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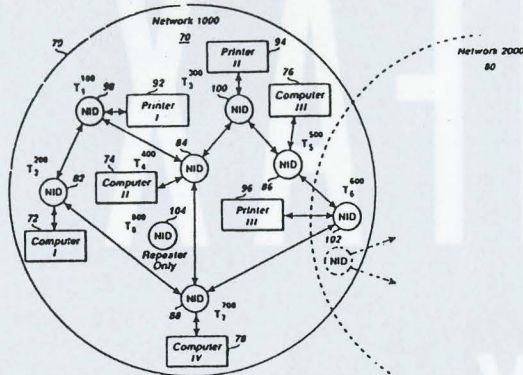
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A promise of smaller, more robust
components able to withstand higher
power loads without overheating

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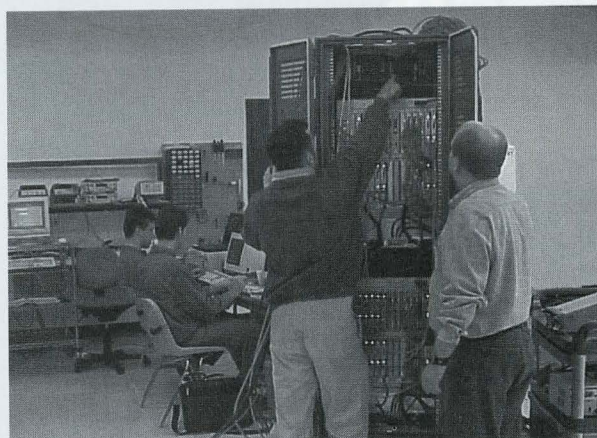
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Chairman

Pat Murphy, E.E., P.E.
Phone 312-733-7000 ext. 6805
Fax 312-432-7118
E-mail patmurphy@IEEE.org

Editor

Gerry Ryan
Phone 773-380-7955
Fax 773-380-7979
gryan@hdrinc.com

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Publisher

Barbara Slack

Advertising Sales

Beth Vander Grinten
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KNOW WHEN TO HOLD, FOLD OR WALK AWAY
Monday, September 24, 2001

CHICAGO SECTION EXECUTIVE COMMITTEE MEETING

Tuesday, September 11, 6:30 pm

DeVry DuPage, Room TBA, 1221 N. Swift Rd., Addison, IL

No Registration Needed

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New Silicon Carbide Technology

A promise of smaller, more robust components able to withstand higher power loads without overheating

By Sandy Ryan

Professor Krishna Shenai of the University of Illinois-Chicago's (UIC) Electrical Engineering and Computer Science Department, in cooperation with Philip G. Neudeck and Gene Schwarze of the NASA Glenn Research Center (NASAGRC) are working toward the development of new material technologies including Silicon Carbide (SiC).

NASAGRC is based in Cleveland and works to define and develop advanced propulsion, power and communications technologies for application to aeronautics and space travel. NASAGRC is the latest sponsor to join UIC's Power Electronics Reliability Group (PERG).

PERG was founded in March of 2000 and the group's goal is to improve the reliability and lowering costs of power electronic systems. PERG corporate sponsors include IBM, Toshiba and Tyco Power Systems and the group is led by Shenai. Shenai said his group's work with NASA's Glenn Research Center may see future results including space transportation and laboratory applications.

SiC was developed in the 1950s but the technology sat dormant because it was difficult to manufacture. Silicon alone has been a major factor in the semiconductor industry but the projected power demands of new technologies are so high, they would turn many silicon chips back into sand. Shenai said SiC's promise lies in its abilities to make components smaller, more robust and able to work under high power loads without overheating.

"For example, today's typical mainframe computer is guaranteed to run a minimum of 100,000 hours continuously without failure," Shenai said.

"While that may sound impressive, the growing demands of the information age will require future generations of equipment to be far more robust. What is really needed is more than 1 million hours per system. Systems are now reliable more than 99.99 percent of the time. What we really need is a reliability improvement of three orders of magnitude or 1,000 fold."

In the 1980's, Shenai began working to develop SiC and he said it is the hottest technology in the industry when it comes to development of compact high-power converters for next-generation power electronics applications. Research regarding silicon material technology, combined with novel electronic device development, has sparked system improvements for power electronic applications including motor control, electric utility, medical electronics, automotive electronics, smart power electronic application-specific integrated circuits and high-density high-frequency power supplies.

Shenai's research of elemental and compound semiconductors included high power electronic applications of wide-bandgap semiconductors that took into account on-state

resistance, power loss caused by junction leakage, heat conduction, radiation hardness, high frequency performance and high temperature operation.

Shenai said the research showed that wide-bandgap semiconductors such as SiC and diamond could offer significant advantages compared to either silicon or group III-V compound semiconductors for the applications. Theoretical calculations showed the potential for successful operation at temperatures beyond 600 degrees C for diamond high-power devices. It was shown that improvement in power-handling capabilities of semiconductor devices by three orders of magnitude is feasible by replacing silicon with silicon carbide and improvement in power handling capability by six orders of magnitude was projected for diamond based devices.

Shenai said failures in power-processing systems are often the result of complex, application-specific interactions between semiconductor switches and surrounding circuitry.

"Despite intense industry research into power electronics reliability, the problem of premature failure in power-processing

systems is still too common" Shenai said. "Field failure rates in some instances are 2%-5% after one year of operation. This results in billions of dollars in direct losses to consumers. However, because our computing and communications systems depend on power converters, secondary losses to information and its exchange can be much larger.

"State of the art silicon high-power, high voltage DC-DC converters are bulky, heavy, inefficient and require extensive thermal management and cooling," Shenai said. "For example, a 100V2kV, 7kW silicon power converter switching at 50 kHz has 85% efficiency and a power density of less than 4W/cm. It can be operated reliably up to a junction temperature of only 150 degrees C, thus requiring extensive thermal management and cooling.

"With silicon carbide, I can switch perhaps three orders or more of power without the problem of needing extra cooling," said Shenai. "In most power systems, the problems of higher cost and weight are with cooling management. So what you want is a semiconductor which can switch very high amounts of power, but isn't destroyed



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in the process by high heat."

Shenai said a key requirement to develop a compact, light-weight, high power DC-DC converter is to increase switching frequency but switching losses in a silicon high-power switch become excessively large above 50kHz. Research conducted by Shenai and NASA indicates SiC high power switches to be more efficient at much higher switching frequencies and operating temperatures.

"Our calculations show that a 100V-2kV, 7 kW SiC power converter switching at 500 kHz has an efficiency of 89% at 150 degrees

C and a power density of 7 W/cm, provided high-temperature magnetic components and capacitors become available," Shenai said. "This result is more than a 50% increase in converter power density as compared to a silicon converter with identical ratings. Increasing the power density results in a reduction in size, weight and cost of the power converter. The SiC power converter is also capable of efficient operation (85% at 300 degrees C at elevated junction temperatures. This results in a reduction in mass/volume and complexity of the cooling system."

SiC research utilized a "top-down" approach that established application requirements from which circuit switching topology and control strategies were selected. Simple circuit calculations yielded component ratings—components were designed and performed using available material and device data and were based on extensive computer simulations.

Shenai said development of high frequency, high-power density and high-efficiency magnetic components such as transformers and inductors is paramount in the realization of high-power density DC-DC power converters.

"In order to decrease the mass/volume of magnetic components, and thus increase the converter power density, requires an increase in switching frequency. For power transformers a frequency is approached beyond which no appreciable gain in transformer power density is realized. Our designs of magnetic components are based on the available materials data and follow first-order simple design approach. We have developed an extensive core loss database for crystalline and amorphous soft magnetic materials for frequencies up to 50 kHz and temperatures to 300 degrees C and limited core loss data up to 1 MHz at room temperature is also available."

Shenai said he is excited about the range of possibilities linked to SiC technology and expects electronic parts made of SiC to eventually replace large, heat-producing components in products that range from railroad locomotives to home computers. After several years of development, PERG sponsor Infineon, the semiconductor branch of Siemens, introduced its first commercial SiC power switch in January. ■



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EVENING MEETING

IEEE - IAS/PES Dinner Presentation Considerations in Application and Selection of Unit Substation Transformers Wednesday, September 12, 2001

Charles J. Nochumson, PE

About the Topic:

Based on a paper presented at an IEEE/IAS conference, Mr. Nochumson will be discussing the selection and application of Secondary Unit Substation Transformers (USTs) ranging from 300 kVA up through 2500 kVA with 34.5 kV maximum primary voltages and with secondary voltages 600 volts and below. The presentation will include a discussion of Liquid and Dry-Type (non-liquid) types of UST's. Liquid types will include a discussion of mineral oil, High Temperature Hydrocarbon, Silicone and new Vegetable Based fluids. Dry Types will include a discussion of VPI Polyester, VPE Silicone and Cast Epoxy Designs. National Electric Code location requirements as they effect both Liquid and Dry Type Transformers for both indoor and outdoor locations will be considered. The relative advantages of each type of UST will be discussed within each category with respect to 1) First Cost, 2) Operating Costs (Losses), 3) Overload Capability, 4) Fan Cooling, 5) Space Factor, 6) Environmental Factors 7) Sound Levels and 8) Maintenance.

About the Speaker:

Education: University of Illinois in 1965 with BSEE, MBA from Northwestern University 1970. Present Position: Cutler-Hammer, Application Engineer. Charles J. Nochumson is an Application Engineer for Cutler Hammer and was previously an Application Engineer with Westinghouse Electric Corporation in their Distribution and Control Business Unit for 29 years. Mr. Nochumson is co-author of an IEEE paper on "Transfer Considerations in Standby generator Application", author of a TAPPI and IEEE paper on "Application of New Technologies in Power Circuit Breakers with Higher Interrupting Capacity and Short Time Ratings". He has also been a previous guest speaker at the Chicago Chapter of IEEE/IAS and for Plant Services

magazine. He has written an article on "Basic Electrical Distribution Systems" for Electrical Distributor magazine and also authored articles in Plant Engineering magazine. Besides providing technical and application information on Cutler-Hammer products for consulting and design engineers, he provides technical direction for the committee that publishes Cutler-Hammer Consulting Application Catalog 71 and its Product Specification Guide. Mr. Nochumson is a Professional Engineer and Senior Member of IEEE.

Location:

Costa's (Greektown)
340 S. Halsted St.
Chicago, IL
Costa's is located in Greektown on the corner of Van Buren and Halsted.
See www.iaschicago.com for detailed directions and a map.

Time:

5:30 PM Social

6:00 PM Dinner

7:00 PM Presentation

Reservations:

Your cost includes the presentation and a four-course dinner with a choice of the main entree - Roast lamb, Chicken, or Fish. (Vegetarian or special dietary meals available upon request). Cost is \$25 IEEE Member and \$30 non-member. Valet parking is included with your meal.

Please call the IEEE Business Office at (800) 898-IEEE or (630) 493-4333 with your reservation. Please note any special meal requests at the time of the reservation. **You can also make your reservations on line at www.iaschicago.com**

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HIPAA, Elections High on List of EMB Society Fall Activities

Y2K has come and gone. The Electronics in Medicine and Biology Society has a remedy for all the time on your hands: Get active in EMB! There are HIPAA issues facing us which make EMB look like a minor inconvenience.

Meetings are currently scheduled for the fourth Monday of the month (Except for December's Xmas party) at the DeVry Campus on Swift Road in Addison. (Between Lake and Army Trail. Swift is the first light west of the I355 interchanges.)

EMB will be needing additional officers shortly. Anyone interested in running for Chair, Vice-Chair, or Secretary-Treasurer should e-mail Connie Kelly at ckelly@megsinet.net

An e-mail survey will be going out shortly to all EMB members who have provided addresses with their renewals. We are looking for ways to better serve the membership by improved meeting structure and expanded meeting content. The survey will request comments on meeting day and locations.

Meetings resume after the summer break on September 24 at 7:00 with a summary of HIPAA. Most people know HIPAA as being responsible for maintaining insurance when you change companies. But there are numerous security and transaction processing aspects, which will have to be addressed in the coming months. Join us for an informative session on the practical aspects of HIPAA for those connected even peripherally to health care.

Be sure to answer your survey and return it.

Message from your Programs Committee Chair

As the newly elected Chair of the Chicago Section's Program Committee we are trying to plan joint meetings among our Chapters, Sub-Sections, and our Section. Please contact me at j.feitler@ieee.org with your suggested topic and the relevant section entities who can co-sponsor this meeting. If necessary, we'll try to help you arrange a meeting date and place to be announced in SCANFAX.

Joe Feitler

IEEE EMC Society-Chicago Chapter

Meeting dates are listed below. Please stay tuned to our web site for meeting topics, locations and guest speakers. Start time for Chapter Meetings is 7:30 PM.

www.ewh.ieee.org/soc/emcs/chicago/

September 12, 2001 Chapter Meeting
October 17, 2001 Chapter Meeting
November 14, 2001 Chapter Meeting
December 12, 2001 Chapter Meeting
January 16, 2002 Chapter Meeting
February 20, 2002 Chapter Meeting
March 26, 2002 Chapter Meeting
April 17, 2002 Chapter Meeting
May 21, 2002 Mini-Symposium

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EVENING MEETING

Chicago/Rockford IEEE Consultants' Network Meeting Know When to Hold, Fold or Walk Away Monday, September 24, 2001

About the Topic:

In addition to networking and sharing leads and referrals, there is usually a guest speaker. On September 24, instead of a speaker, we plan to have an open discussion on "Know When to Hold, Fold, or Walk Away" and how to identify contractual problems and how to make them acceptable.

Meetings are usually held on the last Monday of odd-numbered months. Preceding the meeting, we will be getting together for our group dinner. You are invited to join us for the optional informal dinner. We order individually from the menu.

Location:

Dinner: Bakers Square
270 E. Northwest Highway and North Court, just south of the library.

Meeting: Palatine Public Library
700 North Court, Palatine, IL
847-358-1216

Time:

6:15 PM Dinner
7:30 - 9:00 PM Meeting

Reservations:

Reservations are not required. There is no charge for attendance at the meeting. Both members and non-members are invited.

Information:

Information about the network can be obtained by e-mail: g.l.blank@ieee.org and at our web site <http://www.drblank.com/coaction.htm>

See you on September 24 and bring other consultants and those who are interested in learning about consulting.

IEEE 2001 CHICAGO

The 2001 IEEE-Industrial Application Society's Annual Meeting and Exposition is being held in Chicago this year. This conference will be held at the Hyatt Regency Hotel in downtown Chicago, from September 30 through October 4, 2001.

This conference will share the latest information in the areas of:
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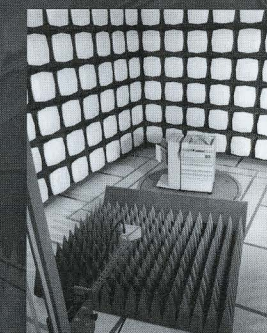
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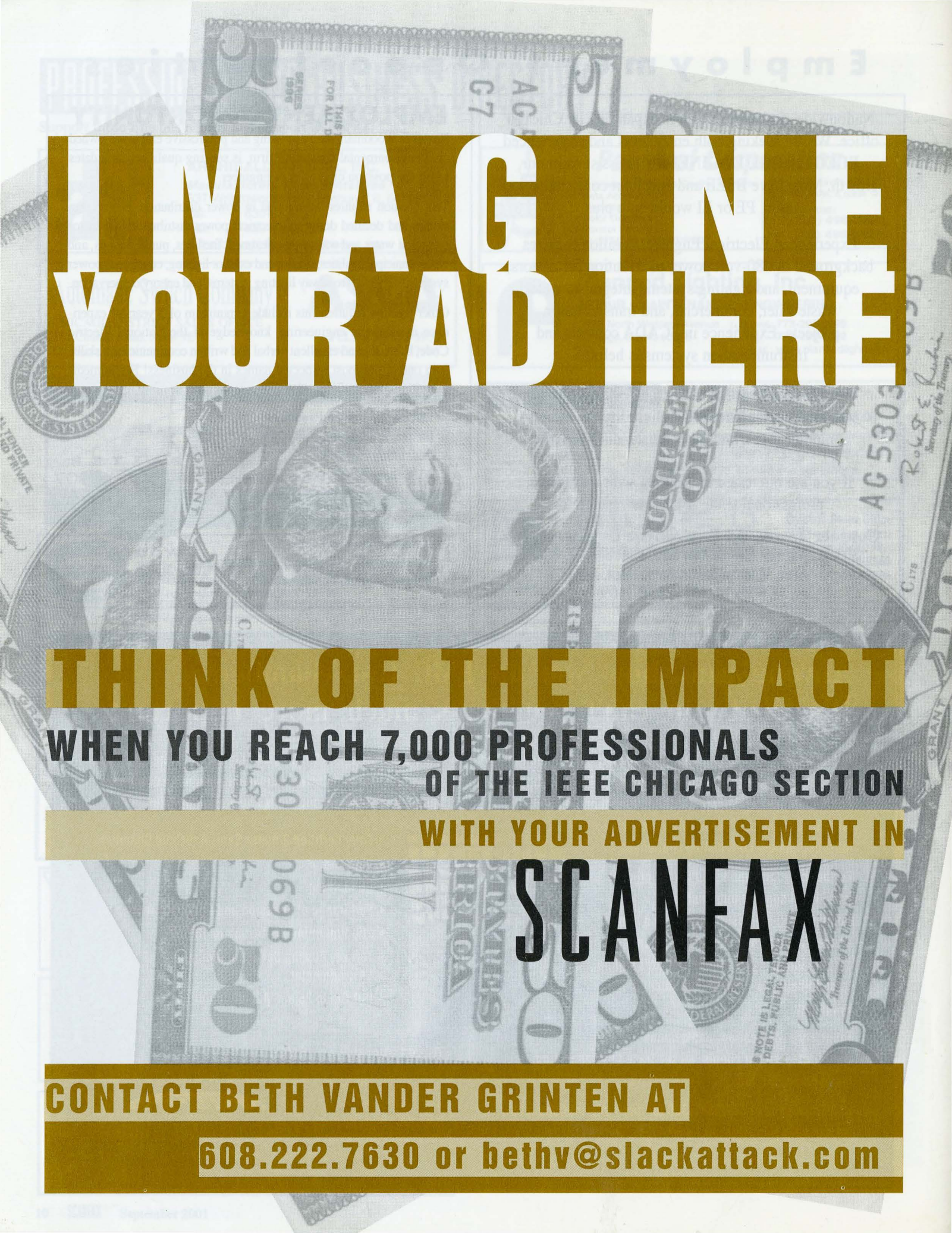
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