweeney, of DLS Electronic Systems, (L-R) prep for the NARTE exam during the Seattle Symposium. For more information about NARTE activities during the Symposium, see page 30. (Don passed the exam by the way!)

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**DAN HOOLIHAN**  
PRESIDENT,  
EMC SOCIETY

## Transition Time

This is the final President's Column I will be writing as the end of my two-year term is imminent. It has been an honor to serve as the Electromagnetic Compatibility Society's President for the calendar years 1998 and 1999. I have appreciated the many opportunities that have come my way the last two years and it has been great to meet fellow EMC Society members all over the world at conferences and other social and technical occasions.

The President for the next two years will be Joe Butler and we are already communicating daily to make a smooth transition between our administrations. Joe has been a long-time member of the EMCS Board of Directors and is familiar with our history and procedures. He will do an excellent job for us, I am sure.

Joe will have his strategies and favorite topics to stress. I have tried to emphasize our growing international strength and have tried to grow chapters around the world. We have managed to have Board meetings outside the United States once each year (Italy - 1998 and Japan - 1999) and we have encouraged new chapters to be formed worldwide.

We have more work to do in both areas. We need to have representation on the Board from Region 9 (Mexico, Latin America, and South America); I have urged the Board to consider a change in the bylaws of the Society to help make this happen. We have representation from Regions 7, 8 and 10 plus United States representatives but we need to have a member from our neighbors to the South of the United States.

I would like to congratulate the newly elected members of the Board as they look forward to their three-year terms of serving the Society in their special roles. Congratulations to Andy Drozd (reelected board member), Andrew Podgorski (past board member from Region 7 who joins us on the board again), and Larry Cohen, Fred Heather, Moto Kanda, and Jose Perini (all elected to the Board for the first time).

One of my last duties as President is to prepare a report for the IEEE summarizing our accomplishments over the last five years. (Each of the 36 Societies in the IEEE must do this once every five years on a rotating basis.) In short, our last five years has been quite good:

Our total Society membership has grown from around 4400 to approximately 5200 members (18% increase) since 1994.

We have produced an IEEE International Symposium on EMC every year in the last five years and they have all been both technical and financial successes.

We continue to produce IEEE Standards in the area of EMC at a rate equal to IEEE Societies many times our size.

Our Transactions and Newsletter continue to be published on a timely basis and offer technically outstanding articles.

Our educational and technical service activities continue at a high level.

Our website (<http://www.emcs.org>) was developed to service our membership and provide information about EMC to the public.

I hope that the 20% of our Society members that went to the 1999 Seattle Symposium on EMC had an interesting and educational experience. The technical papers were excellent as well as the workshops and tutorials offered during the week. The social activities were outstanding and the Seattle weather cooperated with our interests for most of the week (there was this unusual lightning storm one night!). My sincere congratulations again to the local organizing committee (chaired by Bill Gjertson) for a great EMC symposium!

I look forward to enjoying the 2000 EMC Symposium in Washington, DC; I know that Bill Duff and his committee are working hard to make it happen next August.

I would like to close with a thank you to the Executive Committee of the Board of Directors for all their support over the past two years; they made my job go very smoothly. My thanks also to the board members who served with me in 1998 and 1999; I appreciated your time and efforts to continue to make the EMC Society one of the premier Societies in the IEEE.

To the regular members of the Society, I thank you for your support also. I anticipate meeting many more of you over the next few years and keep those phone calls, faxes and e-mails coming to me at 651-638-0250, 651-638-0285, and [dhoolihan@tuvps.com](mailto:dhoolihan@tuvps.com), respectively.





**Bill Gjertson, Chairman of the 1999 IEEE International Symposium on EMC in Seattle, and Newsletter Editor Janet O'Neil.**

## Tales from the Trenches

In early 1997, I volunteered to work on the 1999 IEEE International Symposium on Electromagnetic Compatibility steering committee. I was new to the area of Seattle, and thought this would be a good way to meet others in my new surroundings as well as contribute

to the EMC Society. Little did I know then about the tremendous amount of work required to put on one of these symposia. In fact, the steering committee meetings were held monthly for several years and then weekly as the symposium date approached. Subcommittees such as arrangements, exhibits, publications, and technical program also met on a regular basis. I enjoyed working on the committee; the purpose of this commentary is not to complain, but rather to salute all those who have worked on the annual EMC Society Symposium steering committees in years past. It's the old adage, unless you do it, you cannot imagine what it's like.

The problem is, each EMC Symposium is great and the appearance to the attendees is that these events "just happen." (That's what I always thought!) Which, in reality, is the utmost compliment since if things weren't running so smoothly, people would recognize that someone, somewhere had "dropped the ball." The truth is that some 20 people or more are working on these committees for several years to ensure that the members of the EMC Society and others are treated to great technical sessions and memorable social events at the annual symposia. With attendance growing and budgets expanding, this becomes more and more of a formidable challenge for volunteers.

So, let's acknowledge and thank all those who have worked on the IEEE EMC symposia in years past, and remember to thank the Washington DC 2000 steering committee *personally* next year when we convene at the Washington Hilton and Towers for our annual symposium.

No wonder those who have served on these symposia steering committees have their secret nods and knowing glances. They're acknowledging that they've been there in the trenches!

**Editor's Note:** As a follow-up to the article "EMC in Academia" from the Spring 1999 issue of this Newsletter, it was announced that a joint study agreement has been formalized between the Thomas J. Watson IBM Research Center and the Department of Electrical Engineering of the University of L'Aquila (UAQ), Italy. This agreement formalizes the currently active joint research work on the development of the Partial Element Equivalent Circuit (PEEC) technique to address EMC problems on printed circuit boards. It will be administered by Dr. A. Ruehli, IBM Yorktown and by Prof. A. Orlandi and Dr. G. Antonini at UAQ.

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*Associate Editor for Chapter Chatter Todd Hubing (L) takes a break from attending the technical presentations during the Seattle Symposium to visit with Robert Hughes of Intel.*

**C**onversations at the Rolla Downtown Barber Shop are always interesting and generally more productive than our city council meetings. I generally try not to say too much though. The topics are usually controversial and I don't want to argue with the person cutting my hair. Two of the worst haircuts I've had in my life were the result of conversations about power bus decoupling and shielding effectiveness.

The other day, they were discussing the IEEE EMC Society President's Memorial Award. This award honors a deceased, eminent member of the EMC Society through scholarship support for graduate study given in his or her memory. The \$2,000 scholarship is the society's most prestigious award. At the Seattle symposium, the award was made in honor of Richard B. Schulz, a former editor of the EMC Transactions and past-president of the EMC Society. The recipient was Rodolfo Araneo, a young graduate student at the University of Rome "La Sapienza" who is destined to become a prominent contributor to the field of EMC. Everyone in the barbershop agreed that this year's award recipient and honoree were excellent choices.

I thought that this was a fairly non-controversial topic so I joined in. Most of the people in the barbershop didn't realize that the President's Memorial Award is funded entirely through private contributions. I suggested to Donzie, the barber, that the Rolla Downtown Barber Shop should make a contribution to the fund. Donzie replied that he would be happy to contribute if he could give me a haircut like Don Heirman's. Donzie thinks everyone should have a Don Heirman haircut.

Many of you know Don Heirman. He is Vice-President for Standards and a past-president of the EMC Society. He has been a major contributor to the EMC Society for more than twenty years. His picture often appears in this newsletter and looking back through past issues, it appears

that Don hasn't aged a day since he first joined the society. Also, during that entire time he has had the same haircut.

Don's hair is quite a bit shorter than I normally wear mine; so I was reluctant to accept Donzie's offer right away. I asked a graduate student to generate a composite image on the computer to give me an idea of how I would look with a Don Heirman haircut. The result is shown below:



What do you think? Not bad really (some would even say quite handsome) and it is for a good cause. Ok, I told Donzie that if

he and a few other businesses would contribute a total of \$10,000 to the President's Memorial Award fund, I would get a Don Heirman haircut. I told him all he had to do was send his contribution to:

Warren Kesselman  
Treasurer, EMCS  
31 Hope Road  
Tinton Falls, NJ 07724-3009

Donations are tax deductible. If the fund gets \$10,000 in contributions prior to the EMC Symposium in Washington D.C. this August, I will get my hair cut like Don Heirman's. Also, if the Rolla Downtown Barbershop or any other major contributor to this fund has a booth at the symposium, I will help staff their booth during the symposium. Perhaps Don Heirman will join me. If so, we will be sure to wear nametags so that your customers can tell us apart.

### **Austria**

The EMC Society Austria chapter elected a new chairman (Dipl.-Ing. Kurt Lamedschwandner) and a new secretary (Dr. Gerhard Diendorfer) on the 27th of May. The vice chairman (Dipl.-Ing. Habel) and the treasurer (Dipl.-Ing. Horak) were re-elected. After the election, attendees were treated to a very in-



teresting lecture by Prof. Douglas M. Jordan, University of West Florida, Pensacola, USA. The topic of his presentation was "Electrical and Optical Properties of the Lightning Discharge." The chapter later held a nice social event in Vienna.

### Central New England

In June, an EMC session was sponsored and organized for ELECTRO 99 in Boston. John Luchini and John Clarke were co-chairs. Robert Martin, of Intertek Testing Services, presented a paper on "Use of Technical Construction Files as a Method of Demonstrating Compliance to the EU's EMC Directive." Ronald Emerich, of Global Semiconductor Safety Services, gave a presentation titled: "Laser Safety: Introduction to CDRH and IEC Laser Safety Requirements." Jim Wright, of Global Semiconductor Safety Services, presented a paper titled "Understanding and Designing to Comply with SEMI S2."

### Chicago

Autumn is here and it's time to return to the EMC Society meetings after the long summer break. We are off to a great start. Our first meeting was held in September at Lucent Technologies' auditorium. Dr. Clifford Kraft from Lucent presented an interesting and practical session on "Coupling into Cables." He ended with the following hints for reducing coupling: for inductive coupling, reduce the area of the receptor loop and ground shield at more than one point and for capacitive coupling, reduce the length of the center conductor extending beyond shield and ground the shield at a minimum of one point.

The Chicago chapter continues to schedule meetings and speakers that promise to enlighten and expand one's knowledge of EMC. Please watch your e-mail for the dates, places and times of our upcoming events. If you would like to receive e-mail regarding meetings, please send your request to [mmartin@dlsemc.com](mailto:mmartin@dlsemc.com). Maxine would be happy to add your name to the e-mail list. We are beginning to make plans for another mini-symposium to be held in May 2000. Tom Braxton is hoping to snare a "Big Name" in EMC for our technical program.

### Dallas

The April meeting of the Dallas chapter of the EMC Society was held on April 19th at Hewlett Packard in Richardson, Texas. The guest speaker was Distinguished Lecturer Donald Bush who spoke on Spread-Spectrum Clock Techniques. We had 25 people in attendance (17 were IEEE members).

The May meeting featured EMC Society Distinguished Lecturer Robert Dockey of Hewlett Packard, who spoke on "New Techniques for Reducing Printed Circuit Board Common Mode Radiation." There were 38 in attendance (22 were IEEE members).

Election of Officers for 1999-2000 for the Dallas chapter of the EMC Society was also held during the May meeting. Mark Bushnell (Raytheon - Greenville) was elected as Chair, Gary Shimko (Marconi Communications) was elected as Vice-Chair and Bill Paschetag (SpectraPoint Wireless) was elected as Secretary-Treasurer.

No Dallas chapter meetings were held during June, July and August.

The September meeting was held at Hewlett Packard in Richardson. The guest speaker was Jim Press, Chief Engineer, National Technical Systems, who spoke on "Lightning." There were 39 in attendance (21 were IEEE members).

### France

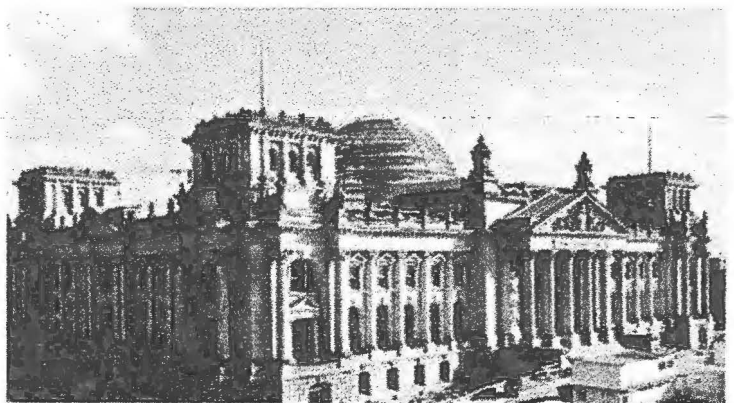
The French Chapter of IEEE EMCS and Club 25 of SEE France have started a new development program, of which the regular publication of a Newsletter is an important part. The NEWS represents the follow-up of LEAD-NEWS of October 28, 1998, acknowledging a quantum step in the development of Electromagnetic Compatibility (EMC) in France and Europe, with the cooperation of local national scientific Societies, comprising SEE France (and IEE in the UK, VDE in Germany, INI in Italy, etc.).

The cooperation between IEEE EMCS and SEE Club 25 will undergo a major overhaul. In addition, free evening conferences and post-university educational seminars will be organized. The first evening conference was held on October 18. Prof. Ferdy Mayer, chair of the French EMCS chapter, repeated the demonstration presented at the 1999 IEEE International Symposium on EMC titled "New Broadband Absorbers" assisted by the staff of Co. SIEPEL. New reflectivity improvements were demonstrated between 30 MHz and 1 GHz.

Prof. Mayer, who is also the Region 8 Membership Chairman for the IEEE EMC Society, represented the Society at the Division I and IV Region 8 chapter meeting in Leuven (Louvain), on September 12.

### Germany

A new series of monthly technical meetings started in Berlin on April 21, one day after the official re-opening of the Berlin



*The Reichstag in Berlin after its reconstruction in 1999.*



*The Berlin University of Applied Sciences (TFH Berlin), center of the regional EMC activities.*

Reichstag as the seat of the German Parliament. The meetings were held at the Berlin University of Applied Sciences (TFH Berlin), organized and chaired by Prof. Ermel.

The April meeting featured Dr. Diethard Hansen of Euro EMC Service speaking about "Performing Radiated Immunity and Emission Measurements Economically and Complying." Over 30 attendees listened to a profound explanation of the technical and economical limitations of radiated EMC tests in absorber chambers and of the problems with the measurement accuracy of conventional OATS. Practical solutions and alternative sites were discussed in depth.

At the May meeting, Uwe Kampet of Bosch Siemens, Berlin, and Dr. Wolfgang Hiller of Robert Bosch Company, Stuttgart, presented a new test method for measuring the magnetic flux density in the vicinity of household appliances. The topic of the June meeting was "Net-based Training Systems for Effective PCB Design Concerning



*About 30 professionals attended the April presentation of Dr. Diethard Hansen (standing on the right) at the Berlin University of Applied Sciences.*

Signal Integrity and Analysis." Werner John of Fraunhofer Institute of Reliability and Microintegration made a special trip from Paderborn to Berlin for this presentation of an interesting new EMC training system for intranets. At the July meeting, Eckart Hoene spoke on "Optimization of Filters for Conducted Electromagnetic Emissions by New Simulation and Measurement Methods." He presented current results of his Ph.D. thesis in progress.

All summer meetings were organized by the Berlin-Brandenburg EMC Society ("EMZ"), a small society of EMC experts in the so-called "electropolis area" of Berlin, in co-operation with the German IEEE EMC Chapter. Professor Garbe and Professor Ermel agreed to continue this successful line of regional meetings and to intensify the co-operation for mutual benefit. The winter program 1999/2000 will start in October. For more information, please contact the web site [www.emv-zentrum.de](http://www.emv-zentrum.de).

### **Mohawk Valley**

The Mohawk Valley Section EMC Chapter held a meeting on 11 June prior to the summer hiatus. Seventeen members and guests were in attendance for the luncheon meeting which had as a guest speaker Professor Mairtin O'Droma of the University of Limerick, Department of Electronic and Computer Engineering, Limerick, Ireland. Mairtin's talk was on "High Frequency Nonlinear Power Amplifier and EMC Concerns: Accurate Prediction of Undesired Amplifier Output by Numerical Methods." The talk began with a brief review of microwave and millimeter wave power amplifier behavior as a function of frequency and incident power. Such amplifiers are becoming ubiquitous with mobile communications. Good models of these devices are important for accurate calculation and counteraction of the impairments due to their nonlinear effects such as spectrum spreading, intermodulation products (IMPs) and out-of-band emissions all which give rise to EMC concerns. The problems are more acute when designing transmitter front-ends for applications requiring efficient use of limited available energy resources, where tradeoffs must be made between competing requirements e.g., power efficiency and undesired emissions. This presentation included a review of Shimbo's Nonlinear Amplifier (NLA) model focusing on how insights gained through a new mathematical derivation enable more accurate and controlled modeling of these nonlinear devices to be accomplished. Constructing a numerical model from device measurements was also discussed, along with how the model has recently yielded additional insights into an unexpected asymmetry associated with device IMP measurements previously attributed to measurement error. Both empirical and analytical results were shown where the latter was based on a computer simulation program developed by Mairtin and his colleagues that accurately models the performance of circuits containing amplifiers and other nonlinear elements.

It should be mentioned that Mairtin O'Droma's professional experience is quite eclectic. Before entering acade-



mia, he worked on the design of Ireland's first transmit/receive satellite earth terminal which became part of the European Space Agency's (ESA) Orbital Test Satellite (OTS) program. This was followed by the design of high bit-rate data communications, a VSAT type telecommunications network which links high-energy physics laboratories across Europe. He was also the senior telecommunications engineer for the ESA group responsible for data analysis of the classical repeater tests of the OTS. In academia, he has held lecturing posts in University College Dublin, National University at Galway and at the University of Limerick. Besides fundamental research, he has been involved in a number of R&D projects for telecommunications companies and has been Director of several engineering companies including Communications Software Ltd. and ODR Patents Ltd. His range of research interests include: engineering design by simulation and modeling of complex telecommunication systems/subsystems and certain classes of nonlinear microwave and mm-wave devices; signal processing algorithms for Smart antennas; and public and private telecommunication networks (such as ISDN, B-ISDN, GSM, UMTS and satellite networks), particularly the design of specialized protocols and services for telecommunication network devices and terminals.

The timing of Mairtin's presentation couldn't have been better. In fact, many of the members and guests in attendance had been studying topics on component nonlinear behavior in mobile communications systems, so his talk was very well received. The presentation generated many questions and quickly evolved into a highly dynamic information exchange forum. Our thanks and appreciation goes to Mairtin for his contributions and support of the chapter's activities!

Chapter Chair Andy Drozd later announced that he was planning to invite an EMC Distinguished Lecturer to give a presentation in the Fall of 1999. Andy continues to poll engineers and technical managers in the Mohawk Valley concerning their subject areas of interest in order to plan chapter meetings. One of the areas of interest expressed by circuit designers and PCB manufacturers in the Mohawk Valley Region is the control of board-level EMI in high-sensitivity electronics packages. This is expected to be a topic at an upcoming meeting.

In September, the Mohawk Valley Section's Reliability and EMC Chapters were formally merged. The EMC Chapter is the lead entity. All reporting, administration and related activities as a consequence of this merger will fall under EMC. This merger is expected to revitalize membership participation in Reliability Chapter activities in the Mohawk Valley Region, and will result in a balance of topics to be covered in future meetings that appeal to those interested in or involved with both engineering disciplines.

## Nanjing

93 people, including 30 IEEE members, attended a meeting of the Nanjing chapter on August 24th. This meeting featured

two speakers. Prof. Wen Xun Zhang, of Southeast University gave a presentation titled: "The Trend of Antennas Development." Jack Qiu, of AnSoft Corporation, gave a presentation titled: "Introduction to EM Simulators." On August 25th and 26th, the chapter was a co-sponsor of the 1999 National Symposium on Antennas. 66 papers were presented at this symposium in three parallel sessions.

On September 24th, the Nanjing chapter hosted another meeting featuring two speakers. Prof. Wei Cao, of the Nanjing University of Post & Telecommunications, spoke on "Propagation Models for Land Mobile Communications." Prof. Wen Xun Zhang, of Southeast University, gave a presentation titled: "The Simple Formulae of Propagation Path-Loss for Planning PCN Cells."

## Orange County

The Orange County Chapter of the IEEE EMC Society sponsored a one-day colloquium on Design for EMC and EMC Troubleshooting Techniques at the Double Tree Hotel in Costa Mesa, California, on October 4th. Four of the most respected experts in the EMC arena were on hand at the event, titled "EMCFest '99", to present talks and answer questions on a variety of EMC topics. The event's goal was to provide an opportunity for low cost, cutting edge education on EMC related topics to EMC professionals in the region who may not have the opportunity to attend the Society's annual Symposium on EMC. Also on hand with the latest in EMC mitigation products and test equipment were 24 vendors, who were kept busy answering questions and providing information to over 60 attendees.

The presentations included four invited technical papers. After the crowd had consumed an ample amount of coffee at the continental breakfast, Dennis Ward of CKC Labs started the tutorial with his presentation, "An Overview of EMC Requirements." This talk provided the audience with up-to-date information on EMC standards and requirements from throughout the world. It was truly



Photo by Randy Flinders

*Break time was busy time in the exhibits area for EMC Fest '99 in Orange County. The one day EMC Colloquium and Exhibition on October 4 drew engineers from Santa Barbara to San Diego.*



Photo by Janet O'Neil

**Randy Flinders (R), Chairman of EMC Fest '99, visits with Ken Shepherd of Amplifier Research, one of the reception sponsors at the event.**



Photo by Janet O'Neil

**Lee Hill (L) demonstrated the material he presented during the technical sessions at EMC Fest '99 to an appreciative audience. Terry He (foreground) of Boeing in Long Beach thought this was the best part of the event! She's an active member of the Orange County and Los Angeles EMC Chapters.**



Photo by Janet O'Neil

**Mike Krumweide of NEMKO (EESI) (L) was the proud winner of Dr. Howard Johnson's book titled "High-Speed Digital Design: A Handbook of Black Magic." Dr. Johnson is shown ready and able to personally autograph his book. Dr. Johnson was one of the speakers at EMC Fest '99 in Orange County.**



Photo by Janet O'Neil

**Kristen Blakney of CASSPER Instrumentation Systems is overcome with emotion having just won the raffle prize "EMI Suppression Handbook: Communiques from the Trenches" at EMC Fest '99. On hand to present the book and support Kristen is Daryl Gerke who co-authored the book with William Kimmel.**

amazing to watch Dennis condense four hours of information on this topic into a one-hour talk. In an industry where the standards and requirements change faster than the weather, the insight and information provided by Dennis was very well received by the crowd.

Upon the completion of Dennis' excellent presentation, Lee Hill of Silent Solutions dazzled everyone with his presentation on "Inductance and Radiated EMI in PCBs and Cables." Lee went on to characterize the one true nemesis of the EMC Engineer: Inductance. Everyone present left with a good understanding of how inductance creates problems and what to do to resolve those problems. At the very least, they walked away with the term "LEAD INDUCTANCE" removed from their vocabulary! Lee also presented an excellent demonstration in the Exhibit Hall, and judging by the huge crowd gathered around his demonstration, it was very popular!

Dr. Howard Johnson of Signal Integrity gave a presentation on "Ground Planes and Layer Stacking." This was also very well received by the entire group of attendees. Coming from a signal integrity background, Dr. Johnson was able to offer the audience a different perspective on designing for EMC and signal integrity. The inter-relationships between the two disciplines were pointed out, much to the interest of the crowd. Dr. Johnson's command of the material and appealing speaking style got him rave reviews from many of the attendees.

Now that the audience had received all of the information on worldwide EMC requirements from Dennis, and was armed with excellent design guidelines from Lee Hill and Dr. Johnson, they were ready to take on the world, right? Well, hold on a second. What if you know the standards, implement all of the design guidelines, and find you are still not quite meeting the specification? What then? That's where Daryl Gerke's talk comes in. His talk on "Di-





Dennis Perry and Brian Halligan of Packaging and Component Specialists were a few of the local vendors who exhibited at EMC Fest '99 in Orange County.

Photo by Janet O'Neil



Photo by Janet O'Neil

Allen Fischer of Fischer Custom Communications, James Collum of Assured Access Technologies, and Randy Flinders of Emulex (L-R) are shown during the reception held at EMC Fest '99. James traveled from Northern to Southern California to attend the colloquium and exhibition. He won the drawing for the Clip-On Current Probe (10khz) - 200 MHz) donated by Fischer Custom Communications. That was worth the trip!



Sid Kritzstein, President of Technologies West, couldn't resist the freshly baked chocolate chip cookies during the afternoon break at EMC Fest '99.

Photo by Janet O'Neil

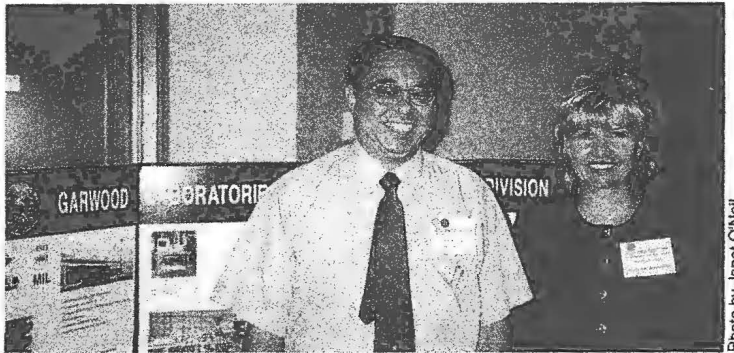


Photo by Janet O'Neil

Ed Nakauchi did double-duty at EMC Fest '99. He was the colloquium secretary/treasurer and he assisted Norgene Ketchum of Garwood Labs in staffing their booth during the event's exhibit hours.

agnosing and Troubleshooting EMI Problems – Tips and Techniques" described how to diagnose and find difficult sources of EMI problems, as well as some quick fixes. He also covered immunity problems and offered advice not only on finding the problem, but fixing it as well. In case you don't know, Daryl's with Kimmel Gerke Associates.

So, from deciding what specification to test to, to designing the product to meet the requirements, to debugging a failing product, EMC Fest '99 had it covered. The Orange County Chapter of the EMC Society would like to thank all of the speakers, vendors, chapter officers, and the attendees for making this event so successful and so much fun! A very special thank you needs to go out to Janet O'Neil of

Lindgren RF Enclosures, whose guidance, coordination efforts, and selfless generosity made the event possible.

## Oregon and Southwest Washington

The Fall season started with our traditional "Buster's Bar-B-Que"! It was a hit as usual. We had approximately 35 folks at our September chapter round-up held at Tektronix. Scott Bennett got the minds thinking as he presented his talk on "The Basic Source of EMI."

The chapter officers were also involved with sponsoring an EMC session at Northcon '99 on October 5th. The session called "Product EMC Compliance – Start to Finish" included the three following topics: Regulations, Standards and Worldwide Harmonization by Henry Benitez of Tektronix; Product Compliance Process and Test Preparation by Daniel Arnold of Underwriters Laboratories; and EMC Test Methods by Edward Blankenship of Hewlett-Packard.

The chapter is once again planning a Holiday get together as well as a superb monthly program.



Photo by Janet O'Neil

*"Buster's BBQ" was the featured menu for the September meeting of the Oregon and SW Washington chapter. Shown enjoying the finger-lickin' good ribs are (L-R) chapter members Laudie Doubrava, Andrew Meier, and Jim Larson – all with Tektronix, who hosted the meeting at their facility in Beaverton.*



Photo by Janet O'Neil

*Scott Bennett spoke at the Oregon and SW Washington chapter meeting in September. There was a raffle for his book "Control and Measurement of Unintentional Electromagnetic Radiation" following his presentation. Katie Fretwell of Tektronix was the lucky winner and Scott personally autographed his book for her.*

## Philadelphia

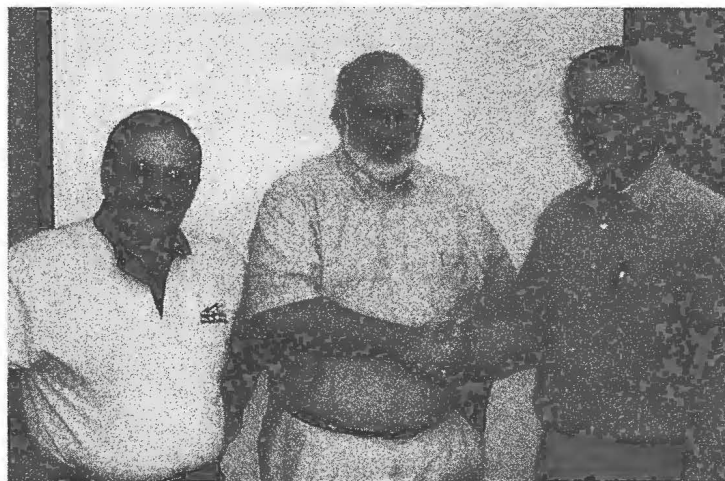
Gino Dignetti reports that the September meeting of the Philadelphia EMC Society was held at the Drexel University Faculty Club. The featured speaker was Jim Nadolny, who presented a talk on the "Application of EMI Modeling in Design." With the advent of commercial electromagnetic field solvers, modeling of electromagnetic interference problems becomes more practical. Mr. Nadolny presented a case study, which addressed the use of commercial code to understand a shielding problem. The case study centered on the shielding performance of a connector and correlated measured and modeled results. For some shielding problems, measurements are more suspect than the simulation and the combination of the two leads to confidence in the results.

## Rocky Mountain

[Thank you, Lyle Luttrell, for sending in the following update on the Rocky Mountain chapter activities.]



*Galen Koepke discusses some reverberation chamber concepts.*



*Vice Chair Charles Grasso (L) and Chair Lyle Luttrell (R) welcome Daryl Gerke to the Rocky Mountain Chapter Meeting.*



*Inside the NIST near-field antenna test site with Katie MacReynolds.*

A band of 20 hearty souls braved the Boulder June weather to attend a customized tour of the National Institute for Standards and Technology (NIST) in Boulder, CO. The officers of the Rocky Mountain Chapter in conjunction with NIST arranged for the Society to visit three division laboratories. The Time and Frequency Division produces and maintains the national standards of time and frequency and coordinates them internationally; provides time and frequency services for the Nation, and performs research and development on new time and frequency standards and measurement methods. The





*Jim Grey discusses some time base measurements.*



*Chapter members Bob German and Barry Wallen are ready for pizza.*

Electromagnetic Fields Division conducts basic and applied research on the interaction of electromagnetic radiation with devices and materials, and the development and evaluation of measurement methods and standards needed to characterize both guided and free-space electromagnetic fields, and the performance of electromagnetic instruments, systems and devices. The Information Technology Laboratory responds to the growing need for measurement and testing technology to support the development of computing and communications systems that are usable, scalable, interoperable, and secure. This need has come into sharper focus in recent years with the national effort to develop an infrastructure to support a global information marketplace. Several technical contributors to the EMC Society, including Dr. Robert Johnk, Dr. Chris Holloway and Dr. Galen Koepke, were present during the tour.

### San Diego

Dave Bernardin, chair of the San Diego chapter, reports that their April meeting featured Mr. Jozef Baran and Mr. Mark Frankfurth. The subject of their presentation was "The Broadband Gigahertz Field Simulator Chamber." The May meeting featured a talk on "Designing for Compliance and Safety" by Christine Ruth. Attendees of the June summer BBQ and meeting were treated to a talk by Ste-

phen Watkins, Mike Marino and Ed Nakauchi on "EMI Ambient Cancellation and Source Localization." At the September meeting, Charles M. Bayhi spoke on "Designing for Safety for the Year 2000 and Beyond."

### Seattle

The chapter reconvened on September 28 for its first monthly meeting of the 1999-2000 season. The meeting was held at the all-new CKC Labs facility in Redmond. Pat Andre, Laboratory Manager at CKC Labs, led a tour of the new facility for those that arrived early. Carol Grout, Administrative Assistant at CKC Labs, did her best to ensure there was plenty of hot pizza and cold soft drinks for all. It was a nice, casual environment for the first chapter meeting after that REALLY BIG meeting (i.e. symposium) in August in Seattle. Scott Bennett was the speaker on the topic "The Basic Source of EMI — And the Key to EMC." The basic source of EMI is the current element. Scott showed that by visualizing circuits as super positions of current elements — physically, not mathematically — the door to EMC is easily opened. There was perfect weather in Seattle during Scott's visit so the chapter hopes he will return one day. In October, the chapter will feature Doug Smith on "Unusual Forms of ESD" and Maqsood Mohd will speak about "Lightning Effects on Electronics and Humans" at the November chapter meeting. It promises to be a good year of technical presentations for the Seattle chapter! If you plan a visit to Seattle, check out the IEEE Seattle Section web site at <http://www.ieee-seattle.org/>. You'll find information about EMC Society Seattle chapter meetings and other society activities in the area.



*Scott Bennett was the featured speaker at the Seattle EMC Chapter's September meeting. The day following his presentation, he took in an al fresco lunch on Lake Washington with the Seattle Chapter's Vice-Chairman, Janet O'Neil.*



**BOB ROTHENBERG**  
ASSOCIATE EDITOR

This section of the Newsletter provides a simple and effective way to share experience-based knowledge or measurement results with your colleagues in the EMC community. Articles or application notes should be no longer than about 2000 words, and may include up to 6-8 figures (depending on word count). Submit them to this Associate Editor via e-mail, fax or real mail. See addresses and fax number on page 3.

The following articles on absorber design and reverberation chambers should be of interest to many Newsletter readers. Dr. Mayer and his co-authors, Dr. Berthon and Prof. Perini, present a unique approach for creating ferrite absorbers with improved broadband performance characteristics. Kevin Goldsmith explains the nature of Reverberation Chambers and describes their advantages (and disadvantages) compared to anechoic chambers and shielded rooms. In addition, Ken Javor, author of the paper on differential mode conducted emissions in the Winter 1999 issue, responds to comments from Michel Mardiguian in the Summer 1999 issue.

Comments from readers concerning these articles are welcome, either as a letter (or e-mail) to the editor or directly to the authors.

# Response to Mardiguian's Critique<sup>1</sup> of "Investigation into Radio Susceptibility to Power-Line Conducted Noise"<sup>2</sup>

by Ken Javor

**M**ichel Mardiguian questioned aspects of the subject investigation in the Summer newsletter. My response summarizes his concerns and provides detailed answers.

- 1) "Javor assumes that...power line CE investigations and modeling were made considering that power return and power earthing reference were a same conductor, such as a one-LISN configuration would represent actual installations (sic). This is not correct..."

CBEMA threshold of interference (TOI) assessment did use a single 5  $\mu$ H LISN. A limit for conducted emissions for a two wire above ground power bus configuration was *analytically* derived from the test data garnered. In contrast to the single LISN TOI measurement technique, CBEMA recommended a two LISN conducted emission (CE) measurement technique. CBEMA explicitly addressed the effect on radio TOI due to a second source of CE available when power bus configuration supplies an above ground neutral. The CBEMA report assumed that the conducted voltage at which TOI occurs would decrease 6 dB, due to twice the amount of CE available with this measurement technique. The validity of this last assumption was the entire basis for my investigation. It appears reasonable as long as the second source of rfi is held to be identical to the first. Equation set 1 models the CBEMA assumption.

$$\text{TOI single LISN (dB}\mu\text{V)} \sim V_{\text{measured}} \quad \text{Eqn. 1-1}$$

$$\text{TOI two LISN (dB}\mu\text{V)} \sim \frac{1}{2} \cdot V_{\text{measured}} \quad \text{Eqn. 1-2}$$

However, the two LISN technique measures two different types of CE, cm and dm. What is measured at each LISN port is a linear combination of these two noise components. Equation set 2 models my assumption.

$$\text{LISN 1 (dB}\mu\text{V)} \sim [V_{\text{cm}} + V_{\text{dm}}] \quad \text{Eqn. 2-1}$$

$$\text{LISN 2 (dB}\mu\text{V)} \sim [V_{\text{cm}} - V_{\text{dm}}] \quad \text{Eqn. 2-2}$$

$$\text{TOI}_{\text{author's model}} \text{ (dB}\mu\text{V)} \sim [\alpha V_{\text{cm}} + \beta V_{\text{dm}}] \quad \text{Eqn. 2-3}$$

With the model of 2-3, CBEMA assumption is only valid if  $\alpha \approx \beta$ . If this is not the case, as I suspected, then it makes sense to control CE by modes, with the degree of strictness proportional to the ratio of  $\alpha$  to  $\beta$ , that is cm to dm susceptibility.

- 2) "I think that the real danger...is that of mode conversion in the utility wiring...where a purely DM-originated noise creates, after some distance, a CM component..." Mardiguian mentions a bus with an isolated neutral, and provides a figure (reproduced below) to support the contention.

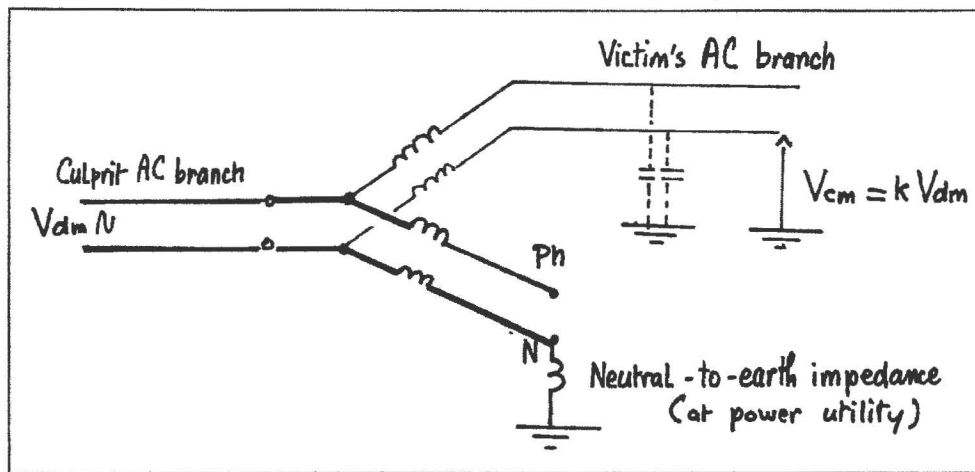
Key issues here are that

- 1) the dm source is floating (as shown), and
- 2) distributed capacitance between bus wiring and ground is equal or nearly so because phase and neutral wires are in close proximity to each other. Phase and neutral are either both far removed from ground (in Mardiguian's figure) or both equidistant from it (with modern phase, neutral, and green wire buses). Mardiguian is concerned that a conversion efficiency of greater than - 20 dB could cause a 20 dB relaxed dm potential to look like a cm potential over the limit. This cannot happen. The capacitance of an AWG 10 wire 1 m above ground is 2 pF/m. If phase and neutral are 1 m above ground, but one is 1 cm above the other, the unbalance is 0.001 pF/m. Assuming a branch line length of 100 m, and a relaxed dm limit of 70 dBmV at 30 MHz, unbalanced current is less than 0.1  $\mu$ A. A LISN-like 50  $\Omega$  line-to-ground source impedance would drop 14 dB $\mu$ V due to the unbalanced current, more than 30 dB below the common mode CE limit.

There is no mechanism presented here for significantly unbalancing the dm source with respect to ground.

- 3) "Another aspect is...statistical...it is not sure that radio sets...in the upper percen-





(Mardiguian's) Figure 2: DM to CM voltage conversion along AC distribution.

tiles of  $V_{dm}$  TOI ( $dm$  mean  $+ 1\sigma$ ) are the same ones which have the highest  $V_{cm}$  TOI ( $cm + 1\sigma$ )."

Mardiguian questions whether radio dm and cm TOI is really 20 dB apart, based on statistical concerns. No statistical assumptions need be made, except in projecting the results of the investigation across all radio sets. Figure 9 from the subject article shows actual radio by radio TOI as well as both mean TOI and one standard deviation off the mean. The reader should note that for those radios whose dm TOI is well below the dm mean, it is also the case that the cm TOI is below the *present* conducted emission limit. Hence these radios are not now absolutely protected by the levied limit. Such will always be the case. A cost-effective limit protects the majority of victims against the majority of culprits. A bullet-proof limit is not cost-effective.

- 4) "...critical aspect not...addressed by Javor...the conducted limit...also protects receivers from power line radiated rf noise."

Mardiguian apparently did not read the full published report (referenced in the newsletter article) of which the article itself was but a summary. The report provides exhaustive detail on all the controls placed to ensure accurate and

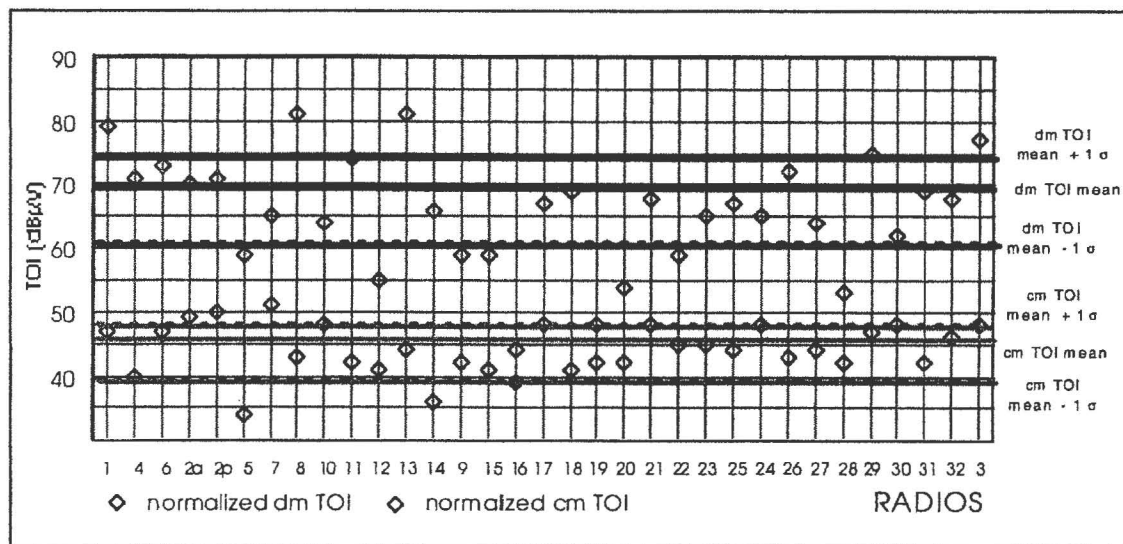
wire was in intimate proximity to the victim radio, not three meters away). The radiated TOI often could not be ascertained at levels available using a signal generator output, but in all cases it was well above the conducted TOI.

Mardiguian calculates the electric field resulting from common (actually, antenna) mode noise at the 46 dB $\mu$ V limit to be 45 db $\mu$ V/m on a two wire power bus, and uses the answer to justify the present conducted emission limit. I agree, that to the extent that such wiring still exists, common mode emissions must be controlled so as to also control radiated emissions. However, the subject of my investigation was a relaxation of the *differential mode* limit. Mardiguian's analysis is inapplicable to the subject relaxation. Calculation of the field resultant from the relaxed dm limit shows there is no concern about dm-sourced radiation.

Maximum magnetic field from a long wire pair with equal and opposite currents flowing is  $H_{net} = (I/2\pi)(s/r^2)$ , where  $I$  is the equal and opposite current,  $s$  is wire separation,  $r$  is wire distance from field measurement point.

The ratio between  $H_{net}$  and the antenna mode  $H$  is  $s/r$ . If power bus wires are separated by as much as one centimeter, and the field point is at 3 m, (per Mardiguian's analysis) then net magnetic field due to dm current flow is 50 dB

down from that induced by antenna mode currents. Therefore a relaxation of the dm limit of 20 dB would still result in radiated emissions 30 dB below those resulting from the presently allowed antenna mode currents. Note that the presence of a green wire allows common mode currents to flow back in close proximity to phase and neutral, hence reducing common mode sourced radiated emissions to the same level as those resulting from dm emissions.



(Javor's) Figure 9: TOIs of Figure 8 with CBEMA TOI normalized to 48 dBmV

## References

1. M. Mardiguian, "Comments on Javor's 'Investigation into Radio Susceptibility to Power-Line Conducted Noise,'" IEEE EMC Society Newsletter, No. 182, pp. 20-21, Summer 1999.

2. K. Javor, "Investigation into Radio Susceptibility to Power-Line Conducted Noise," IEEE EMC Society Newsletter, No. 180, pp. 15-20, Winter 1999.

Ken Javor may be reached at 256-650-0646 or [ken.javor@emccompliance.com](mailto:ken.javor@emccompliance.com)

# The Inverse Approach In Electromagnetic Absorber Design: Cloning "Ideal $\mu^*$ Spectra" And Design Of Related New Materials

by Dr. Ferdy Mayer, Dr. André Berthon and Prof. Jose Perini

A practical approach to the design of broadband absorbers starts with a lower frequency ferrite tile material of commercial use for the 30 MHz - 1 GHz frequency range, and then considers a second layer, to be determined, so as to improve the absorber performance and especially to extend the higher frequency limit.

In a two-layer absorber, it is convenient to consider a given first layer (against ground plane), as for example a commercially available 30 MHz - 1 GHz ferrite tile, of given material and thickness. This will determine the surface impedance,  $Z_{1sc}$ , on top of this first layer. Any discrepancies

with free space impedance will now have to be compensated for with a second (flat) layer, with the purpose of achieving the high frequency performance increase. In other words, the surface impedance, on top of this second layer, is to be "driven" to the free space impedance, i.e.:

$$\sqrt{[\mu_0 / \epsilon_0]} + j0 = \frac{Z_{1sc} + [\sqrt{[\mu_0 / \epsilon_0]}(1 / \sqrt{\epsilon_2})(\mu_2)] \cdot \tanh[j(2\pi f / 3 \times 10^8) \cdot (\sqrt{\epsilon_2} \mu_2) \cdot d_2]}{1 + (Z_{1sc} / \sqrt{[\mu_0 / \epsilon_0]})(\sqrt{\epsilon_2})(1 / \sqrt{\mu_2}) \cdot \tanh[j(2\pi f / 3 \times 10^8) \cdot (\sqrt{\epsilon_2} \mu_2) \cdot d_2]}$$

where  $\mu_0$  and  $\epsilon_0$  are the permeability and permittivity of free space,  $f$  = frequency, and  $\epsilon_2^* = \epsilon_2' - j\epsilon_2''$  represents the permittivity of its second layer,  $\mu_2^* = \mu_2' - j\mu_2''$  its permeability, and  $d_2$  is the thickness.  $Z_{1sc}$  represents the first layer surface impedance.

The analysis of this equation demonstrates the need for layered materials, of wave impedances higher than the impedance of air, in a frequency area where  $\mu^*$  values are small. The analysis is simplified by the need to consider only low  $\epsilon^*$  values, which for practical reasons can be non-dispersive (i.e.,  $\epsilon'' = 0$ ). One can then calculate "ideal  $\mu_2^*(\omega)$  spectra" for a given  $\epsilon_2^*$  with the thickness  $d_2$  as parameter. Figure 1 shows such a spectrum with a first layer 42 ferrite (representative of any commercially available 30 MHz - 1 GHz tile), of thickness 6.3 mm, as well as related wave impedance spectra which must be "hi-Z" materials, with wave impedances higher than one, up to the highest frequencies involved.

The feasibility of the "cloning" of such ideal  $\mu_2^*$  spectra involves now known and possibly new magnetic material science. To the physicist, a priori, the cloning is possible between

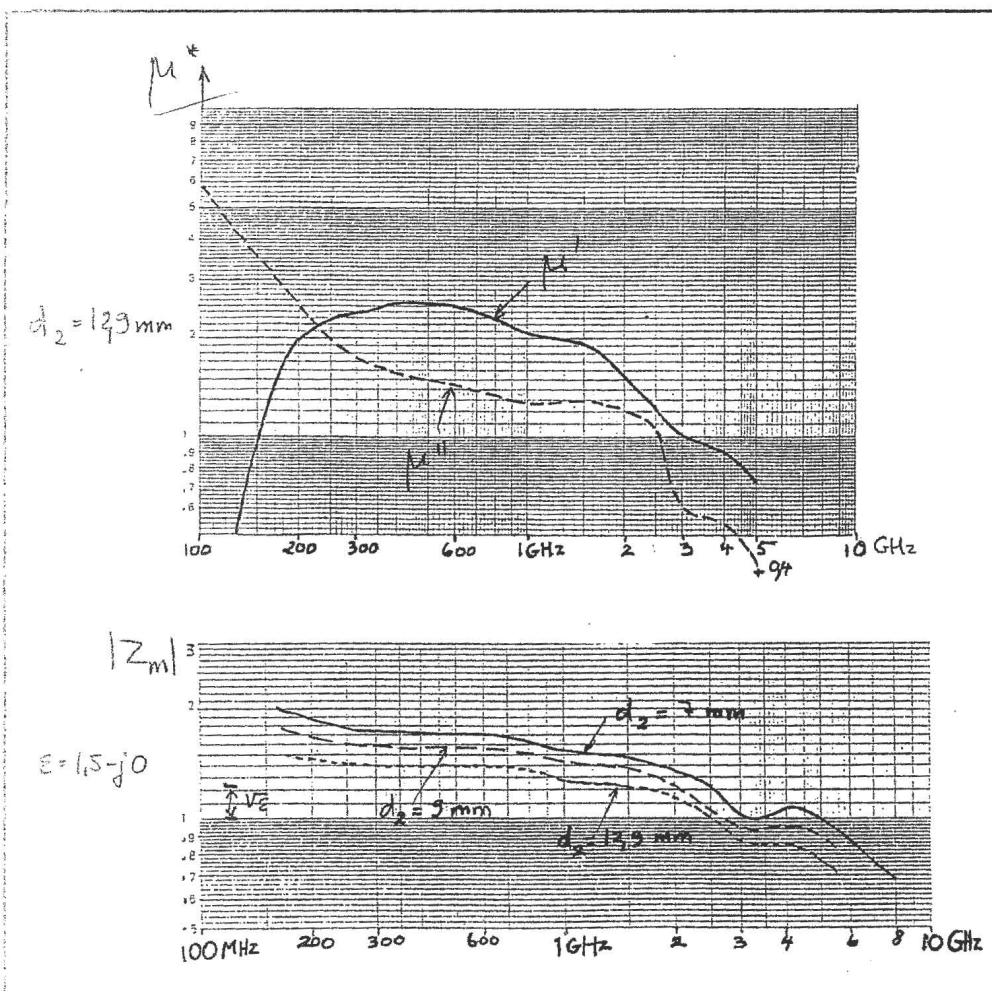


Figure 1.



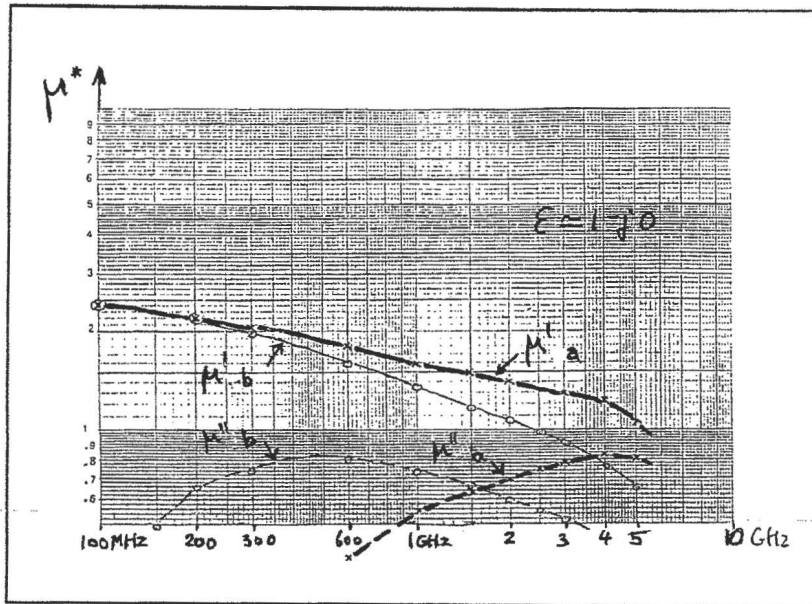


Figure 2.

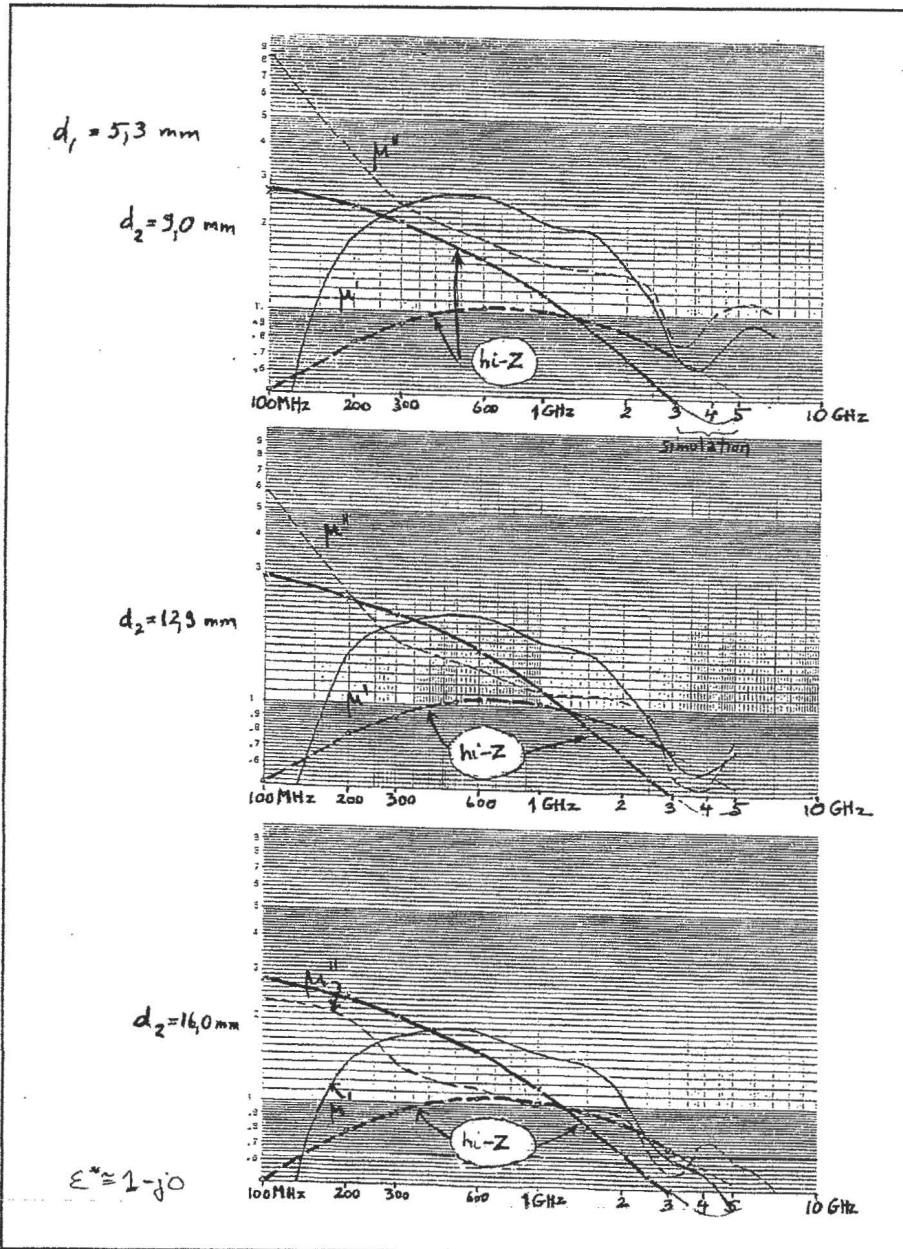


Figure 3.

some 600 MHz (as long as  $\mu''$  becomes dispersive), and some 8 GHz (where  $\mu''$  is positive).

A typical example of the cloning procedure for the second layer is shown in Figure 2 (which must be superimposed on Figure 1 to check the correlation). Figure 2 is relative to a low density ferrite grain assembly (with  $\epsilon'' \sim 1$ ), using two kinds of ferrite:

Ferrite a of a Ni-Zn stoichiometry composition  
 Ferrite b of a Mn-Zn sub-stoichiometry composition  
 (so as to have high resistivity)

If the  $\mu''$  spectra are comparable, the  $\mu''$  spectra are quite different. The figure shows clearly that the best  $\mu''$  cloning is performed with some mix of both ferrites. Nevertheless, the  $\mu''$  values are "disconnected" from  $\mu'$  values; indeed, such low volume concentration of the grain assemblies show preponderant demagnetization effects, and  $\mu''$  does not reach  $\mu'$ , as normally expected.

A solution consists of using oriented grain structures, oriented oblate particles or even radically uniaxially anisotropic structures, such as ferrite posts or ferrite wafers, oriented in the axis of propagation.

Figure 3 shows the  $\mu''$  spectra superposed on the ideal  $\mu''$  spectra, for the Ni-Zn ferrite above, where particles are arranged in a bulk ferrite array oriented by a DC magnetic field, so as to form the "Hi-Z" outer layer. The corresponding implementation, with a thickness  $d_2$  of 12.9 mm, which corresponds to a good broadband correlation, shows the reflectivity spectra of Figure 4, with an excellent reflectivity ( $> 15$  dB) from 25 MHz to over 5 GHz.

The optimization of such a cloning can now use more or less sophisticated techniques, where nevertheless we have to consider that theoretical formalization of such new mixes/shapes/structures of magnetic layers are not currently available. We shall present the theoretical modelization in a future publication.

In a first approach to such an optimization, we have completed the Figure 1 "ideal  $\mu''$  spectra" (achieving infinite reflectivity), with the limits of the deviations of:

$\mu''$  considering  $\mu''$  as having the ideal values, and  
 $\mu''$  considering  $\mu'$  as having the ideal values.

so as to achieve 20 dB reflectivities (Figure 5).

More complicated "double optimizations" are now under study. In a first application of

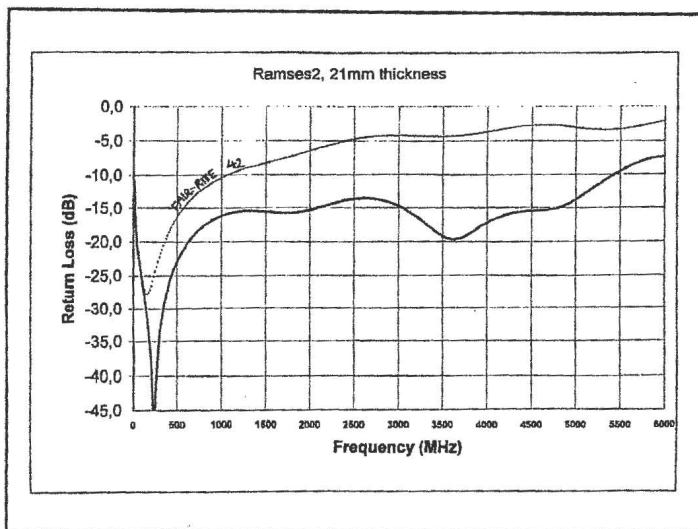


Figure 4.

this technique, we have achieved an over 25 dB reflectivity, using a second layer of a uniaxially partially anisotropic porous ferrite, of thickness 9 mm.

We emphasize the need for an understanding of more complex non-isotropic magnetic structures, including intrinsic anisotropic, shape and structure anisotropic, and bi-anisotropic new materials (Figure 6). Details are given in French patent application # 98/114.70, of September 16, 1998, and related foreign patent applications.

The development of the "inverse-approach" and the knowledge of the spectra of such new materials will be an important incentive for new approaches to broadband electromagnetic wave absorbers.

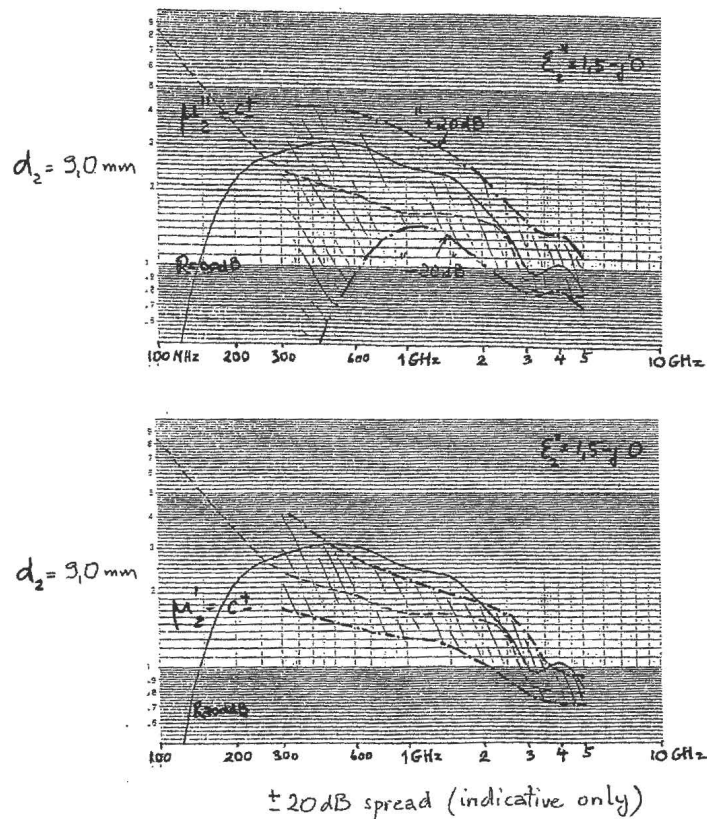


Figure 5.

#### CONTROL OF $\mu^*$ SPECTRA IN PARTIALLY UNIAXIAL COMPOSITES

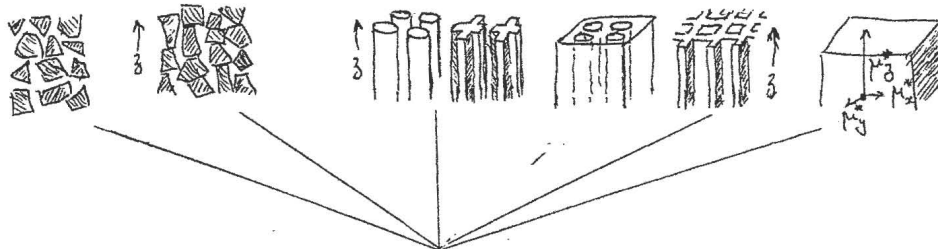
Isotropic soft ferrites or ferrite particles with crystal anisotropy

Shape uniaxial ferrite (oriented particles)

Structural uniaxial ferrite array

Structural uniaxial ferrite array

Ferrites with a preferred plane of magnetization (bulk or oriented particles)



with choice of ferrite / mix of several ferrites (for spectrum shaping),  
with combinations of different schemes (for "partial anisotropy")



Dr. Mayer Dr. Berthon Dr. Perini

Dr. Ferdy Mayer is Chairman of the IEEE EMC Society's International Committee and an Honorary Life Fellow of the IEEE. He can be reached at [FerdyMayerLEADFrance@compuserve.com](mailto:FerdyMayerLEADFrance@compuserve.com). Dr. Berthon is Chairman of Club 25 of SEE France. Dr. Perini was a Professor at Syracuse (NY) University, until his retirement in 1991.

Figure 6.



# Reverberation Chambers – What Are They?

by Kevin Goldsmith

**R**everberation Chambers are the latest development in REM testing, for performing radiated immunity, radiated emission and shielding effectiveness testing. Simplistically a Reverberation Chamber is much like a large microwave oven and like a microwave oven it “cooks” the test object all over. The Defence Science and Technology Organisation (DSTO) Chamber is shown in Figure 1. Reverberation Chamber development will produce a test technique that is robust (ie., highly repeatable, highly reproducible, and technically thorough). An increasing number of Reverberation Chambers are being built around the world, with general agreement on test standards and procedures. However, there is only one published standard, ED14D “Environmental Conditions and Test Procedures for Airborne Equipment” (which is Europe’s equivalent of RTCA DO 160D), with ED90 “Radio Frequency Susceptibility Test Procedures” giving more detail on the test method. In draft is IEC 61000-4-21, which will cover immunity and emission testing.

Test houses have been using an uncontrolled version of a Reverberation Chamber for many years — i.e., a shielded room. A Reverberation Chamber is a metal box (shielded room) with a tuner. The tuner (the white object in Figure 1) is used to stir the inevitable standing waves that occur inside the room. RF energy is injected into a corner of the chamber and allowed to reflect off the walls, ceiling, floor and tuner. Inside the chamber the electromagnetic field is the vector sum of all the reflected waves arriving at any point. At each reflection the wave loses a little of its incident energy (incident magnitude) to wall ohmic losses, absorption by the test object and leakage from the chamber. The reflected waves arrive at a point inside the chamber with different magnitudes, due to the number of times the wave was reflected before arriving at the point. The reflected waves have different phase with respect to each other as a result of the different path lengths they have taken to arrive at the point. The revolving tuner changes the path lengths and the number of reflections of the waves as they arrive at a point. All this means the magnitude at any point in the chamber is different from that at any other point and different at each tuner position. However, a single revolution of an effective tuner perturbs the field to give it a known statistical distribution (i.e., chi squared with two degrees of freedom when measured with a standard linear matched antenna). The same statistical distribution is evident if many points in the field are measured, with all of the objects inside the chamber held in the same place. A typical single point measurement for a single revolution of the tuner is shown in Figure 2. Two tuner revolutions give identical tuner sweep plots. Measurements at DSTO show the shape to be identical, with magnitudes of the peaks and troughs commonly within 0.3 dB.

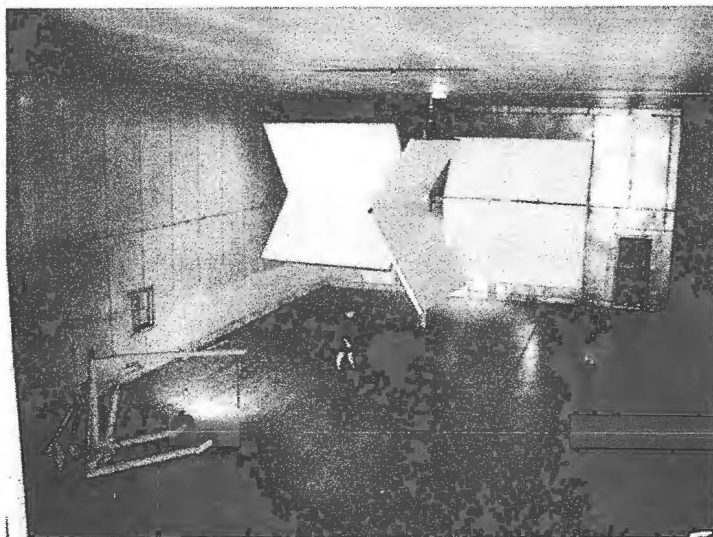


Figure 1: Inside the DSTO Chamber just after construction of the tuner.

The result of a tuner revolution is a statistically isotropic, randomly polarised, uniform field across a large proportion of the chamber volume. The useable volume of a Reverberation Chamber is approximately 50% of the volume of the chamber, significantly larger than that of an anechoic chamber. The Reverberation Chamber is a resonant cavity; hence the field inside has a resonant cavity quality factor (Q) associated with it. A plot of the Q factor for the DSTO chamber is shown in Figure 3. The field inside the chamber has a much larger (statistical) average than an equivalent open area test site (OATS) or anechoic chamber field for the same power input. Figure 4 shows the electric field for a 1 Watt input power for the DSTO chamber. An unusual feature of reverberation chambers is that the field uniformity becomes better when they are heavily loaded by a test ob-

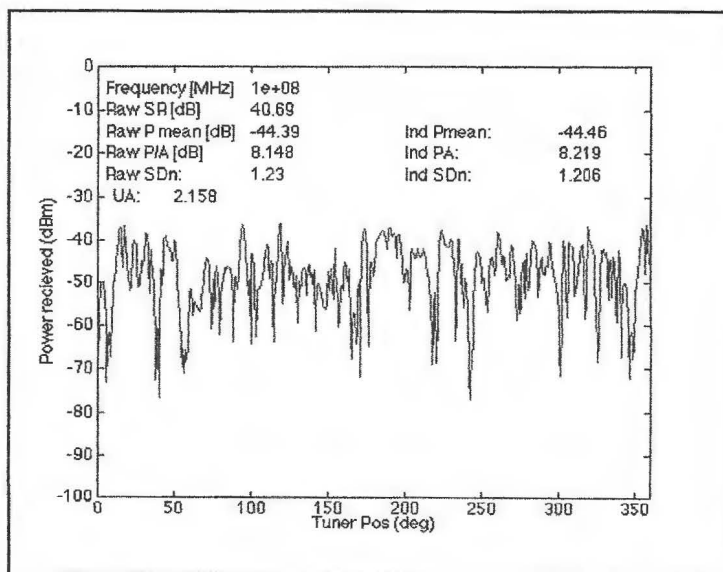


Figure 2: A sample tuner sweep plot.

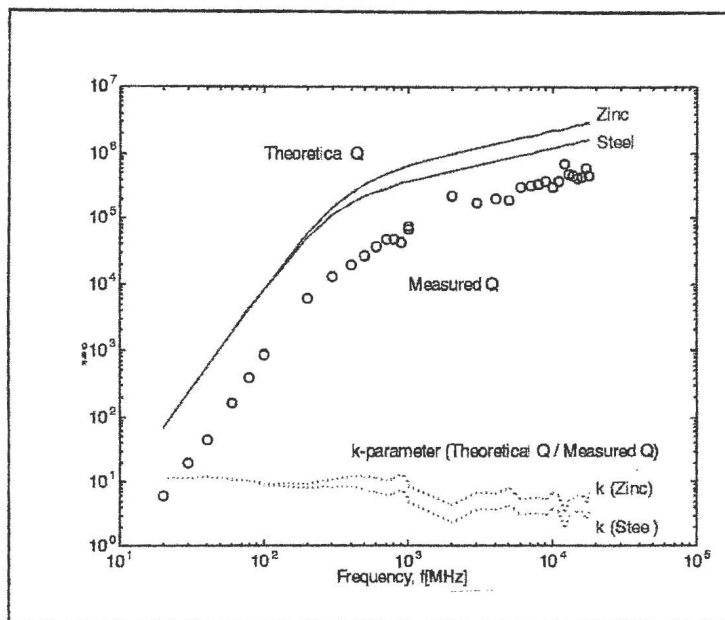


Figure 3: Theoretical and Measured Q factor for the DSTO Chamber.

ject; however, the Q drops. Reference 1 describes these and other loading effects.

Researchers in the USA have developed the theory of chamber statistical behaviour (see reference 2). The theory has provided an understanding of the nature of the field, resulting in a known statistical relationship between chamber average and maximum fields. The maximum field is 7 to 8 dB higher than the average field for a properly operating chamber. These statistical relationships have been experimentally verified at DSTO and many other places. A measurement of the average field at a number of points within the working volume of a Reverberation Chamber gives a distribution that has a standard deviation of approximately 0.5 dB, which is better than that of an anechoic chamber.

Material attenuation and shielding effectiveness measurements benefit greatly from the statistically isotropic, randomly polarised, uniform field within a Reverberation Chamber. The field ensures that the least attenuation values are obtained without the need for moving antennas to get different exposure angles and polarisations. Reverberation Chamber measurements are fast, requiring only a few minutes for each amplifier/antenna combination.

Reverberation Chamber based tests will highlight any susceptibilities a test item possesses and will measure all the emissions from an object. The susceptibility found in one chamber can be reproduced in a different chamber to within mathematically derivable uncertainty. These factors are due to the isotropic, randomly polarised, uniform field within the chamber. A Reverberation Chamber test is realistic. This is because the equipment's operational environment is often similar to the resonant cavity of the chamber (albeit with a lower Q); for example, a train, car, aeroplane or shielded room. In contrast it is impractical (although possible) to test all aspect angles and all polarisations inside an anechoic chamber

due to the test time required. The field inside a shielded room is identical to that of a Reverberation Chamber except that the tuner is not present so uniformity, isotropicity and random polarisation cannot be achieved. Hence the Reverberation Chamber technique is perhaps the only technically thorough test.

This technically thorough test will provide manufacturers with confidence that their design and manufacturing processes are sound, and that their product will operate in any location (relevant to the test levels used). The consumer will benefit from products that operate without interference or causing interference.

The construction of Reverberation Chambers is relatively straightforward. A shielded enclosure is built (using conventional designs is suitable) and a tuner installed. Tuner drive systems are commercially available for modest sized chambers: the larger the tuner the better the low frequency performance. A chamber's minimum operating frequency is defined by the chamber's dimensions; the larger the size the lower the lowest useable frequency. The maximum useable frequency seems only to be related to the maximum power available to drive the chamber. Chamber characterisation measurements to 18 GHz have not found an upper limit in the DSTO chamber. The lowest useable frequency is related to the dimensions of the chamber and the effectiveness of the tuner. Reference 3 gives insight into the design of the DSTO chamber.

Reverberation Chamber testing is not all-good news. An understanding of Reverberation Chamber behaviour does require an open mind and some understanding of statistics. A measurement of the field in the chamber looks more like noise, as shown in Figure 2, than the deterministic field of an anechoic chamber. The isotropic and randomly polarised field inside the chamber does not give the operator any information about the direction and polarisation of the field that causes a test object to fail. A

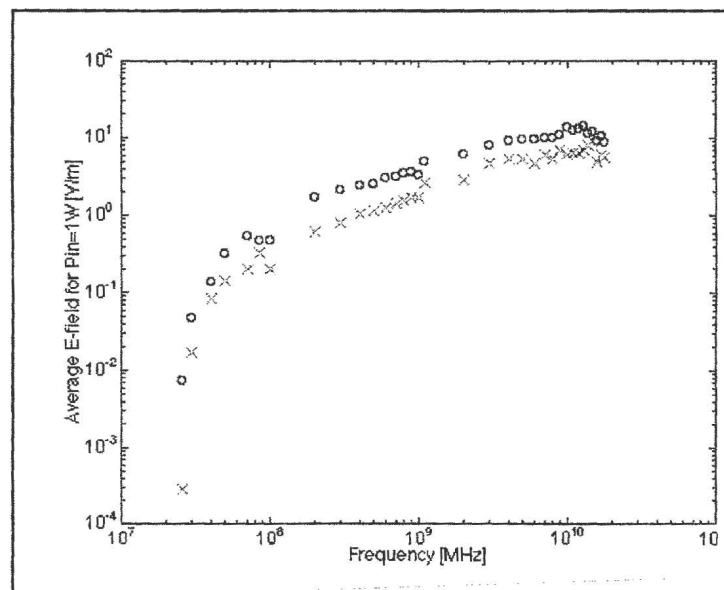


Figure 4: Average E-field achieved with 1 Watt of input power (circles for an empty chamber, crosses for a chamber with a helicopter).



Reverberation Chamber is only able to measure the total radiated power of a test object, not the electric field at a specified distance, as required by most test standards. Some aspects of the behaviour of Reverberation Chambers are yet to be scientifically explained, despite being experimentally verified in many chambers, so research is continuing. An issue of considerable interest to Reverberation Chamber builders is the design of effective tuners which will maximise chamber useable volume.

Research is being conducted in many countries — USA, UK, Sweden, Italy and Australia to mention a few. Most EMC conferences have at least one session on Reverberation Chamber research. Much of the research is written in a highly readable form. A good place to start is the IEEE EMC Symposium proceedings of the 1990s.

In summary, a Reverberation Chamber will find all susceptibilities and allow measurement of all emissions, from all aspect angles and any polarisation. Manufacturers and consumers will benefit from the better performing products. To get these benefits, test houses will be asked to embrace this new technology.

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*Kevin Goldsmith is associated with the Defence Science and Technology Organisation (DSTO) at Salisbury, Australia, where his primary focus has been aircraft E3. His current research interest is the suitability of mode stirred chambers for whole aircraft electromagnetic vulnerability assessments. Kevin can be reached by e-mail at: kevin.goldsmith@dsto.defence.gov.au*

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## MARK YOUR CALENDAR! August 21-25, 2000

2000 IEEE International Symposium on Electromagnetic Compatibility at the Washington Hilton in Washington DC.

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Technical Program: Larry Cohen  
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Exhibits: Penny Caren  
804-897-5334, x109

Publicity: Michael Violette  
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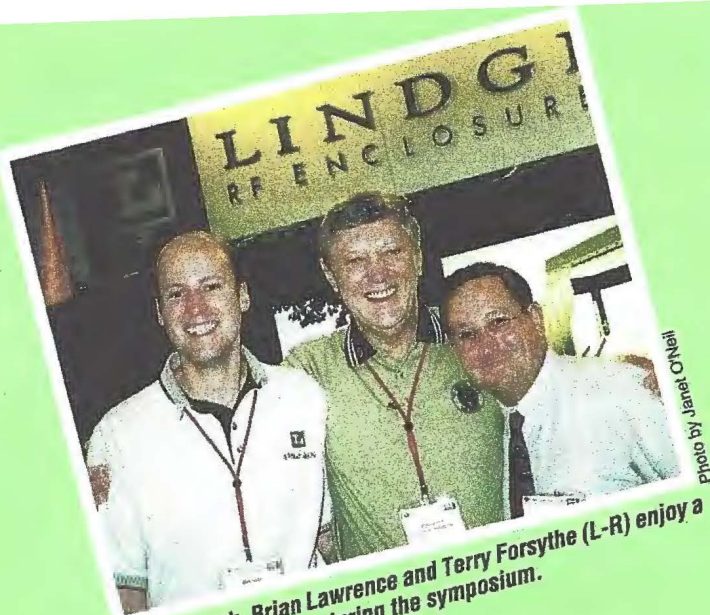
**[www.dcemc2000.org](http://www.dcemc2000.org)**

## ATTENTION ALL VENDORS OF EMC PRODUCTS AND SERVICES!

### ADVERTISE ON THE EMC SOCIETY WEBSITE IN 2000

As a service to its members, the EMC Society will launch an electronic directory of EMC related products and services in the year 2000. If your company provides EMC related products and services, consider having an electronic institutional listing and your company logo on the EMC Society website. Visitors to the EMC Society website ([www.emcs.org](http://www.emcs.org)) will soon see a "hot button" with the title "Directory of EMC Products and Services." Clicking on this hot button will lead viewers to a page of institutional listings (similar to that shown on the back cover this newsletter). Company logos will be shown and viewers that are interested in further information about a specific company can click on a company logo and be immediately linked to that company's website. The cost to post an institutional listing and company logo for one year is \$1,500. Those interested in taking advantage of this NEW advertising opportunity should contact the EMC Society Webmaster, Andy Drozd at phone 315-334-1163 or e-mail at [a.l.drozd@ieee.org](mailto:a.l.drozd@ieee.org).





Mark Lucock, Brian Lawrence and Terry Forsythe (L-R) enjoy a little Lindgren levity during the symposium.

Photo by Janet O'Neil



Two long-time friends, Ken Javor of EMC Compliance (L) and Mark Nave of Network Appliance, catch up on the latest during the Awards Luncheon.

Photo by Janet O'Neil



Leo Smale and Jeannie Olson of Kalmus tempted visitors to their booth with an "apple" theme representing the "new crop" of amplifiers they offer.

Photo by Janet O'Neil



Eberhard and Edith Klein of EMC - Technik and Consulting in Stuttgart, Germany are welcomed "regulars" who consistently attend the annual IEEE EMC symposia.

Photo by Janet O'Neil



Fun times at the Pacific Science Center, site of the Tuesday evening reception held during the Symposium.

Photo by Dick Ford



Barbara and Dave Staggs managed to sneak in a dinner at the Space Needle while in Seattle. Dave is a past member of the EMC Society Board of Directors. He's with Dell Computers.

Photo by Janet O'Neil



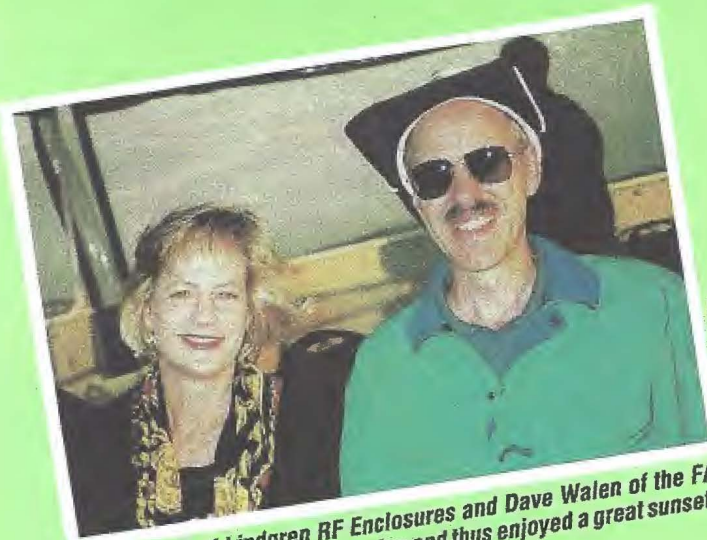


Photo by Len Carlson

Janet O'Neil of Lindgren RF Enclosures and Dave Walen of the FAA caught the last boat to Kiana Lodge and thus enjoyed a great sunset.



Photo by Janet O'Neil

AH Systems designed a t-shirt for the symposium that had the names of the exhibitors in the form of an "A" and an "H"! Showing off their creativity are Michael Cohen (L) and Travis Samuels.

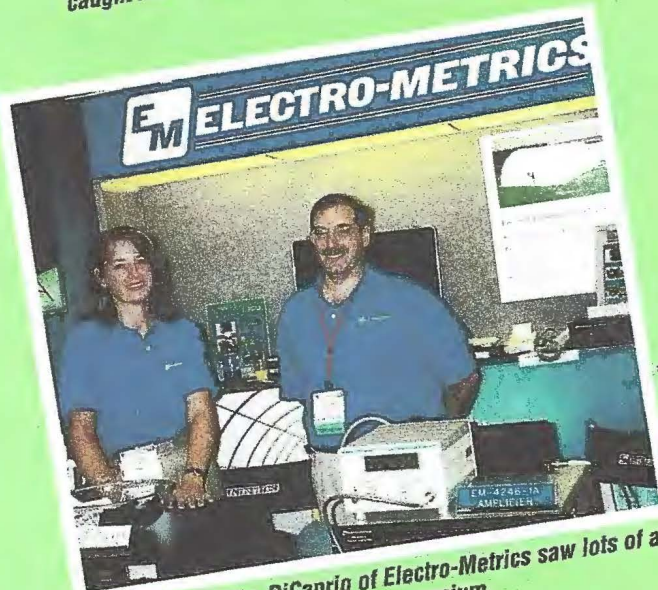


Photo by Janet O'Neil

Val Zabo and Mike DiCaprio of Electro-Metrics saw lots of activity in their booth during the symposium.



Photo by Janet O'Neil

CKC Labs was present in force at the symposium. That's Bonnie and Todd Robinson, Dennis Ward, and Christine Nicklas (L-R) having a good time in their booth. CKC Labs also hosted a reception at their new facility in Redmond, just east of Seattle, while in town.



Photo by Janet O'Neil

It's a line-up of EMC "gentlemen" at the Awards Luncheon. On hand to receive their respective awards were (L-R) Clayton Paul with Mercer University, Ken Javor with EMC Compliance and Mark Montrose with Montrose Compliance Services.



Photo by Dick Ford

EMC Society President Hoolihan is shown with Ed Bronaugh, Jan Schulz, and Rodolfo Araneo (L-R) following the Awards Luncheon. Ed Bronaugh presented the "President's Memorial Award" in honor of Richard B. Schulz who passed away in 1998. Rodolfo Araneo, of the University of Rome "La Sapienza", is the deserving student who won the award.



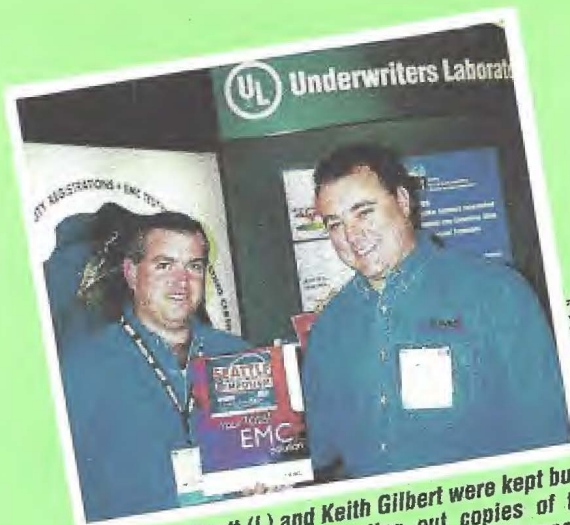


Photo by Janet O'Neil

UL's Corey Hyatt (L) and Keith Gilbert were kept busy during the symposium handing out copies of the CD-ROM containing four years of IEEE EMC Symposium records (96-99). UL completely financed the production and distribution of these CDs.

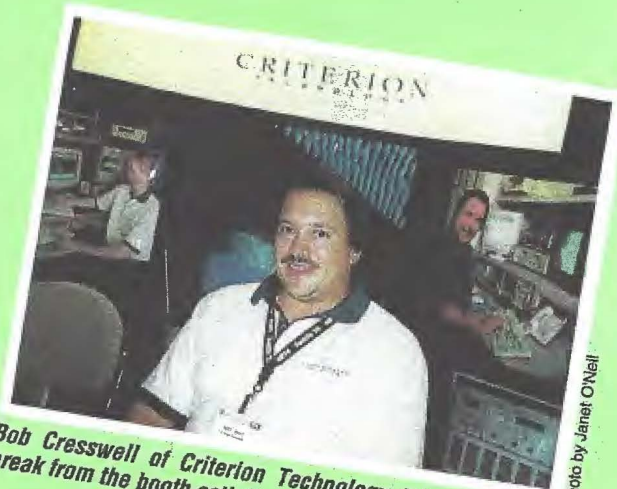


Photo by Janet O'Neil

Bob Cresswell of Criterion Technology takes a needed break from the booth activity.



Photo by Janet O'Neil

Virginia Fischer and Bruce Harlacher of Fischer Custom Communications enjoy some sweets and soft drinks during an afternoon break in their booth.



Photo by Janet O'Neil

Barbara and Bob Goldblum of R&B Enterprises join Ernie Magyar (R) of Magyar and Associates at the annual dB Society "Picnic" held during the Symposium week.

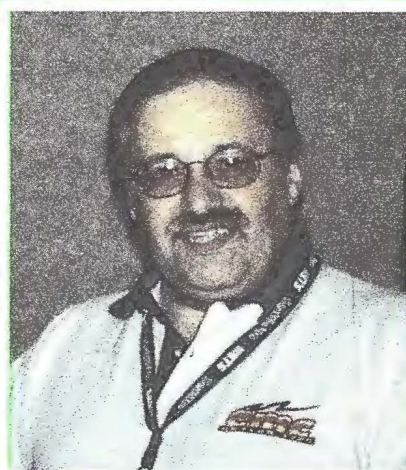


Photo by Dick Ford

Charles Grasso received an award at the Symposium for his contributions to the tutorials, experiments and workshops held during last year's EMC Symposium in Denver.

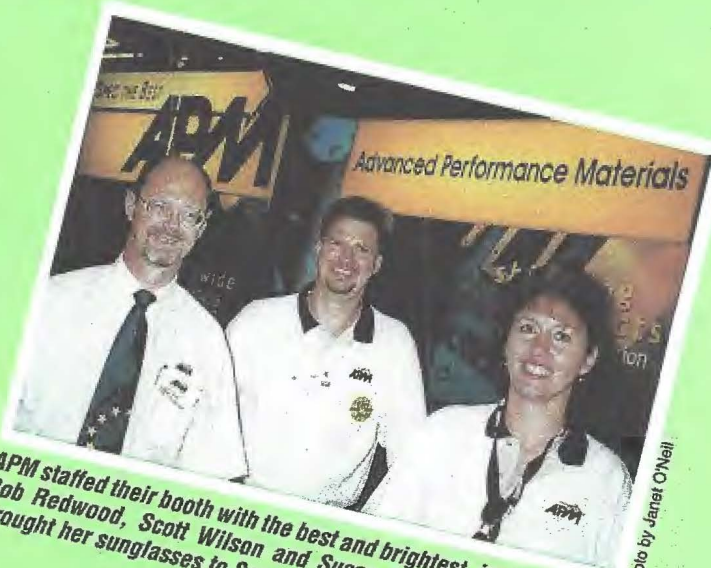


Photo by Janet O'Neil

APM staffed their booth with the best and brightest, including (L-R) Bob Redwood, Scott Wilson and Susan Savage. Susan wisely brought her sunglasses to Seattle in August!





Photo by Janet O'Neil

Michael Hill of EMC Automation (L) welcomes Ralph Parker of UL's Camas, Oregon facility to his booth during the Symposium.



Photo by Janet O'Neil

Mike Hatfield (L) and Mark Johnson of the Naval Surface Warfare Center in Dahlgren, Virginia join Emily Godfrey of the Center's Science and Engineering Apprenticeship Program to visit the exhibits. Emily's paper, which she wrote the week she turned 18, was a candidate for the Best Student Paper Award. She presented the paper the day following her 19th birthday!



Photo by Janet O'Neil

The Seattle skyline is seen in all its glory from one of the boats on its way to Kiana Lodge, the unique site of the Wednesday evening gala dinner.



Photo by Janet O'Neil

(L-R) Tanya Fisher, John Fisher II, Jennifer Fisher, and Bojan Silic represented Test Equipment Corp. from their booth at the Seattle Symposium.



Marianne and Bill Gjertson joined Fran Carlson (center front L-R) for the boat ride to Kiana Lodge. They are shown at Pier 55 on the Seattle waterfront, the departure point for the Lodge. Trying to hide behind the shades is Darryl Ray of Cisco Systems (center back) who enjoyed the famed August Seattle sunshine while on dock.



Marianne Gjertson, Companion Events Chair for the Seattle Symposium, enjoys the abundance of colorful flowers at historic Kiana Lodge. She enjoyed the quiet before the crowds arrived. Over 1,000 people attended the Wednesday evening salmon dinner at the Lodge.



**MAQSOOD MOHD**  
ASSOCIATE EDITOR

## IEEE EMC-Society Education and Student Activities Committee

**K**nowledge is power. And indeed education is the means to get the knowledge. To seek knowledge is a birth right of every human being – young and old alike. EMC professionals are included in this. It is never too late to learn and seek education. Education is a verb. Our goal is to become the premier education committee of the IEEE. This is *your* Committee. We are here to help you and support your education needs. We are striving to undertake unconventional and innovative means to achieve our goals. Help us help you better. Let me update you on activities of various subcommittees. We welcome your help and support that you may be able to provide to any of our subcommittees. Please feel free to contact any of the subcommittee Chairs.

### Seattle Symposium 1999:

The Seattle Symposium is now behind us and it was the best yet for educating and enriching the EMC professionals. The Seattle Symposium Committee deserves thanks and appreciation for the job well done. At this symposium, the Education and Student Activities Committee achieved great success in several areas. In the following paragraphs I have highlighted some of the events that took place that you may find of interest.

### Tutorials:

It was another landmark year for the Fundamentals Tutorials. Although the tutorials are primarily targeted for the entry-level engineers in the EMC field, quite a few seasoned engineers also enjoy brushing-up on concepts that they might not have used in a while. This year several noted experts from several organizations provided the tutorial material to help better understand EMC concepts and to better design systems from an EMC point of view. One highlight of the session was Dr. Howard Johnson bridging the gap between the EMC and the signal integrity worlds.

If attendance is any measure of success and popularity, the Fundamental Tutorials were very successful. Throughout the day on an average there was an impressive attendance of about 400 participants. Thanks to

all the speakers and the attendees who made the Fundamentals Tutorials a great success. The tutorial subcommittee is busy planning for another exciting and informative session during the Washington DC Symposium in August 2000. If you would like to propose a topic or a speaker for the Washington DC Symposium, email your comments and ideas to [mohd@eglin.af.mil](mailto:mohd@eglin.af.mil).

### Demonstrations:

This is probably the most popular and “educational” activity we do as a committee. A variety of EMC concepts are demonstrated experimentally during the symposium to educate the symposium attendees. For three main days of the symposium more than 32 experts demonstrated 29 EMC concepts that sometimes might be classified as abstract or black magic. Many a happy soul was pleased to learn these concepts during these demonstrations. Their doubts changed into convincing beliefs.

There were at least three noteworthy highlights during this year. We had presenters from around the world, a demonstration of corrosion that promotes EMI problems, and a demonstration of EM modeling and simulation examples. Our thanks go to Andy Drozd and Larry Cohen for putting together a fine demonstration program. Our thanks are also due to very supportive vendors like HP, Tektronix, Fluke, Phillips, EMCO, and Amplifier Research, among others who donate their equipment during the symposium for this “educational” cause. If you would like to demonstrate an experiment or demonstrate an EMC concept at the next symposium in Washington D.C., please contact Andy at [andro1@aol.com](mailto:andro1@aol.com).

For detailed information on the demonstrations, please refer to the article by Andy Drozd on page 26.

### NARTE Activities:

As during the past several years, Dr. James Whalen conducted the workshop for engineers and technicians who are preparing to take the National Association of Radio and Telecommunications Engineers (NARTE) examination to certify as EMC engineers and



technicians. This year David Case assisted Dr. Whalen. David Case is co-chair of the NARTE subcommittee.

At the NARTE examination on Friday, 38 engineers and technicians sat for the exams. The word from NARTE is that 65% of the participants passed the exams. Our congratulations to all the successful applicants, and welcome to the ranks of certified NARTE professionals. Our thanks to Dr. James Whalen for championing the cause of "preparing for the NARTE exams," and his able co-host, David Case.

#### **University Grant:**

John Howard heads the university grant committee. This year his committee has been successful in finding a winner for this grant. John says that his committee's workload has increased multifold. This year we had responses from around the world requesting the grant money. The grant is provided to an institution that is on the verge of offering an EMC course. The grant money is used as seed money to start an EMC course as an established part of the curriculum in the Electrical Engineering department. The grant is open to all universities in the world. For more details contact John Howard at [jhoward@supal.org](mailto:jhoward@supal.org). This year's winning school is the University of Michigan at Dearborn.

#### **University Survey:**

Professor Antonio Orlandi is the Chair of this subcommittee. The mission of the university survey committee is to survey the universities and collect data about the EMC course offering, student population, modeling and simulation usage, etc. The data collected will help EMC-S and its members in various ways. Information will be useful for prospective students, industry, and employers. If you have not already done so, please, complete an online survey by going to the website <http://dau.ing.univaq.it/art>. If you know of a school or a college that has not participated in the survey, please encourage them to complete an online survey.

#### **Student Design Contest:**

Dr. William Croisant of TC-7 proposed a joint venture between the Education Committee and TC-7 in the form of a student design contest. The contest is to design an EMC solution as part of the design of a circuit. The details are being worked out. The subcommittee chair is Ahmad Fallah, an able graduate student of a very able professor, Bob Nelson of North Dakota State University. If you have an interest in fame and glory, then contact Bill at [w-croisant@cecer.army.mil](mailto:w-croisant@cecer.army.mil) or Ahmad at [afallah@pheointl.com](mailto:afallah@pheointl.com). This is an exciting area to be in. This effort has the potential of becoming the hallmark of how different technical committees, the industry, and academia can work together.

#### **Experiments Manual On-line:**

Dr. Jim Drewniak is heading up this effort. The Experiments Manual published by the Education and Student Activities is on the web site at: <http://emclab2.ee.umn.edu/files/EMCman./pdf>. If you have an Adobe Acrobat Reader,

you can download the entire manual from this site. If you don't have the Adobe Acrobat Reader, it can easily be downloaded from the site: [www.adobe.com](http://www.adobe.com).

Jim is looking for a volunteer who can do the follow-up work of soliciting and arranging the new experiments. If you are interested in broadening your career horizons, contact Jim or any other officer of the Education and Student Activities Committee.

#### **Continuing Education Products:**

Andy Drozd is the Chair of this subcommittee. This committee is an adjunct to the life-long learning committee. This committee is examining the development of products such as Introduction to Antennae, and Introduction to EMC.

#### **Student Activities:**

Mike Bogusz is the Chair of this subcommittee. The mission of this committee is to reach out and touch some students (in fact, all students). Primarily, the focus is on working with student chapters in four areas: The Awareness of EMC, Student Paper Contest, The President's Memorial Award, and the Design Contest.

#### **Video/CD-ROM Based Educational Material Production:**

The task of this committee is to produce educational material in appropriate and useful medium to the EMC-S membership. Dick Ford is the Chair of this committee. He will welcome any help you can provide him in this task. What we do in this committee will have a far-reaching impact in the 21st century.

#### **Education and Student Activities Officers:**

Some changes have occurred during the Seattle Symposium. Contact any one of the following to become a part of the ongoing innovation in EMC engineering through education.

Student Activities	Mike Bogusz, <a href="mailto:m.bogusz@ieee.org">m.bogusz@ieee.org</a>
NARTE BOD Liaison	David Case, <a href="mailto:dcase@texlon.com">dcase@texlon.com</a>
Experiments Manual II	Jim Drewniak, <a href="mailto:drewniak@ece.umn.edu">drewniak@ece.umn.edu</a>
Vice Chair & CEPC	Andy Drozd, <a href="mailto:andro1@aol.com">andro1@aol.com</a>
Demonstrations	Andy Drozd & Larry Cohen, <a href="mailto:cohen@radar.nrl.navy.mil">cohen@radar.nrl.navy.mil</a>
Student Design Contest	Ahmad Fallah, <a href="mailto:afallah@pheointl.com">afallah@pheointl.com</a>
Video Productions	Dick Ford, <a href="mailto:dford@radar.nrl.navy.mil">dford@radar.nrl.navy.mil</a>
University Grant	John Howard, <a href="mailto:jhoward@emcguru.com">jhoward@emcguru.com</a>
Tutorials	Maqsood Mohd, <a href="mailto:mohd@eglin.af.mil">mohd@eglin.af.mil</a>
University Survey	Antonio Orlandi, <a href="mailto:orlandi@electtrica.ing.uniroma1.it">orlandi@electtrica.ing.uniroma1.it</a>



NARTE

Life Long Learning

Jim Whalen & David Case,  
*jjw4@ece.umn.edu*  
Maqsood Mohd,  
*mohd@eglin.af.mil*

I would like to express my personal thanks and appreciation for each of these officers who tirelessly work throughout the year to bring the very best in EMC education mate-

rials, workshops, demonstrations, and tutorials to every symposium and to all the members of the EMC profession. When you email them, contact them, or see them during a symposium, please express your appreciation for their volunteering valuable time for the EMC-S and the Education and Student Activities Committee.

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## 1999 EMC Symposium Experiment Demonstrations: Seattle and Beyond!

### A Forum Sponsored by the EMC-S Education Committee

*By Andy Drozd*

**T**he 6th Floor Lobby of downtown Seattle's Washington State Convention and Trade Center was the place to be on August 3-5, 1999 to experience the highly popular EMC Symposium Experiment Demonstrations. The experiments have been an integral part of the international EMC symposia for nearly the past eight years and this year in Seattle, the three-day special session peaked more interest and curiosity than ever. Attendance was never better. Taking a head count would be virtually impossible. It is safe to say that the vast majority of the approximately 2,500 symposium registrants visited the experiment stations at least once during the three days of experiment demonstrations. You get the picture!

What sparked a lot of interest this year was an increase in the number of experiments, a more diverse mix of topics that included a computer modeling and simulation demonstration, the addition of several new demonstrations and presenters, and of course, the spacious 6th floor venue. Our sincere thanks and appreciation goes to the 1999 Seattle Symposium Steering Committee for securing such an excellent spot for the experiments, and for assisting us during the setup and presentations. In particular, I would like to acknowledge Diane Heidlebaugh and Grant Erickson of the Boeing Company, and Dave Walen of the FAA in Seattle for their tireless efforts on our behalf. The location of the experiments session is key to its overall quality and success. Our goal since the inception of the session back in 1992 has been to maintain an interactive forum which complements the traditional symposium technical and exhibition format, promotes technical dialogs, encourages information exchanges, spurs creativity for the advancement of EMC, and provides a unique educational experience for the novice or veteran EMC technologist. The planning and coordination by the Seattle Symposium crew helped us to meet this goal.

We are extremely grateful to the many other supporters behind the scenes, in particular, those individuals who loaned state-of-the-art test equipment for the experiments. These included all of the oscilloscopes, spectrum and net-

work analyzers, signal and function generators, meters and probes, etc. that many of you saw set up at the experiment stations. I would like to specifically thank the following individuals and organizations for their help in getting us the equipment this year and for their on-site support during the demonstrations (I should add that many of these were the same individuals who assisted us with a similar pilot experiments session held this past May in conjunction with EMC Japan 1999 in Tokyo):

#### **Tektronix Inc., Rohde & Schwarz, and Advantest**

Mark Klein of the Albany, NY Measurement Business Division

Cliff Morgan, Henry Benitez, and Peggy Rogers of the Beaverton, OR Division

Kevin Sousa of the Boston, MA Measurement Business Division

#### **Hewlett-Packard Company**

Maribell Thomas and Dave Lee of the TMO Consignment Hub, Rockaway, NJ Business Support Division

Jim Carney of the Buffalo, NY Business Support Office

Jan Brown, Dennis Handlon, Jan Bradshaw and Dawn Gernhardt of the Santa Rosa, CA Division

Ken Wyatt, Soni Mayberry, and Ray Hanson of the Colorado Springs, CO Division

#### **Fluke Corporation**

Irene Geyer and Hilton Hammond of the Everett, WA Division

Ben Bartholomew of the Colorado Springs, CO Division

#### **EMC Test Systems (ETS)**

Glen Watkins of the Austin, TX Division

#### **Amplifier Research**

Dick Rogers, Souderton, PA

The test equipment provided by these companies once again played a major role in assuring the success of the experiments. We gained an appreciation for the capabilities of



*Jim Muccioli of X2Y Attenuators (formerly he was with DaimlerChrysler) was on hand to conduct a few experiments during the popular session held Tuesday through Thursday of the Symposium week.*

their equipment and witnessed how these are used to perform EMC measurements. As always, I encourage you to contact these individuals and organizations, among others, for guidance in the selection and application of EMC test equipment. As I've said before, these people are true professionals who know their hardware and who are willing to work with you. The EMC Society hopes to more formally acknowledge the help and support that these individuals and their companies have provided over the past several years on behalf of the experiments session.

Now, on to the experiments. Up to five demonstrations were conducted continuously during each morning and afternoon period. The lineup this year included 29 experiment demonstrations and 32 presenters. This was the most extensive agenda to date. The experiments are partially based on those documented in the EMC Society Education Committee's "EMC Experiments and Demonstrations Manual", Volume 1 originally compiled and reviewed by Clayton Paul and Henry Ott (download the PDF document from the ftp site address ). Volume 2 of the manual is still in progress. Below is a brief synopsis of the experiments (for brevity's sake, I have listed each experiment below and describe only a few and their findings in short detail).

The experiment titled "Applications of a New Common-Mode Voltage Probe for Predicting EMI from Unshielded Differential-Pair Cables" by Neven Pischl of Cisco Systems (presenting work completed while employed at

Nortel Networks, Inc.), and Mary Wilson and Mark Villegas of Nortel Networks, Inc., EBG/WGP EDSO/EMC Dept., Santa Clara, CA showed a new probe for the measurement of common-mode (CM) voltage on connectors utilizing differential pairs (e.g. RJ45, RJ11 etc.). A concept of CM voltage measurement at a connector instead of CM current measurement on cables was demonstrated. The probe terminates the differential pairs with the proper differential impedance, terminates the differential pairs in a connector with CM impedance of 100 ohms with respect to chassis, and enables data traffic throughput. The main advantage with the new approach versus current probes is that there is no cable-maximization involved, hence the measurements are more reproducible and take less time. The probe's response is linear up to at least 1 GHz, because it is resistive, and there are no frequency-sensitive elements used. The technique is less sensitive to ambient noise than techniques involving current probes. The probe's main applications include EMI troubleshooting, prediction of EMI, and component evaluation for EMI.

In the experiment "Minimizing the Effect of ESD on a Timing Circuit — Evaluation of Protection Devices and Topologies", Ahmad M. Fallah of NCE Phoenix International®, Fargo, ND and Robert Nelson of North Dakota State University, Fargo, ND demonstrated the effectiveness of ESD suppression devices in a timing circuit. A standard timing circuit, based on a C555 timer chip, was employed for this experiment. Several "fixes" were incorporated and added onto the circuit, and their effectiveness on minimizing the effect of the ESD on the timer were observed and demonstrated. The method of evaluation (of the effectiveness of the suppression techniques) involved examining the output of the timer for the peak-to-peak level of disturbance and the recovery time compared to the case where no mitigation techniques were implemented. The fact that a large ceramic chip capacitor provided an excellent level of protection received a fair amount of attention from the attendees.

Roy Ediss of Philips Semiconductors, Southampton, UK applied Doug Smith's "Noise Measurement by Induction" experiment to his demonstration "Analyzing Current Paths and Effects on Circuits". Using the probing method on various circuit layouts enabled relative direction, level and the route of signal and return currents to be visualized. With a microstrip structure, the position of minimal induced probe voltage and the associated flux profile warranted consideration. The audience comments ranged from concerns about probe trickery, to "I would like to try that myself", together with some suggestions for enhancement.

The experiment "Clock Separation and SSCG as a Method of EMI Reduction" by Donald R. Bush of dBi Corporation in Winchester, KY showed that by slightly varying clock frequencies, one can reduce emissions from a product by 6 or more dB. If the clocks are varied by an amount that exceeds the receiver bandwidth of the measurement instrument, this will usually be the case. This was an encore of last year's highly popular experiment demonstrated in Denver.

"Transient Suppression" by J. L. Norman Violette of Violette Engineering Corporation, McLean, VA and Mike Violette of Washington Laboratories, Gaithersburg, MD reviewed surge phenomena and demonstrated transient protection techniques. Lightning and AC power load anomalies create destructive surge energies that can harm equipment, if not properly protected. Several examples of surge coupling and prediction were presented, along with a live demonstration of the effects of surge energies on typical components. Protection techniques were demonstrated that included MOVs, filters, and hybrid suppressor arrangements. This was a variation of an experiment demonstrated last year in Denver by the presenters.

In another encore demonstration titled "Crosstalk Between Parallel Current Loops and Shielding Mechanisms in Multi-Conductor Transmission Lines", Hans Regtop of Philips Research Laboratories in Eindhoven, Netherlands demonstrated an original experiment originally devised by Jasper Goedbloed and Pierre Beeckman. This experiment demonstrated that crosstalk between parallel current loops is a consequence of both the electric and magnetic field coupling between these loops. The experiment also demonstrated that: the load conditions in the loops determine the electric and magnetic field contributions to the crosstalk; near-end crosstalk effects, i.e. only crosstalk at the end near to the generator occurs when the loops are terminated in their characteristic impedance; the amount of crosstalk depends on the distance between the parallel loops, and may be reduced by an intermediate loop; unwanted resonance effects may occur when the electrical length of the intermediate loop is a fraction of the wavelength of the applied signal; and that grounding of a screen (shield) at only one end may lead to an increase in crosstalk.

In "Practical Applications of Ferrites for EMI Control", Jack Meyer of Anteon Corporation in Fairfax, VA showed a simple method of measuring EMI voltages and currents inside an equipment under test (EUT). Also shown were the advantages and potential problems of using ferrites to reduce conducted EMI problems. In one part of the demonstration two physically identical, but electrically different ferrites were placed between the source and the EUT to show the difference in reduction of EMI current and voltage inside the EUT, resulting from the frequency responses of the two different types of ferrite materials. In the second part of the demonstration, a ferrite was placed between the EUT and the point where the cable was grounded. To the surprise of many, the current inside the EUT decreased just as before, but the voltage increased. The reason for this is that the increased impedance to ground caused more voltage to drop across the ferrite. If one puts a ferrite on a cable and the EMI at the EUT worsens, then it probably means that the ferrite was placed on the ground side of the EUT, rather than on the source side, and that the EMI problem inside the EUT is caused by high impedance or voltage coupling rather than by magnetic field or current coupling.

James Whalen of the State University of New York at Buffalo demonstrated the experiment "How Parasitic Effects in Inductors and Capacitors Affect Electrical Equipment". This was a follow on to his experiment which he conducted last year in Denver titled "Demonstrating Parasitics in Passive Components in a Line Impedance Stabilization Network (LISN)".

In the experiment "Transmission-Line Effects in PCB Design", James Drewniak of the Electromagnetic Compatibility Laboratory, University of Missouri-Rolla, MO showed how certain transmission-line effects such as reflection from resistive and reactive (R LC) loads can be measured. Reflection characteristics and time constants were demonstrated for parallel and series, RC and RL combinations. Parasitic effects were also discussed, and approaches for constructing equivalent circuit models for a physical geometry were suggested. The parasitic parameter values were then measured with a time-domain reflectometer (TDR). These ideas were then demonstrated on a simple test PCB. Reflection and voltage calculations were illustrated for resistive loads. Reflection and charging effects for capacitive loads were also shown. Lumped versus transmission-line theory was discussed as well. Reflections from discontinuities such as a step change in impedance, signal line fan out, and ninety degree corners versus mitered corners was also demonstrated. The design implications were discussed in light of the severity of each case.

In "The Effect on Pulse Rise/Fall Time on Signal Spectra" (an experiment directly based on the EMC Experiments and Demonstrations Manual), Clayton R. Paul of Mercer University's School of Engineering in Macon, GA showed the effect that changes in risetime can have on a signal's spectral content. In the demonstration, a 4 MHz DIP oscillator is powered by a 5 volt source producing a 4 MHz trapezoidal pulse train. The rise/fall times were displayed on an oscilloscope and then the output was displayed on a spectrum analyzer. Next, various capacitors were placed across the output. This slowed the rise/fall times which were again viewed first on the oscilloscope and then the spectrum analyzer. This showed how slowing (increasing) the pulse rise/fall time can reduce the high-frequency spectral content of the waveform. It also showed the effect of lead length of the capacitors.

In a similar experiment titled "Non-Ideal Behavior of Circuit Elements and the Effect on Signal Spectra", Elya B. Joffe of KTM Project Engineering, Ltd., Kfar Sava, Israel showed a very similar demonstration as Clayton's, but with a slightly different viewpoint which emphasized the effect of capacitor lead lengths as a function of frequency.

Mark Montrose of Montrose Compliances Services, Inc., Santa Clara, CA demonstrated the "Effects of Logic Devices and Their Spectral Emissions Profile" and "Effectiveness of Image Planes and Distance Spacing To Signal Traces on PCBs". The former illustrated the effects that are observed from digital components and their edge rate switching speeds. As a component becomes faster in edge rate transitions, a greater spectral



distribution of RF energy is developed. An interesting aspect of this experiment illustrates that although a digital component may be identified as a particular logic family with a slow edge rate, in reality the device may be an extremely high speed device, silicon wise. The latter demonstration showed how the use of image planes provides a return path for RF current. The effectiveness of the image plane is examined based on whether the plane is physically adjacent to a source trace, or located a distance away, typical of two-layer assemblies. The closer the distance spacing between plane and trace, the more enhanced is the cancellation of the magnetic flux lines that surround the transmission. The advantage of using the test PCB for both experiments is that a wide variety of test configurations is possible. Attendees found this to be a valuable presentation, along with numerous technical discussion on many aspects of PCB design and layout for EMC compliance.

The demonstration "EMC Aspects of Spread Spectrum Communications" by Art Light of ITT Industries, Alexandria, VA showed the forms of spread spectrum transmissions and their effects in the electromagnetic environment on communications processes. The demonstration also showed the apparent reduction of peak power by spreading the energy across a much larger frequency band for direct sequence spread spectrum and for frequency hopping spread spectrum signals.

The above provides some of the flavor of this year's agenda. However, there were many more topics covered by a number of well-known presenters who are avidly involved in EMC engineering. This year's other presenters and topics included:

"Using Magnetic Field Probes to Measure Signals and Noise" by Douglas C. Smith of Auspex Systems, Santa Clara, CA

"Demonstration of Modeling and Simulation of Simple Problems in Electromagnetics" by Maqsood Mohd of Sverdrup Technology, Eglin AFB, FL

"Electromagnetic Fields Caused by ESD Events" by Vladimir Kraz of Credence Technologies, Inc., Santa Cruz, CA

"Penetration of Radiated EM Fields Through Shielded Barrier Material" by George Kunkel of Spira Manufacturing Company, North Hollywood, CA

"Electric-Field Shielding" by Tom Van Doren of the Electromagnetic Compatibility Laboratory, University of Missouri-Rolla, MO

"Demonstration of Fundamental On-Broadband Absorbers" by Ferdy Mayer of LEAD, France, José Perini, Professor Emeritus of Syracuse University, Syracuse, NY, and Tom Ellam of Fair-Rite Products Corporation, Wallkill, NY

"Radiated Emissions Due to the Finite Partial Inductance of PCB Ground Planes" by Frank B. J. Leferink of Hollandse Signaalapparaten B.V., Environmental Test Laboratory, Hengelo, Netherlands and the University of Twente, Department of Electrical Engineering, Enschede, Netherlands

"Common-Mode Noise Measurements on a Motor in a Paint Can" and "RF Measurements on an Integrated Circuit Using a TEM Cell" by James Muccioli of DaimlerChrysler, Auburn Hills, MI

"Choosing Metals for Seams and Interconnections Using: Galvanic Corrosion Series, Electrochemical Impedance Spectroscopy and High Frequency Resistance" by Richard Haynes of Richard Haynes Consultants, Princeton, NJ and Mary Betts of Solartron, Inc., Antioch, CA

"Shield Terminations, Radiated Emissions, Common-Mode Current and Pigtailed", "Clock Frequencies, Duty Cycle, and Low-Pass Filtering", and "Ground Traces and Crosstalk" by Lee Hill of Silent Solutions, Hollis, NH and Randal Vaughn of Motorola, Arlington, IL

"Realistic and Un-Realistic Filter Measurement Techniques" by Kermit O. Phipps, EPRI-PEAC and Rafik Stepanian of LCR Electronics, Knoxville, TN (this one is expected to have a significant impact on EMC standards development in the near future!).

We also had a most interesting demonstration by Fred Heather of the Naval Air Warfare Center's Aircraft Division, Patuxent River, MD which involved a lightning attachment simulator for a scaled aircraft model. I reference his paper on the subject in the 1999 Symposium Proceedings (Vol. 2, p. 640) for a detailed description of the simulation method which is quite fascinating.

Our thanks and appreciation also goes out to each of the presenters for a job extremely well done! I also wish to thank my Co-Chair Larry Cohen for his hard work and assistance in the planning and conduct of the experiments session. Last, but not least, I want to acknowledge Cliff Carroll and Jason Miller of ANDRO Consulting Services for their help in delivering, setting up, and dismantling the test equipment stations.

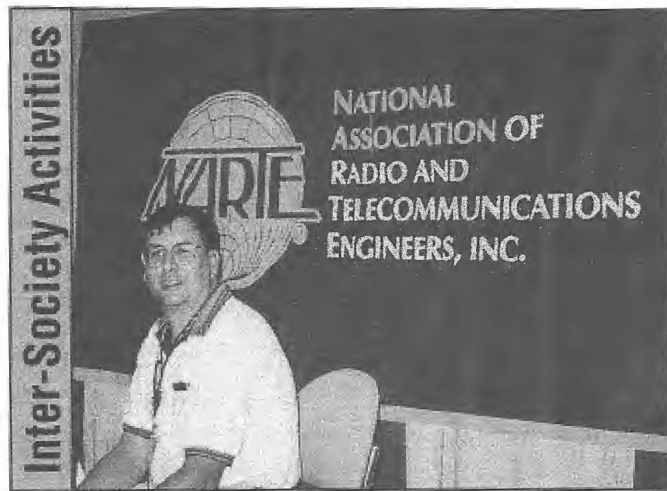
We have already begun planning next year's experiments session and have a partial list of demonstrations identified. Perhaps for the 2001 symposium we will institute a formal "Call for Experiments" and set up a separate technical evaluation committee that will be responsible for selecting the experiments each year. I'll keep you posted on the progress of this and other news concerning the future of the experiment demonstrations. If you have ideas for an experiment and want to have it considered, please contact me at (315) 334-1163 or 337-4396, andro1@aol.com to discuss your ideas. Also, periodically visit the official Washington, DC 2000 IEEE International Symposium on EMC web site to find out more about the upcoming conference and session agendas. The site will also provide a list of experiment topics being considered. We look forward to your comments and suggestions!

See you in Washington, DC!!



**ANDY DROZD**

*Andy Drozd of Andro Consulting Services may be reached at andro1@aol.com.*



Associate Editor for Inter-Society Activities Dave Case, NCE, mans the NARTE booth during the Seattle Symposium.

## Representative Advisory Committee (RAC) Report

David A. Case, NCE, RAC Chairman

It seems ages ago that this year's EMC symposium ended but in reality it was just a few weeks ago. At one of the committee meetings, I understood that someone suggested adding

another day to the week to allow time to attend all committee meetings and avoid conflict. We decided that until we have an additional seven new committees, adding an extra day to the week (most likely between Tuesday and Wednesday) was impractical.

This year the Representative Advisory Committee was involved in hosting a special session on Type Approval and EMC Requirements for Wireless Devices. There were four speakers in this session, each dealing with various aspects of wireless devices.

Issues that were covered included FCC and Industry Canada test requirements for spread spectrum and PCS devices which was presented by Bill Graff of M. Flom Associates. Steve Dillingham of RFI Labs located in the UK presented an overview of the implementation of the proposed European Radio and Telecommunication Terminal Equipment (R&TTE) directive. Art Wall of the FCC presented requirements for Telecom Certification Bodies (TCBs) accreditation. Yours truly spoke on Asia Pacific Requirements for Spread Spectrum Devices.

Incidentally, since this invited RAC session was geared towards wireless devices, Murphy (Patron Saint of RFI) paid a visit and gave a real world demonstration of wireless interference issues even though we did not have any lab experiments scheduled for this session. As the program started, my voice was not being transmitted in the room. However, two other voices of the neighboring technical sessions came booming in across the PA system. We could not have had a better lab demonstration showing the interference of wireless devices if we had tried!

The overall session was well attended and RAC hopes to be able to present some-

thing similar at next year's EMC Symposium as well as at other symposia geared toward Wireless Devices.

On Monday August 2<sup>nd</sup>, RAC also held a joint luncheon with the Standards Advisory Committee, chaired by Bob Hofmann. The joint meeting helped establish the groundwork for relaying information between both groups.

As with previous years, NARTE held both a pre-exam workshop as well as offered the actual exam at the symposium. Unfortunately, this year the passing curve was slightly below average. We did have one member who had grandfathered in years ago take the exam along with several of his employees. We're pleased to advise he passed the exam!

The various groups that make up the membership of RAC have also been busy. Following are some interesting reports from a few of these groups.

### COMMITTEE ON MAN AND RADIATION (COMAR) - EMC Society Representative: Dan Hoolihan

COMAR has a Web Page where you can check membership of the committee and status of their activities. See

<http://homepage.seas.upenn.edu/~kfoster/members.htm> (members)

<http://homepage.seas.upenn.edu/~kfoster/comar.htm> (homepage)

A COMAR meeting was held on June 19, 1999 in Long Beach, California. A number of subcommittees reported on the status of their activities. A Technical Information Statement on 60 Hz power line frequency issues was approved for publication by the Executive Committee of the IEEE's Engineering in Medicine and Biology Society as of July 10, 1999. Two new DRAFT Technical Information Statements have been developed; one on base stations and one on handsets. Dan Hoolihan sent COMAR information on the latest IEC proposal to add a new subcommittee under TC77 to look at "Assessment of Human Exposure to EMF." Also, additional information was sent on the European Council recommendation of 12 July 1999 on "The limitation of the general



public to electromagnetic fields (0 Hz to 300 GHz)." The next COMAR meeting is scheduled for October 16, 1999.

#### EMC LAB ACCREDITATION WORKING GROUP (ELAWG) - EMC Society Representative: Bob Hots

The last meeting of the EMC Laboratory Accreditation Working Group was held on July 27, 1999 in Washington, DC. It was reported that the EU had formally confirmed the list of proposed US EMC Conformity Assessment Bodies (CABs) and the CABs for transmitters and telecom. This information is available on the NIST web site located at <http://ts.nist.gov/gsp/http>.

At the last APEC meeting in Singapore it was reported that there are presently (8) APEC economies that are ready to move to forward with the APEC Mutual Recognition Agreement. Phase I refers to the mutual acceptance of test data and Phase II refers to mutual acceptance of product certification. The economies indicating that they are ready to proceed are: Australia, Chinese Taipei, Singapore, Korea, Japan, Canada, Hong Kong and the U.S.

Mr. Gladhill stated that NIST sent a list of (79) labs to the BSMI (Taiwan) and they in return had sent NIST a list of (23) labs. A2LA, NVLAP or BSMI may accredit these labs.

Richard Reitz is leading a group that is working on a document titled: "Technical Criteria for the Accreditation of Electromagnetic Compatibility (EMC) Testing Laboratories." This document is intended to be used as a guide by accreditation bodies.

Mr. Unger discussed the pilot Automotive EMC Laboratory Accreditation Program (AEMCLAP). Presently three labs have completed their assessments and there are two remaining labs to yet complete theirs. Once the results have been reviewed, tweaked and accepted by the Big Three automakers, the program will be open to other laboratories that may wish to become accredited. It is expected that this might take place as early as September, but more likely it would be in December 1999. The automotive standard under review can be downloaded from the ACIL web site (<http://www.acil.org>).

The next ELAWG meeting is scheduled for November 2, 1999.

#### NATIONAL ASSOCIATION OF RADIO AND TELECOMMUNICATIONS ENGINEERS (NARTE) - EMC Society Representative: Dave Case

NARTE presented a "Preparing for the NARTE Exam" as part of the Monday Workshop Sessions held during the EMC Symposium. There were about 75 plus attendees for this session. The NARTE exam was given on the Friday session with 38 people taking the test. The overall pass percentage this year was 67%; however, the last 5 years the average has remained above 75% total.

Currently under the new NARTE Lab Grade EMC program, we have some 100 people who are either certified or who have received endorsements. Official kick off of this program was August 1, 1999.

NARTE hopes to be able to offer a certification for those installing unlicensed wireless systems beginning early next year.

The next Board of Directors meeting will be held on October 9, 1999.

Contact NARTE via the web at [www.narte.org](http://www.narte.org).

#### UNITED STATES COUNCIL OF EMC LABS (USCEL) - EMC Society Representative: Dave Case

USCEL held its annual membership meeting on August 2nd at the IEEE EMC Symposium.

To date USCEL has completed a total of 19 technical opinions available to members at no charge or \$10 each to non-members.

Mr. Sweeney and Mr. Gubisch reviewed the status of the pending Round Robin Testing Program within USCEL. The test artifact is due back from calibration on August 15, 1999. The testing will begin in September and will include (20) laboratories.

Their next meeting is scheduled for early February 2000. For additional information, contact ACIL at phone 202-887-5872 or e-mail [acil@ix.netcom.com](mailto:acil@ix.netcom.com).

## EMCS Standards Committee Reorganizes

by Hugh Denny, SETCom Chairman

As part of the reorganization of the EMCS Standards Committee, the Standards Education/Training Committee (SETCom) was formed. This new committee was established to provide more formal training opportunities for working groups involved in the development of IEEE EMC standards. Traditionally, working groups "learned by doing" and via informal exchanges between the EMC Standards Committee and with previous working groups. This occasionally resulted

in unnecessary delays and often caused much extra work for the working groups and the chair, in particular.

The purpose of the SETCom is to "develop working group processes to assure that EMC standards are prepared in accordance with IEEE policies and procedures." The goals of the committee are to (1) prepare and conduct seminars for Working Groups on the development, coordination, balloting, and support of IEEE

*continued on page 33*



**DR. WILLIAM G. DUFF**  
ASSOCIATE EDITOR

## Introducing Professor Takeo Yoshino

- Submitted courtesy of Mark Montrose

**O**ur personality profile travels to Japan, to present the fascinating life and career of Professor Takeo Yoshino. Professor Yoshino is a descendent of a local feudal lord of 1250 AD, whose land contains the ruins of a castle, along with a town which carries his family name in the Nara prefecture of Japan. His great-grandfather was the last feudal lord of scholarship of Tokugawa Shogunate, while his grandfather was the vice speaker of the first House of Representatives of Japan. His wife is a professor of literature at Sanno University. His son holds a Ph.D. in geology and a daughter (Master's degree in electrical engineering) is involved in the development of low-noise microwave and optics circuits at NEC.

Professor Takeo Yoshino received his B.E degree in 1953 from the University of Electro-Communications (U.E.C.), Tokyo, Japan, and joined the Department of Electronic Engineering upon graduation. In 1973, he became department head for graduate students. He retired from UEC in 1995 to teach at the graduate school Fukui University of Technology. In 1970, he worked concurrently as the Director of the Sugadaira Space Radio Observatory which is owned by U.E.C. He has performed research at the Institute of Space and Aeronautic Science (ISAS), National Institute of Polar Research (NIPR) and the Nobeyama Radio Observatory of the National Astronomical Agency.

From 1958 to 1960, he worked at the Syowa Station in Antarctica during the winter as a member of the third Japanese Antarctic Research Expedition. From 1975 to 1977, he was at Syowa Station again, this time as the leader of the 17th Expedition. In Antarctica, his main field of work involved the analysis and investigation of the auroral phenomena related to the natural VLF radio wave emissions observed by people, rockets and satellites.

His research interests include:

1. The investigation on both the emission mechanisms of electrostatic ion-cyclotron waves related to VLF aurora hiss by satellite observations.
2. Observation and study of earthquakes and volcano eruptions by means of seismographic emissions.



*Mr. and Mrs. Takeo Yoshino are shown during the reception held in May to celebrate EMC '99 Tokyo.*

3. The phenomena and bio-effects of radio emission phenomena related to VDT and electromagnetic fields.

4. The observation and development of burst VLBI system in the millimeter band associated with radio astronomy.

Professor Yoshino received the IEEE-Antenna and Propagation's Best Paper Award in 1967, and the Distinguished Service Award at the 1992 EMC Symposium in Wroclaw, Poland. Professor Yoshino is a member of IEIEC, SGEPSS and ASJ (Japan), IEEE and AGU (USA), URSI, IAGA and COSPAR, and is an advisory board member of the Zurich EMC Symposium, Wroclaw EMC Symposium, and Lowell Observatory. He is currently a member of IEEE-EMC Society Board of Directors. From 1990 to 1994, he was chairman of the IEEE EMC-S Tokyo Chapter.

His favorite hobby and pastime is amateur radio. He received his license for the beginner class two months before Pearl Harbor. He could not receive his call sign until after World War II. He was fortunate to receive a National NC-200 receiver one-month before the arrival of the last commercial ship from the U.S.A., prior to the war. The receiver is still operational. After the war, in 1958, he became active as JA1XF, where he continues to frequent the airwaves. His interest in amateur radio has been extended to the collection of both old and new equipment, representing models used from every decade until now.

Currently, Professor Yoshino owns 47 amateur radios produced between 1931 to today. The oldest is a National SW-3 regenerative 1-V-1 receiver built in 1932. He also



owns one of the first super-heterodyne receiver produced National FB-7 in 1933. This radio was made only one year after the super heterodyne circuit was developed by Armstrong in 1932. He personally restored all of the equipment in his collection to its original condition.

The most activity related to amateur radio was from the Antarctic during expeditions in 1959 and 1976 with the call of 8J1RL. His "radio shack", part of his traditional Japanese style home, is one of the most amazing and heart-stopping experiences for amateur radio operators! Many visitors and government officials have visited his home. It was also featured in an article in the American Radio Relay League's (ARRL) QST magazine.

Professor Yoshino was introduced to EMC in Antarctica during his 1959 visit while studying the violent nature of noise in the polar region. This branched into the study of interference and crosstalk between circuits used within rockets and satellites used for space science research. Included in his field of EMC work is an interest in the bio-effect phenomena related to the measurement of electromagnetic field conditions around mobile transmitting antennas, including amateur radio equipment. His research resulted in the development of a standard for CRT makers to reduce electrostatic field intensity emitted.

In 1980, he discovered phenomena related to ELF, VLF and MF background noise that is observed prior to an earthquake, with the assistance of a Russian scientist. This published work is used by scientists and engineers around the world for predicting when an earthquake is anticipated to occur.

He area of specialty is being a researcher in Geo- and Space Physics for the Institute of Space and Aeronautics

Science (ISAS), Japan's equivalence of NASA. He assisted with the first launching of small rockets in 1953, which began Japan's space program. He performs research on the emission mechanism of natural electromagnetic waves, launching 22 observation rockets from various countries around the world, including Antarctica. These satellites studied the VLF natural electromagnetic phenomena in space. His greatest discovery was the electrostatic mode wave along the Aurora oval area in the polar upper atmospheric region.

Additional work included the construction of the Nobeyama radio observatory for deep space research of radio waves. This 45-meter dish is currently the world's largest dish for research in the millimeter band. Discoveries include several pulsar stars and a black hole in the galaxy of our galaxy, plus radio emissions after the great crash of the Shoemaker Levy comets into Jupiter in 1994. Another major design accomplishment was the Hydrogen Maser nuclear standard time generator used for millimeter networks. The short-term accuracy (within several hours) of this oscillator is 10-14, much greater than the Cesium system used by NIST (10-12).

Professor Yoshino continues to live a very active life at the age of 70, with no slowing down on research and educational activities, including being an avid fan of skiing and mountain climbing.

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## EMC Standards Committee Reorganizes

*continued from page 31*

EMC standards, and (2) enhance the awareness of IEEE EMC standards throughout the EMC community and demonstrate how these standards can be effectively applied to the development, production and use of equipment and systems.

To accomplish these goals, SETCom will be developing guidelines for working groups, illustrating and clarifying IEEE standards development and adoption requirements, preparing information materials on IEEE EMC standards, and coordinating standards educational activities with the EMCS Education Committee.

The SETCom expects to periodically organize and present seminars at the annual IEEE EMC Society Symposia on the requirements and recommended procedures for active and newly formed working groups, and when appropriate, take the lead in organizing special sessions on standards at the symposia.

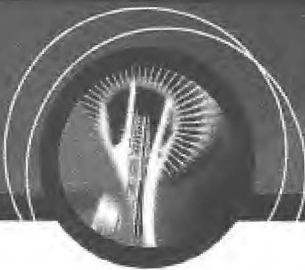
The SETCom officers currently are Hugh Denny, Chair, and John Kraemer, Secretary. In addition, Kimball Williams, Dale Sventanoff, Bill Ritenour, and Ahmad Fallah are committee members. Persons interested in participating in SETCom and assisting in achieving the goals of the committee are invited to contact Hugh Denny at 404-644-9464 or via email at [hugh.denny@gtri.gatech.edu](mailto:hugh.denny@gtri.gatech.edu).

## New Members of the IEEE EMC Society Board of Directors Announced!

As you know, a ballot for the election of the six members to the IEEE Electromagnetic Compatibility Society Board of Directors was issued on July 12, 1999. The ballots returned have been counted, and the following candidates have been elected for a three-year term beginning January 1, 2000:

Lawrence S. Cohen  
Andrew L. Drozd  
Fred Heather  
Motohisa (Moto) Kanda  
Jose Perini  
Andrew Stan Podgorski

Brief biographies of these candidates will be featured in the next issue of the EMC Society Newsletter.



# 1999

IEEE International Symposium on  
Electromagnetic Compatibility

## EMC Society

Awards Luncheon • August 5, 1999  
Seattle, Washington

### CERTIFICATE OF ACKNOWLEDGEMENT

**Barry Wallen**

For contributions as general chair of the 1998 IEEE International Symposium on EMC

**Daniel Arnold**

For contributions as Treasurer of the Oregon EMC'99 Colloquium

**Chris Kendall**

For conducting EMC workshops for several West Coast EMCS Chapters

**Janet O'Neil**

For contributing to the coordination of the Oregon and Arizona EMC '99 Colloquiums

**Takeo Yoshino**

For arranging the EMCS Board of Directors' activities at the Tokyo '99 EMC Symposium

**Dave Southworth**

For creation of web pages for the technical committees of the EMC Society

**Harry Gaul**

For services as Treasurer of EMC'99: A Colloquium and Exhibition on Pre-Compliance EMC Testing, Problems and Solutions sponsored by the Phoenix EMC Chapter

**Daryl Gerke**

For services as Chairman of EMC'99: A Colloquium and Exhibition on Pre-Compliance EMC Testing, Problems and Solutions sponsored by the Phoenix EMC Chapter

**Terry Donohoe**

For services as Registration Chairman of EMC'99: A Colloquium and Exhibition on Pre-Compliance EMC Testing, Problems and Solutions sponsored by the Phoenix EMC Chapter

**John M. Stadille**

For contributions as Publication Chair of the 1998 IEEE International Symposium on EMC

**Anthony John O'Hara**

For contributions as Local Arrangements Chair of the 1998 IEEE International Symposium on EMC

**Bob Reinert**

For contributions as Committee Secretary of the 1998 IEEE International Symposium on EMC

**Charles Grasso**

For contributions as Tutorials, Experiments and Workshops Chair of the 1998 IEEE International Symposium on EMC

**Shane T. Reinert**

For contributions to the graphics and production of advertising materials, programs and covers on the records and workshop notes of the 1998 IEEE International Symposium on EMC

### CERTIFICATE OF RECOGNITION

**Douglas C. Smith**

For contributions to the EMC experiments and demonstrations at the Oregon EMC'99 Colloquium and Tokyo '99 EMC Symposium

**Don Bush**

For contributions as speaker at the EMCS Oregon '99 Colloquium and to the spread spectrum demonstrations conducted at the Tokyo '99 EMC Symposium

### CERTIFICATE OF APPRECIATION

**Jose Perini**

For service to the EMC Society as a 1997/1998 Distinguished Lecturer

**T.J. "Bill" Ritenour**

For service to the EMC Society as a 1997/1998 Distinguished Lecturer

**Jim Drewniak, Tom Van Doren, Jasper Goedbloed, Lee Hill, Maqsood Mohd, John Norgard, Clayton Paul, Doug Smith, Mike Violette, Norm Violette, James Whalen, Lawrence Cohen, and Andrew Drozd**

For significant contributions to the success of the annual EMC Symposium Experiment Demonstrations Forum since its inception and for promoting EMC education within our community

**Ray Adams**

For service to the EMC Society as Chapter Coordinator

**Steve Mullenix**

For service to the EMC Society as Membership Committee Chair

**William McGinnis**

For service to the EMC Society as Awards Committee Chair

**Gene Cory**

For service to the EMC Society as Chair of the Fellow Search Committee

### CERTIFICATE OF ACHIEVEMENT

**Mark Montrose**

For publication of a second best-selling IEEE Press book on EMC design

**Ken Javor**

For demonstration of common mode versus differential mode conducted emission effects relative to FCC specification limits

### IEEE TRANSACTIONS ON EMC – 1998 BEST PAPER AWARD

"Estimates of Lightning-Induced Voltage Stresses Within Buried Shielded Conduits" by F.M. Tesche, A.W. Kälin, B. Brändli, B. Reusser, M. Ianoz, D. Tabara, P. Zwiackier

### UNIVERSITY GRANT AWARD

The University of Michigan-Dearborn

### BEST SYMPOSIUM PAPER AWARD

"Reverberation Chamber Relationships: Corrections and Improvements or Three Wrongs Can (almost) Make a Right" by J.M. Ladbury and G.H. Koepke, National Institute of Standards and Technology, Boulder, Colorado

### BEST SYMPOSIUM STUDENT PAPER AWARD

"Microstrip Coupling Algorithm Validation and Modification Based on Measurements and Numerical Modeling" by T. Zeeff, C.E. Olsen, T.H. Hubing, J. Drewniak, and D. DuBroff, University of Missouri-Rolla, Rolla, Missouri

### LAURENCE G. CUMMING AWARD

**Motohisa Kanda**

For outstanding service to the EMC Society as editor of the IEEE Transactions on EMC

### RICHARD R. STODDARD AWARD

**Fred Tesche**

For contributions to the modeling and measurement of field coupling to cables

### HONORARY LIFE MEMBER AWARD

**Bill Gjertson**

For his outstanding leadership and mentoring of EMC engineers both within the EMC Society and in the industrial/academic arenas for the past four decades.

### EMC SOCIETY PRESIDENT'S MEMORIAL AWARD

Rodolfo Araneo, University of Rome, "La Sapienza"

### MOST IMPROVED CHAPTER AWARD

Orange County, California

### CHAPTER OF THE YEAR AWARD

Rocky Mountain, Colorado

## 1999 AWARDS LISTING





**COLIN BREACH**  
TC-9 COMMITTEE

Welcome to the first TC-9 column! It is our goal to make this an ongoing contribution to the EMC Newsletter. The IEEE EMC Technical Committee 9 – Computational Electromagnetics, is concerned with broad aspects of applied computational electromagnetic techniques, which can be used to model electromagnetic interactions in circuits, devices and systems. The primary focus is with the identification of modeling methods that can be applied to interference (EMC) phenomena, their validation, and delineating the practical limits of their applicability. Included are low and high frequency-domain techniques, as well as time-domain methods.

Each year TC-9 organizes modeling workshops and special sessions at the IEEE International Symposia on EMC to provide basic training on, and insight to, the world of computational electromagnetics. TC-9 also provides technical expertise in reviewing relevant papers submitted to the EMC Symposia.

TC-9 is composed of members with a wide range of backgrounds. Within the committee are those who have developed EMC modeling approaches, engineers whose designs hang on their abilities to effectively understand and use these tools to solve problems, and those working in universities who have been developing numerical techniques and training others. Additionally, the membership includes participants from many countries around the world. This committee benefits greatly from the synergy that results from bringing together experts from diverse areas, interests, and places.

At the 1999 EMC Symposium, the TC-9 members met to review the past year's results and to plan for the 2000 Symposium in Washington DC. As in previous years, two workshops were sponsored by TC-9 this year. The first was an introduction to the basics of computational electromagnetics (CEM), and was held on the Monday afternoon of the symposium week. The main focus was on the common numerical techniques used for solving electromagnetics problems computationally. The presented techniques were the Finite-Difference Time-Domain method, the Finite Element Method, the Boundary Element Method, more commonly known as the Method of Moments, and the Partial Element Equivalent Circuit method. Additionally this year, there was also a presentation on quasi-static modeling, which is a very efficient

means of approaching the solution of electrically small geometries.

The second workshop was held at the end of the week on Friday morning, and provided a series of application examples. These were selected to provide as much insight as possible to the strengths and weaknesses of the various numerical methods and approaches to modeling. The presenters were gratified to see a large attendance on Monday and even more so to see that there was an enthusiastic attendance on Friday.

Given the growing interest in EMC modeling, TC-9 plans to continue to organize these two workshops at future symposiums. The content of these workshops, while changing somewhat from year to year, will always be focused on providing a solid background to the most common modeling techniques currently in use. The application workshop will offer presentations showing how modeling has helped engineers with practical problems on relatively recent product designs.

For those who are more at the forefront of developing and using numerical techniques for EMC work, TC-9 organized two special technical sessions on modeling topics at the 1999 EMC Symposium to ensure the latest information is available to the community. One such session was the solution to "challenge problems", organized by Bruce Archambeault and Al Ruehli, where experts in a given technique were invited to solve a particular, EMI-relevant problem, not only to show how well they can do it, but also to show the limits of a given technique. In addition, Antonio Orlandi and Salvatore Celozzi organized a session on validation of modeling methods. A number of invited papers were presented at this special session.

In addition to the work being done for the symposia, there are a number of on-going projects within TC-9 that are intended to help EMC engineers utilize CEM effectively in their job functions. A web site has been created with a growing set of EMI modeling problems ([www.emcs.org/tc9](http://www.emcs.org/tc9)). The main goals of this web site are:

- as a repository for well defined problems that can be used to test vendor software,
- to provide solutions so that others may compare their own modeling results, and,

- to provide comparisons of measured and modeled results.

One objective of this site is to provide a set of problems from which an EMC engineer may choose an example to test CAD tools on the types of problems the engineer wishes to solve. In this way, a tool demonstration can provide the engineer with results related to his or her application, rather than displaying a demonstration of a problem designed to highlight the tool's strengths. It will also serve as a set of problems from which an engineer can use examples to develop their knowledge of, and facility with, a particular tool that they use. With this evolving problem set, engineers will have a powerful aid to help them determine if their own modeling work is providing suitable answers. Further, for certain well-defined problems, it is possible to make careful measurements for developing confidence in the modeling. While measurements come with their own sources of potential error, with a sufficiently well defined problem it is possible to correlate both approaches. Discrep-

ancies that are identified and resolved will help bring the practical design oriented EMC engineer in closer accord with the modeler.

The focus of future columns will be to keep the EMC community apprised of the activities of TC-9, both the personalities involved and the work being done. In keeping with TC-9's goal of furthering the understanding of CEM within the EMC community, a variety of topics are planned for future columns. Future topics include integrating modeling into EMC design practice, overviews of different numerical techniques and applications to EMC, and getting the most out of modeling results.

#### **Contacts:**

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## **Board of Directors Activities**

### **Seattle, Washington**

#### **Call to Order**

President Hoolihan called the August 1, 1999 meeting of the EMC Society Board of Directors to order at 9:00 am. A round of introductions was made. Board members present included H. Benitez, D. Bush, J. Butler, L. Carlson, T. Chesworth, A. Drozd, W. Duff, R. Ford, W. Gjertson, D. Heirman, D. Hoolihan, T. Hubing, E. Joffe, W. Kesselman, F. Mayer, W. McGinnis, D. Millard, M. Montrose, J. O'Neil, H. Ott, G. Pettit, D. Smith, D. Sweeney, D. Traver, N. Violette, K. Williams and T. Yoshino. No Board members were absent. Several guests were also present.

The agenda was presented. Marie Leonardis and Barry Wallen were added to the agenda to report on the Seattle and Denver symposia, respectively. The agenda was approved with this one addition.

#### **President's Report**

Dan Hoolihan advised each Board Vice-President is required to prepare a five-year report on their respective activities for the formal EMC Society review by the IEEE. With respect to IEEE TAB activities, at the June TAB meeting two hot items were discussed. One was the Branding Proposal (change the IEEE logo, etc.) and the second was the New Financial Model (more money from the Societies to support IEEE administrative costs.)

#### **Treasurer's Report**

Treasurer Warren Kesselman presented his report. He advised that 1998 income for the EMC Society shows 12% from membership fees. There are a large number members in arrears (934) who have not renewed their EMC Society membership. Regarding the EMC Society 2000 budget, this shows a surplus of \$38K, which is in accordance with IEEE financial guidelines. The IEEE's deficit resulted from increased expenses from IEEE initiatives in recent years. These initiatives include the trend towards electronic dissemination of material, globalization efforts, etc. and the associated costs for these efforts. TAB recommended that the subscription costs for periodicals be increased. Treasurer Kesselman advised that the EMC Society implemented the recommended TAB price increases.

#### **Secretary's Report**

Secretary Janet O'Neil presented the minutes from the Board meeting held May 21 in Tokyo, Japan. A few changes were required. The minutes were approved as amended.

#### **Membership Service's Report**

Todd Hubing, Vice-President for Membership Services, distributed his report. He discussed the cash value of the various EMC Society awards. It was moved and approved that the EMC Transactions Best Paper Award be increased from



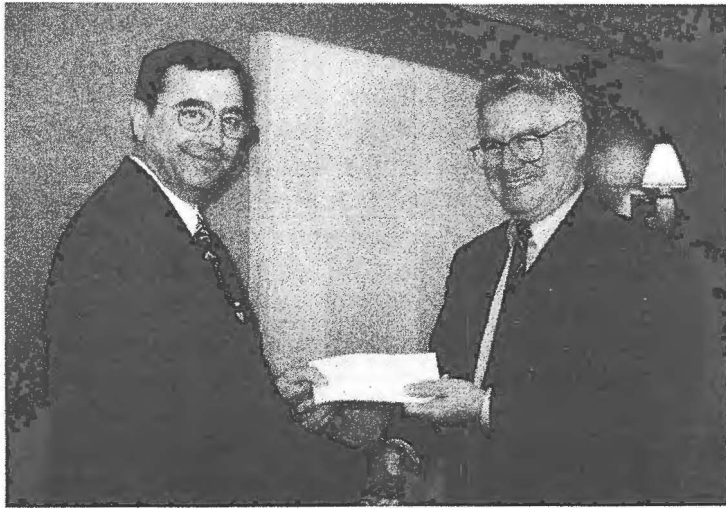


Photo by Dick Ford

**Barry Wallen (L) presents EMC Society President Dan Hoolihan with a check at the August Board meeting. The check represents the financial surplus from the 1998 IEEE International Symposium on EMC in Denver. Barry chaired this successful symposium.**

\$50 to \$1000 for 2000 and beyond. Bill Duff reports that there were eight fellow nominations submitted in 1998. Andy Drozd attended an IEEE membership workshop recently and will prepare an article for the EMC Society Newsletter to promote membership outreach. Bill McGinnis will attend the annual PACE workshop over the Labor Day weekend. After the workshop, he will prepare an article for the EMC Society Newsletter. Ferdy Mayer distributed his report concerning Region 8 membership. He discussed efforts to promote membership in Europe. Bill Gjertson advised that the IEEE is significantly supporting international membership through various initiatives. There will be an IEEE Sections Congress which Mr. Gjertson and Mr. Mayer will attend to promote international membership. President Hoolihan noted that the Board is actively seeking representation from the non-US regions on the Board and in voting procedures. This is being coordinated through Todd Hubing in the restructuring of the Membership Services subcommittees and Bill Gjertson (to change the by-laws to reflect the new policies). Since the regions outside the US are growing more quickly than the US regions, attention is needed for these growing areas. President Hoolihan indicated that Todd Hubing is tasked to prepare a report for the November Board meeting regarding voting by region. Dick Ford is attempting to steer the survey to be exclusively about the annual symposia. He has budgeted for an IEEE scientific survey of the entire EMC Society membership for the year 2000. This should be distributed after the first of this year. Bill Gjertson reported that the elections for Board members are under way. There were 12 names on the ballot. Mr. Gjertson is working with Board members to implement changes to the by-laws necessitated by Board approved motions during 1999.

### Technical Services

Kimball Williams, Vice-President for Technical Services, called on his subcommittee chairs to present their respec-

tive reports. Maqsood Mohd reported for the Education Committee. The only major problem they are having involves the student hardware contest, as they cannot obtain support to promote this. The student paper contest this year was very successful. The quality and quantity of the papers surpassed expectations. Mr. Williams advised that the committee would approach TAB to formalize the student paper award. Kimball Williams presented the RAC report in Chair Dave Case's absence. Open RAC positions include the ACIL and Energy Committee representatives. Outreach efforts are underway to include more committee representation. Andy Drozd advised that there are some upcoming ITS conferences, one is in Japan which is completely funded by Japanese organizations. President Hoolihan noted that Norm Violette has retired from his position as the Board alternate representative to this committee. Mark Montrose has agreed to replace Mr. Violette. In the absence of the Technical Activities Committee Chair Andrew Podgorski, Kimball Williams distributed a flow chart which summarizes the proposed electronic paper review process. David Southworth is creating this system as a volunteer. Mr. Southworth also created the TAC website.

### Standards Services

Don Heirman, Vice-President for Standards Services, next presented his report. This included an organizational chart of the three committees reporting to Standards. Some standards have been eliminated, such as standard 213, which are adequately covered in other global standards (i.e. CISPR, ISO, etc.). There is a new Standards Association that requires a separate membership charge in order to vote on the standards. Mr. Heirman discussed the IEEE Standards On-Line Program. This includes standards in pdf files. If a standard is revised, those who purchase this program will automatically be notified immediately via e-mail that the standard has been updated. They can then download the latest version of the standard. Standards Education and Training Committee (SETCom) Chair Hugh Denny reported that this committee desires to enhance the awareness of the EMC standards process by conducting training seminars for Working Groups. They also want to educate the broader community to show how standards can be implemented. Standards Advisory and Coordination Committee (SACCom) Chair Bob Hofmann reported that there are several vacancies on the committee that they need to fill.

### Communication Services

Len Carlson, Vice-President for Communication Services, called upon his subcommittee chairmen to present their respective reports. Moto Kanda, EMC Transactions Editor, advised that the IEEE is encouraging the electronic review of papers for publication. He is working with the IEEE and his staff to implement this process. Hugh Denny, IEEE Press Chair, presented his report. There have been nine books issued by the EMC Society. Gross sales are some



**EMC Society President Dan Hoolihan (L) presents an IEEE pin and photo of past Society Presidents to Don Heirman at the August Board meeting. Don was President of the EMC Society during 1980-81. Better late than never to receive the past President's pin!**

\$600K in EMC books sold by the IEEE Press. Mark Montrose's two books have been the biggest selling books. In 1998, the EMC Society earned \$4,048 from these book sales. Mr. Denny expects this figure to greatly increase for 1999. He encouraged Board members to utilize the IEEE Press to write books. Janet O'Neil, Newsletter Editor, reported that there will be continued use of color in the newsletter, both in photos and graphs that accompany the practical papers. The page count for each issue continues to increase as more material is being submitted to the associate editors. A special issue in 1999 was devoted to "EMC in Academia." Andy Drozd, Website Chair, reported on the activities of the EMC Society web pages. The first website the committee developed was created by David Southworth for TAC to promote the exchange of information between the various technical committees. Basic templates for web sites have been designed. He is preparing a report on some IEEE "do's and don'ts" for web sites. David Southworth summarized his work with the IEEE to jointly create a template for web sites. IEEE offers free web space so all work is being coordinated through them.

Next followed the reports of various EMC Symposia chairmen. Bill Duff, Chairman of the 2000 Symposium in Washington DC, advised that the call for papers is included in the Seattle Symposium record and it was published in the regional IEEE Section newsletter that has a distribution of 14,000 local engineers. The Washington Hilton will handle the entire room block required, the space for the technical sessions and the exhibit hall space. A special "Government" session is under consideration for the symposium with a corresponding special, discounted registration fee. Barry Wallen, Chairman of the 1998 Symposium in Denver, reported on the financial status of the symposium. On-site registrations and exhibitor booth rental fees were over-estimated which re-

sulted in over-estimating revenue. The net expenses are \$691,661 and the net revenue is \$793,100, resulting in a net surplus of \$101,439. Mr. Wallen presented a check to President Hoolihan for \$95K which represents the surplus from the Denver Symposium. (He retained some money to cover auditing costs and incidentals.) Bill Gjertson, Chairman of the 1999 IEEE International Symposium on EMC, discussed this year's symposium. He introduced Marie Leonardis and Michael Ellis of ITCMS, the "show managers", and Diane Heidlebaugh, Arrangements Chair. He presented a report which addressed registration, exhibit sales, publications, and the technical program. The predicted surplus is estimated at 10%. The total advance registration number is 1,113 people.

Janet O'Neil agreed to chair a task force to address commercialism and the Society's web page. Don Bush, Andy Drozd, Ghery Pettit, Tom Chesworth, Dave Millard, and Doug Smith volunteered to be on the committee. The committee will present the policy for voting at the November Board meeting.

It was moved and approved that the EMC Board of Directors approve the creation of a Vice-President of Conferences.

### Planning Committee

Joe Butler, President-Elect and Vice-President for Planning, distributed a report that summarized the Board's efforts on Long-Range Planning over the past several years. He would like to model the EMCS planning after the newly established IEEE strategic planning efforts. At the November Board meeting, he would like the Board to confirm and target goals and eventually establish a budget for the goals. This planning is necessary in light of the upcoming Society Review in November 1999. Mr. Butler would like to focus on Globalization, Member Benefits, Communications and EMCS Organization and divide into four groups in November to address these issues.

### New Business

Warren Kesselman, chairman of the IEEE Third Millennium Awards Task Force, presented the slate of 27 nominations received from the call for nominations prepared by the task force. Additional nominations were requested from the floor. More were offered. The sample ballot was presented with the 27 names. The EMC Society can only issue 17 awards. It was moved and approved that the nominations be closed.

The meeting adjourned for the day at 5:00 pm.

### Continuation of the Board Meeting on Thursday Night, August 5, 6:00 PM

**Report of Membership** – Andy Drozd reported that booth activity went well. Several new members joined the IEEE and EMC Society during the symposium. Henry Benitez reported that the awards luncheon went well and ran on time. Ghery Pettit advised that the Chapter Chairman's luncheon went



well and some 45 people attended. Scott Roleson presented his final report as Chairman of the Distinguished Lecturer Program. The number of attendees at all the DL presentations last year was 467. The terms of Donald Bush and Bob Dockey will end this year.

**Report of Technical Services** – Andrew Podgorski was not able to give a report. With the exception of one TC, all TCs are doing well. The Matrix report system is working well as one can view at a glance how well a TC is doing. Maqsood Mohd reported that the tutorials were well received, as were the experiments/demonstrations. He advised that Johan Catrysse is seeking funding to hold his EMC class in Region 8 countries. Kimball Williams advised that the RAC/SACCom luncheon went well (attended by some 30 people) and that the special session on wireless EMC went well.

**Report of Standards** – Don Heirman advised that the first audit report has been completed. Three new PARs have been approved, including 299 and 475. New officers were elected including Steve Berger as Chairman, Dave

Traver as Vice-Chairman, and Hugh Denny as Secretary. During the SACCom luncheon, Bob Hofmann advised that he collected several new names for volunteers on this committee. He also received several leads from the call for volunteers article he wrote for the last EMC Society Newsletter.

**Report of Communication Services** – Len Carlson advised that 145 people pre-purchased the “40 years for 40 bucks” CD-ROM as part of the Seattle Symposium registration, and 38 additional CD-ROMs were sold on site. It was moved and approved that the Washington DC 2000 symposium preliminary budget be approved subject to modifying the registration price differential to be 25% between members and nonmembers. Warren Kesselman advised that the ballots were closed for the Third Millennium Awards. The call for nominations was submitted to the Board electronically before the August Board meetings and made verbally during the August Board meeting. The Board voted on the ballot submitted. The IEEE will announce results. It was moved and approved that Henry Ott be appointed as the new VP of Symposia and Conferences for an 18-month

*continued on page 40*

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## CALL FOR PAPERS

### THE APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY

*Announces a Special Issue on*

#### **“Computational Electromagnetic Techniques in Mobile Wireless Communications”**

*Expected Publication Date: Fall 2000 Issue of ACES Journal*

*Deadline for Papers: March 28, 2000*

**“Share Your Expertise and Knowledge with Professionals in the Wireless Communications Industry”**

The ACES Journal is pleased to announce a Special Issue on the role that computational electromagnetics plays in the design and analysis of wireless communications components, subsystems, and systems. The complexity of present wireless mobile architectures and the future complexities of wideband wireless mobile systems has sparked an interest in computational electromagnetics (CEM) as one of the many tools needed for the design of third generation mobile wireless communications systems. The purpose of this special issue is to draw analysts, designers, and management from both industry and academia to outline their ideas and research on the role of CEM in present or future wireless designs. Applications oriented papers are highly encouraged.

Contact the guest editors below for suggested topics. The review process of papers will commence as soon as papers are received. Notification of accepted papers will be made immediately as papers are reviewed.

Guest Editors:

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## Board of Directors Activities

*continued from page 39*

18-month tenure. Mr. Ott identified Barry Wallen as being appointed International Conference Committee chairman. The Exhibitors Committee chairman is Glen Watkins. The Regional Symposia Committee Chairman is Janet O'Neil. It was moved and approved that the top five candidates for the EMC symposia best paper award and the top three student paper award be posted to the EMC Society web page.

Since there was no further business, the meeting adjourned at 8:15 pm.

**Janet O'Neil**

**Secretary, EMC Society Board of Directors**

Congratulations to the following members of the EMC Society who were elected to Senior Member grade at the May, July, and August 1999 meetings of the IEEE Admission and Advancement Panel:

Atanas I. Lazarov  
(Bulgaria)

Giuseppe Mazzarella  
(Italy)

Stefano Maci  
(Italy)

Alexander A. Worshevsky  
(Russia)

John P. Donohoe  
(USA)

Eric Michielssen  
(USA)

R. P. Dahlgren  
(USA)

James E. Hamlin  
(USA)

Kee K. Chan  
(Canada)

M. Irsadi Aksun  
(Turkey)



Two Associate Editors for EMCABS exchange tips at the Seattle Symposium. That's the current Associate Editor, Osamu Fujiwara (L), with Bill McGinnis who previously contributed to the EMCABS for the EMC Society Newsletter.

Following are abstracts of papers from previous EMC symposia, related conferences, meetings and publications.

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### "HOW CAN I GET A COPY OF AN ABSTRACTED ARTICLE?"

Engineering college/university libraries, public libraries, company or corporate libraries, National Technical Information Services (NTIS), or the Defense Technical Information Center (DTIC) are all possible sources for copies of abstracted articles of papers. If the library you visit does not own the source document, the librarian can probably request the material or a copy from another library through interlibrary loan, or for a small fee, order it from NTIS or DTIC. Recently it became clear that EMCABS were more timely than publications which were being listed in data files. Therefore, additional information will be included, when available, to assist in obtaining desired articles or papers. Examples are: IEEE, SAE, ISBN, and Library of Congress identification numbers.

Also, the steering staffs of the Japan Technical Group and the EMC Japan Tokyo Chapter have offered to act as a central point for requests of papers abstracted here. Most of the papers will be available in Japanese only. Abstracts of papers from EMC Japan will be clearly identified. As a member of the steering staff, I will assist in routing your request to the author(s) but will not translate the papers.

Some of the Chinese papers are not available in English. Professor Sha Fei, EMC Research Section, Northern Jiatong University, has offered his time and assistance in routing requests for papers to appropriate author(s). He is not furnishing a translation service.

As the EMC Society becomes more international, we will be adding additional worldwide abstractors who will be reviewing articles and papers in many languages. We will continue to set up these informal cooperation networks to assist members in getting the information or contacting the author(s). We are particularly interested in symposium proceedings which have not been available for review in the past. Thank you for any assistance you can give to expand the EMCS knowledge base.



**THE MYTHOLOGY OF GROUND BOUNCE**

Robert G. Kaires

Tektronix, Inc.

Beaverton, OR 97077, USA

Record of 1999 IEEE EMC Symposium, Seattle, USA, August 2-6, pp. 405-410

**Abstract:** The concepts of "ground bounce" or "noisy reference planes" or "voltage drops along ground" are all tied in with the idea that a ground plane (or just a length of wire for that matter) can be modeled as an equivalent lumped inductor. If care is taken to consider the entire circuit, and mutual inductances are properly taken into account, this inductor model works. However, it appears that this model is often interpreted too literally. One notices that in the literature, authors often refer to "voltage drops" along ground. Some even purport to be able to measure this voltage. Others claim that this voltage can be used to drive antenna elements. In this paper we show that this voltage is fiction. The above inductor model is valid only when measuring a voltage from well-defined model "terminals" or "ports". Misuse of the model can lead to erroneous conclusions.

**Index terms:** System EMC analysis, ground bounce, voltage drop, inductor model.

**EMCABS: 07-11-99****SOLUTION OF A COMPLEX VIA-PIN CONNECTOR PROBLEM USING THE PARTIAL ELEMENT EQUIVALENT CIRCUIT (PEEC) METHOD**

Albert E. Rurhli and George Papadopoulos

IBM Research Division, NY 10598, USA

Record of 1999 IEEE EMC Symposium, Seattle, USA, August 2-6, pp. 673-678

**Abstract:** The complexity of realistic geometries for EMI simulation problems is increasing steadily as the clock frequencies and the speed of the electronic systems increase. Especially the increase in the clock rate for high-end servers and workstations requires a careful analysis of all parts of a computer package. In this paper we analyze a structure which involves multiple pin connections for a high-speed package. The problem involves the electrical properties of connecting pins in the presence of multiple ground pins. The problem is solved with an experimental program based on the Partial Element Equivalent Circuit (PEEC) method. This circuit-oriented solution is ideally suited for this case. We solve the electromagnetic problem in the presence of several conventional circuit elements.

**Index terms:** EMI simulation, multiple pins, via connector, partial element equivalent circuit method.

**EMCABS: 10-11-99****WAVELET-BASED ADAPTIVE SIMULATION OF NONUNIFORM INTERCONNECTS WITH ARBITRARY LOADS**

S. Grivet-Talocia and F. Canavero

Politecnico di Torino, I-10129, Torino, Italy

Record of 1999 IEEE EMC Symposium, Seattle, USA, August 2-6, pp. 450-455

**Abstract:** This paper presents a wavelet-based adaptive discretization of the non-uniform multiconductor transmission lines. The resulting numerical scheme allows time-domain transient simulations of practical interest structures loaded with arbitrary dynamic and nonlinear termination networks. The advantage of the wavelet discretization is the usage of very few automatically determined unknowns for the computation of the solution at each time step. The adaptivity of the discretization does not affect the overall accuracy, which is the same as if a uniformly fine grid were used. The proposed scheme offers an optimized alternative to the more standard finite-difference (FDTD) approach for signal integrity analysis of interconnects.

**Index terms:** Time domain modeling, non-uniform multiconductor transmission line, interconnector, wavelet discretization.

**EMCABS: 08-11-99****SUPPRESSION OF RADIATED EMISSION FROM AN 8-BIT MICRO-CONTROLLER USING GATE-OXIDE FILTERING CAPACITORS**

Hyeongsoo Kim, Jonghoon Kim, Woonghwan Ryu, Myunghee

Sung, Seungyoung Ahn and Joungho Kim

Korea Advanced Institute of Science and Technology, Taejon 305-701, Korea

Record of 1999 IEEE EMC Symposium, Seattle, USA, August 2-6, pp. 811-815

**Abstract:** The voltage fluctuations of the power/ground lines on IC's, packages, and modules have become the major source of the radiated emission. Combined suppression techniques including shielding, cabling and filtering at the package level and the module level are not enough for the complete suppression of radiated emission. Moreover, the power/ground line fluctuations and the resulted radiated emissions caused by the IC surge current must be controlled and considered at the IC design procedure. We have demonstrated more than 10-dB suppression of the radiated emission from a commercial 80bit micro-controller using on-chip gate oxide filtering capacitors. The filtering capacitors are placed under the power/ground buses and the signal buses without ever increasing the die size.

**Index terms:** Interference suppression, radiated emission, gate oxide filtering capacitor, micro-controller.

**EMCABS: 11-11-99****LIGHTNING RADIATED ELECTRIC FIELDS AND THEIR CONTRIBUTION TO INDUCED VOLTAGES**

M. G. Sorwar and I. G. Gosling

Nanyang Technological University, Singapore 639798

Record of 1999 IEEE EMC Symposium, Seattle, USA, August 2-6, pp. 635-639

**Abstract:** During the return stroke, the radiated electric field from a lightning channel contains vertical and horizontal components of electric fields, which are both responsible for producing transients in power lines, telecommunication lines, and electronic circuitry of communication and control systems. This paper analyses the characteristics of the vertical and horizontal components of electric field depending on different parametric conditions of the return stroke. Lightning induced voltages on an overhead telecommunication line are also calculated for different elemental fields. The numerical results show that horizontal electric field (HEF) produces high ringing of fields at distances far from the strike point, and plays an important role in producing induced voltages in the vicinity of the lightning channel. The radiation and the induction components of fields are found to be responsible for the change in polarity of induced voltages.

**Index terms:** Lightning, lightning radiation, return stroke, overhead line.

**EMCABS: 09-11-99****SUPPRESSION EFFECTS OF ELECTROMAGNETIC RADIATION FROM INNER-LEAD PORTION MODELED BY FERRITE-RESIN COMPOSITE**

Tadaharu Akino, Yasuhiro Ono, Shinichi Shinohara and Risaburo Sato

Electromagnetic Compatibility Research Laboratories Co., Ltd., Sendai 989-3204, Japan

Record of 1999 IEEE EMC Symposium, Seattle, USA, August 2-6, pp. 1010-1015

**Abstract:** This paper describes the suppression effects of electromagnetic waves radiating from the inner-lead portion of lead terminals molded by ferrite-resin composite in semiconductor devices. First, using composites in molded cylindrical form having various ferrite power content, the complex relative permeability and complex relative permittivity were measured using the Nicolson-Ross, Weir method. Next, the impedance of the inner-lead portion of lead terminal specimens, molded by the same ferrite-resin composite, was measured. Following this, each of the lead terminal specimens was mounted on a printed wiring board settled to a shield box, and electromagnetic radiation from the inner-lead was measured in an anechoic chamber, while terminating one end of the lead terminal to 50 ohms resistor and feeding a high frequency signal through the other end. The results of these experiments showed that electromagnetic radiation from the inner-lead portion can be effectively suppressed by molding the lead terminal by ferrite-resin composite having a ferrite powder content of 80 weight-% or greater.

**Index terms:** Radiation suppression, ferrite-resin, ferrite powder, inner-lead of semiconductor device.

**EMCABS: 12-11-99**

#### ANALYSIS OF SHIELDED TENTS AND SHIELDED ROOMS

Lothar O. Hoefft+ and Carl Wigg  
+ Consultant, Electromagnetic E  
++TRW, Inc., Albuquerque, NM  
Record of 1999 IEEE EMC Symp

**Abstract:** An analysis of a large sh  
three frequency ranges for a singl  
surface resistivity and enclosure  
independent and depends on the  
inside the enclosure become appa  
facility can be in the range of 60 to  
is essential if significant shieldin

**Index terms:** Shielding, shielded t

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nt, enclosure, thin s

#### SLOT AND APERTURE COUPLING FOR SHIELDING ENCLDSURE DESIGNS

M. Li, J. L. Drewniak, T. H. Hubin  
University of Missouri-Rolla, Rolla  
Record of 1999 IEEE EMC Sympos

**Abstract:** The coupling between ape  
means of the method of moments (M  
interest. Justification for a previous  
between the number N and size a of  
airflow aperture array is given. The  
limit of the empirical design approa

**Index terms:** Shielding enclosure, sl

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#### MODELING OF THE GROUND BOUNCE EFFECT ON PCBs FOR HIGH

S. W. Leung, Lixi Wan and C. M. Ip  
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Record of 1999 IEEE EMC Symposiu

**Abstract:** A Generalized Transmissio  
Ground Bounce (GB) in high-speed d  
a "local wave" concept. The GB effec  
PCB parameters, and simulation re  
behavior.

**Index terms:** Print circuit board,  
computer modeling.

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