

N e w s l e t t e r

**IEEE-SECTION
 CHAIR COLUMN**

Roger Lawrence

2006 IEEE Eastern NC Section Chair.
[rogerlawrence\(at\)rglsolutions.com](mailto:rogerlawrence(at)rglsolutions.com)

As incoming chair for 2006 I have the pleasurable task of thanking our outgoing Chairman, Dave Ruden, for his diligent and energetic contributions in leading us through 2005.



I extend to him my personal thanks for all the help he has given me and I thank him on behalf of the full membership also. Dave

has been an active contributing volunteer to IEEE ENCS for a number of years and he is not off the hook yet! We look forward to his continued input and support during the coming year. I also want to extend heartfelt thanks and a warm welcome to the incoming team; thanks for all their past efforts to help build the ENCS Section and welcome, as they assume their new or continuing roles.

My commitment for 2006 to the ENCS team and to the membership is my ear, my email address, [rogerlawrence\(at\)rglsolutions.com](mailto:rogerlawrence(at)rglsolutions.com), and my telephone number, 919-515-6682, along with an open invitation to you to be in touch. Our organization's suc-

cess depends upon membership volunteers and their enthusiasm to carry us forward. Through you we anticipate increased membership, even more "can-do" volunteers, and unstinting enthusiasm for our profession and for our professional organization in the current year. If you have ideas to share, if you have time to give, if you come along to take part in a meeting, your participation is welcomed and appreciated. I want to hear from you and implement your good ideas for the Section's benefit.

A focus of IEEE ENCS is professional development for its membership. To those ends the ENCS team would like to encourage those of you who have ten years' or more engineering experience in the workplace to consider Senior Membership application. Those with fewer than ten years experience under their belt can plan ahead. The application process is now electronic and we have in place a system of support for applicants. We are ready and willing to answer your questions and help you with the process of application. So, if you are ready to get started, all it takes is an email or a telephone call.

IEEE is moving forward in North Carolina. The North Carolina Council, under Charles Lord, is being revitalized and will facilitate communication and cooperation among the North Carolina Sections of IEEE. We have a newly formed Education Society under the Chairmanship of Steve Walsh that will serve educational needs throughout the state. We plan to revitalize and expand the Lower Cape Fear Section and are looking for interested engineers in the area to help

(Continued on next page)

**Inside this
 Issue**

IEEE-Section Chair Column	1
January Awards Luncheon	2
Robotics & Automation Society	3
IEEE-USA CAPITOL HILL WATCH- Pro-H1B	4
EMBS Chapter Meeting - February 8, 2006	4
Embedded Systems Group	5
Career Development	6
Antarctica: Its Ice, Land and Ocean as viewed by RADARSAT-1	6
How Maxwell fixed Ampere's Law	8
IEEE Events this Spring	10
Contact Information for IEEE Eastern N.C. Section	11

An electronic version of this and previous Newsletters can be found at:

ewh.ieee.org/r3/enc/nl.htm

us with this process. (Call me!) We are exploring the possibility of long distance learning, workshops, and training that will expand the opportunities for professional development for the membership. We would like to meet the needs of engineers in the more remote regions of the state. Let us know what we can do for you. (Call me!)

We strive, as a Section, to be in touch with current trends in the industry. Energy has taken center stage in the engineering industry over the past number of months. As gas prices have risen, energy savings is foremost in the minds of, not only homeowners, but industry and government alike. There is a concerted effort to use energy wisely and economically in all aspects of life. This is a tremendous opportunity for the engineering community and its collective abilities. Some of our recent meetings have considered energy topics such as electrical safety, power quality, and energy storage, all very relevant to efficient electrical performance and energy usage.

For 2006 I encourage you to take personal ownership of IEEE ENCS and make your contribution and a difference. Membership input is what makes the section relevant.

Your Chairman wants to hear from you. Your Executive Committee wants to hear from you. Your Section wants to hear from you. Please use my contact information above and the contact list published in this newsletter to communicate your ideas and your questions.

The Executive Committee meets every third Thursday of the month 11.30am - 1.30pm in Partners 1 conference room on NCSU Campus to conduct ongoing business. All members are welcome. Bring along a packed lunch and sit in.

A Section Meeting is held every third Thursday evening of the month most often on MCNC Campus. It offers the opportunity for pre meeting networking over refreshments and a presentation of a topic of interest by an invited speaker followed by discussion. We occasionally visit places of interest for a presentation and a tour. The planned schedule for the rest of the year will include some of the following ideas: a solar energy forum, a presentation describing the Advanced Vehicle Research

Center, a visit to IBM, a visit to Morehead Planetarium, a visit to WCPE radio station, a pulsed power presentation, a DARPA Challenge presentation, and a consideration of developments in nuclear energy presentation. Members and their invited guests are welcome.

Individual Chapter Meetings are scheduled by Chapter Chairs throughout the year for members and their invited guests.

There will be a family picnic during the summer and we are actively looking for willing volunteers to help plan this event and other socials for the year. (Call me!)

Please check the calendar for upcoming meetings and events:

jape.ieee.org/cgi-bin/cal/calendar.pl?calendar=enc

I look forward to hearing from you and meeting you this year. Make a note of my contact information and be sure to use it. Mark your calendar for one or more of the planned meetings described above and come along. Plan to come to the summer family picnic. Help me to enhance the relevance of this organization to you and to the membership by taking part and sharing ideas. ♦

JANUARY AWARDS LUNCHEON

Roger Lawrence

[rogerlawrence\(at\)rglsolutions.com](mailto:rogerlawrence(at)rglsolutions.com)

The January Awards Luncheon was held at Kemps Seafood in Durham on a cool wet wintry day. It was well attended and we enjoyed great food and fellowship as we honored those who had made outstanding contributions to the organization during 2005. Thanks to Dave Ruden and Lee Haas for organizing what turned out to be a blow out event! At one point, as we squeezed in more chairs, we feared that the room would be too small. Thanks, too, to those who attended, especially our honor-

(Continued on next page)

Editor's Note:

E-mail addressing notation

Due to concerns about spam, all email addresses are ciphered by replacing the at-sign with (at) and the dot-org/com ending with a bullet. In case you wondered, we did not invent a new protocol, but just a "different" way to present the information.

ees and their families. It is never easy to make the final selection from a group of nominees whose contributions are so valued. Even finding a suitable date can be difficult as these are people with busy schedules. This event marked the last official duty for Dave as Chairman 2005. After such a busy year on behalf of ENCS what WILL he do with all that extra time? Thank you, Dave, for being an outstanding Chairman. Thank you all willing ENCS volunteers and participants. Thank you ENCS Honorees. We are proud to honor

Thomas Jepsen and the 2004 NC Symposium Team for their tremendous efforts at launching the NC Symposium in 2004

Dan House for excellent work building University and Student relationships

Steve Lund and the entire Embedded Systems SIG volunteer team for wonderful work creating such a successful and tightly knit community.

Mary Ellen Randall for super work as 2004 Section Chair, and for such valuable guidance during 2005 as Past Chair

Dave Schulman for his quiet and consistently professional support as SAMIEEE (DB) guru

Shobha Saraiya for terrific support over many years as Membership Development Chair

Glenn Robb for excellent and professional, independent work as Chair of EMC

Harold Meder for outstanding energy and initiative in creating the Sections Job-Hunt-Collaboration group

Esther Lumsdon for outstanding energy and initiative as initial leader of JHC's Biology-Health-Pharma group

Lee Haas for much valued help keeping our meetings on topic and on schedule, functioning as ExCom meeting Moderator (now deputized as meeting Sheriff!) and for additional general support to the Section Chair.

Matt Horrer for outstanding work as NL editor ♦

ROBOTICS & AUTOMATION SOCIETY

By **Grayson Randall**

Chapter Chair

There is exciting news for robotics and automation. The NC State legislature allocated funding for an Advanced Vehicle Research Center (AVRC). Currently, there are over 1000 companies in North Carolina that manufacture automotive products. The AVRC is being developed to help NC companies proactively advance automotive technology in North Carolina. It provides the infrastructure required for large scale automotive manufacturing, with the goal of building up the automotive industry in the state.

AVRC will have a test track, dynamometers (for measuring HP, torque and simulating road conditions), emissions testing equipment, wind tunnels, as well as a hydrogen facility for alternate energy research. Companies will be able to utilize the facility on either a short term or long term basis.

AVRC will be run by a non profit organization run by Richard Dell. NC State University is also involved. Auto manufacturer, Lotus, will have an office there.

On March 8th, there was a kick-off meeting with government, University and business. The objective of the meeting was to get people who are doing automotive research together and look for synergy to help North Carolina. There were 87 attendees and over 41 University Research projects displayed.

AVRC will be located in North Hampton County. The first phase which consists of a 2.5 mile closed loop test track, garages, refueling for alternative fuel vehicles and office space, is expected to open later this year. More information is available at www.avrc.com/index.htm.

We will be holding an IEEE sponsored meeting on AVRC in the next few months. Please watch the calendar for more details. ♦

IEEE-USA CAPITOL HILL WATCH- PRO-H1B

Lee Griffin

IEEE-USA CARE Representative

A *Visa Bill* is likely to move easily through US Senate. The Senate Judiciary Committee is currently considering the Comprehensive Immigration Reform Act of 2006.

Of special interest to IEEE-USA members are the student visas, H-1B temporary work visa and the EB-1 and EB-2 permanent, employment-based visa reforms in Title IV of the bill. The Chairman's Mark:

1) Expands the allowable optional practical training (OPT) period for F-1 students from 12 to 24 months and creates a new, uncapped F-4 visa program for foreign students enrolled in advanced degree programs in Science, Technology, Engineering, Math (STEM) and related fields at US educational institutions. Upon completion of their studies, F-4 students who secure employment in the US will be allowed to immediately adjust to legal permanent resident (Green Card) status by paying a \$1,000 fee and passing security clearances.

2) Raises the cap on H-1B temporary work visas from 65,000 to 115,000 and creates a new uncapped exemption from the cap for foreign nationals with advanced degrees in STEM fields from US schools. Current law exempts up to 20,000 advanced degree professionals from the H-1B cap. Title IV also establishes a "flexible, market-based escalator" to facilitate upward adjustments in the cap in response to increases in demand for H-1B visas.

3) Increases ceilings on employment-based immigrant admissions programs from 140,000 to 290,000 per year; and creates an unlimited exemption from this cap for EB-1 priority workers (including outstanding professors and researchers) and EB-2, advanced degree professionals with STEM degrees from US schools.

This bill reflects the growing national consensus on the urgent need to maintain U.S. technological competitiveness, and make it easier for foreign engineers and scientists with advanced degrees from U.S. schools to get green-cards, makes it extremely likely that these provisions will be reported favorably by the Senate Judiciary Committee.

For more information visit IEEE-USA's website on H1-B & L1 Visas at

<http://ieeusa.org/policy/issues/H1bvisa/index.html> ♦

EMBS CHAPTER MEETING - FEBRUARY 8, 2006

Tom Jepsen

[tjepsen\(AT\)mindspring.com](mailto:tjepsen(AT)mindspring.com)

The ENCS Engineering in Medicine and Biology Society held its first meeting of 2006 on February 8 at the MCNC in Research Triangle Park. The featured presenter was Dr. Etta Pisano, Kenan Professor, University of North Carolina School of Medicine, and Professor of Biomedical Engineering. Dr. Pisano discussed the UNC Biomedical Research Imaging Center (BRIC) and the future of technology development and assessment with focus on breast imaging. Dr. Pisano discussed some technical advances in radiology that enable better detection and diagnosis of tumors, and some of the forward-looking research being conducted at BRIC.

Maya Barton has agreed to serve as vice-chair of the chapter. Plans for future presentations include a talk by Dr. Hugh Barton (Chief, Toxicology Department) at EPA, one of the national experts on biomathematical modeling in pharmacokinetics. ♦

EMBEDDED SYSTEMS GROUP

Steve Lund

[slund-ieee\(at\)pobox.com](mailto:slund-ieee(at)pobox.com)

If you're into low level HW/SW work and like to work "close to the metal", come join our Embedded Systems group. We are a tightly knit group of metal-heads, and enjoy exchanging experiences and ideas, and reach to broaden our tech-exposure through our regular meetings. We invite you to come join us and bring a friend or colleague who is also interested in embedded systems to be a part of this excellent group.

During the past year it became apparent that there were just too many IEEE and related professional events regularly scheduled for the 3rd. Week of the month. The Group steering committee looked at this conflict and we have decided to move the meeting day of the Embedded Systems Group. Beginning with the May meeting we are moving to the 4th Monday of odd numbered months. Hopefully this will ease the meeting congestion and also allow those folks with Wednesday conflicts to now join us.

When the Embedded Systems Group was founded one of our goals was to give back to the community. Eve Barkley has picked up the torch and is working on a project to reach out to local schools.

Eve is looking for a few good Volunteers for community service, to develop a series of lesson plans directed towards Middle School children, using the IEEE Pre-University lesson plans as a guide. The goal of the project is to establish and implement a grade 6 through 12 EE engineering curriculum that could be presented to students in Wake, Durham, Orange and Chatham county schools. We have a charter school, interested in working with us for the first year and I have an introduction to the Middle school science teacher. We have some exciting ideas to help keep students engaged and excited about engineering technology.

We will hold the time commitment to approximately 8 hours per month per volunteer and will try to have all school scheduling in place by the end of August for 2006/2007 school year. We have a core team of volunteers and would like to have a total of 8 to 10 people to call on over the school year. If you

would like to know more and volunteer, contact Eve Barkley at [ebarkley\(at\)nc.rr.com](mailto:ebarkley(at)nc.rr.com) or call 919-368-4517. You can make a difference one child at a time.

The programs steering committee has been hard at work arranging some excellent programs for the coming months. Coming up in a few short weeks on April 19th is our first plant tour. Please join us as we tour NCSU's Center for Embedded Systems Research and learn about their program and state-of-the-art research projects in embedded systems.

For May Dr. Mike Izquierdo from Kidde Aerospace will tell us about designing software for safety critical systems. In our cars, we steer by wire, we brake by wire, and our engine performance is controlled by small computers. But as we rely on these ever-more complex systems, we must be vigilant in creating better and safer software to control them.

The Embedded Systems Group is always looking to expand its base. If you or if you know of anyone who might be interested in our group you can find out more information at our web page at: www.ieee-embedded.org. You can also join us at our virtual community here: <https://www.ieee-communities.org/embedded>.

Upcoming Programs

Tour of NSCU's Center For Embedded Systems Research - Dr. Alex Dean, Dr. Frank Mueller, Dr. Mo-Yuen Chow, and Dr. Grant.

DATE: Wednesday, April 19th.
TIME: 6:30 pm. Social, 7:00 pm Program
LOCATION: NCSU Centennial Campus
DIRECTIONS: <http://www.ieee-embedded.org>

Visit North Carolina State University and learn about both research and education activities in the fields of embedded and real-time systems, robotics, mechatronics, sensor networks and network-based control systems. Faculty and students are working on improving run-time, energy, power, memory and real-time performance by developing advanced techniques in the fields of computer architecture, compilers, operating systems, real-time systems, mechatronics and robotics.

Dr. Dean and the CESR staff and students will present an overview of the embedded curriculum and research activities at the Center for Embedded

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Systems Research. This will be followed by a tour of the different labs and demonstrations of different embedded technologies.

Embedded Software for Safety Critical Systems -
By Dr. Mike Izquierdo

DATE: Monday, May 22nd.
TIME: 6:00 pm. Social, 6:30 pm Program
LOCATION: MCNC (3021 Cornwallis Rd),
DIRECTIONS: <http://www.ieee-embedded.org>

Embedded processors control so many functions around us that we seldom notice that they are there at all. In our cars, we steer by wire, we brake by wire, and our engine performance is controlled by small computers. Airplanes also benefit from intelligent controls, through improved safety and a reduction in weight. But as we rely on these ever-more complex systems, we must be vigilant in creating better and safer software to control them.

Dr. Izquierdo will share his experiences working at Kidde Aerospace on safety-critical systems for the Airbus A380. His presentation will range from the aircraft systems themselves to the tools and standards that help make these systems work. ♦

CAREER DEVELOPMENT

Harold Meder

[hwmeder\(at\)alumni.unc.edu](mailto:hwmeder(at)alumni.unc.edu).

IEEE is interested in helping you to develop your career. The "Eastern NC IEEE Career Development Collaboration" is the formal body to do so and its "Triangle Area Career Development Newsletter" helps in communicating their effort.

Subscribe to this weekly newsletter to keep up with local events that help you to keep up with the latest innovations in your field, network with your peers and develop your career.

What career development activities would you like to have access to? Send your ideas to Harold Meder

<http://rtpnet.org/mailman/listinfo/ieee-jhc> ♦

ANTARCTICA: ITS ICE, LAND AND OCEAN AS VIEWED BY RADARSAT-1

Linda Hayden

[haydenl\(at\)mindspring.com](mailto:haydenl(at)mindspring.com)

On March 7, 2006, the Northeastern North Carolina Chapter of the IEEE-Geoscience and Remote Sensing Society held its Spring Distinguished Lecture Series with Dr. Kenneth Jezek of Ohio State University as the guest speaker. Dr. Jezek is the Principal Investigator on the RADARSAT-1 Antarctic Mapping Project at the Byrd Polar Research Center. His presentation was titled "Antarctica: Its Ice, Land and Ocean as viewed by RADARSAT-1".

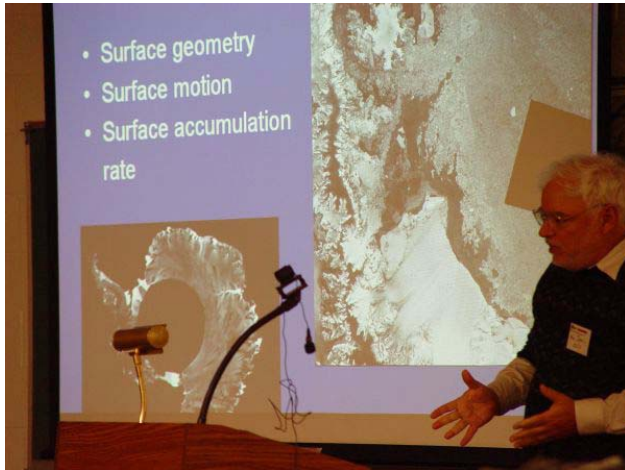


Dr. Ken Jezek is shown answering questions on RADARSAT from Dr. Malcolm LeCompte and Ms. Uniquiea Wade.

The presentation summarizes results from the 1997 and 2000 imaging campaigns. In addition to describing glaciological processes captured in the image mosaics, the RADARSAT 1997/00 data are compared to assess spatial patterns in ice margin advance/retreat, which are themselves contrasted with earlier estimates of ice sheet behavior. Surface velocity data over newly discovered East Antarctic ice streams. These are used to estimate ice

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stream mass balance the role of these ice streams on the stability of the East Antarctic Ice Sheet. Additional information on the RADARSAT-1 Antarctic Mapping Project is available at: bprc.mps.ohio-state.edu/rsl/radarsat/radarsat.html.



Dr. Ken Jezek, previous manager of NASA's polar oceans and ice sheets program and current Principal Investigator on the RADARSAT-1 Antarctic Mapping Project, is shown during the IEEE-GRSS distinguished lecture.

Antarctica is Earth's coldest, windiest, and on average highest of continent. Because of its harsh climate and because it is often covered by clouds or shrouded in darkness during the long polar night, much of Antarctica remained poorly mapped till the end of the last decade. Then in 1997, NASA and the Canadian Space Agency embarked on a collaboration to obtain the first, high resolution synthetic aperture radar image of the southern continent. The first imaging campaign was successfully completed in October 1997 and achieved the primary goal of producing a stunning, new view of Antarctica. It revealed in unprecedented detail extensive networks of ice streams, the positions of ice divides and the ice margin, and even hinted about processes occurring at the base of the ice sheet. Following up on results from the 1997 effort, a second acquisition campaign occurred in the fall of 2000.

Along with providing a second benchmark for measuring changes in ice sheet extent, the 2000 campaign collected interferometric data over much of the ice sheet. These data are being used to measure the surface velocity of the ice sheet, an important parameter for estimating ice sheet mass balance and for understanding the response of the ice sheet to changing climate.



Mr. Charles Luther, Past President of IEEE-GRSS is shown reviewing highlights from the 3-5 March 2006 IEEE-USA Leadership Workshop and awards ceremony

Also during the meeting, recognized Dr. Linda Hayden was recognized for her Professional Achievement Award from IEEE-USA. This award was for outstanding accomplishments in cultivating student interests in engineering and supporting career development. Dr. John Twitchell, Chair of the IEEE-USA Awards and Recognition Committee, joined the meeting by telephone to congratulate Dr. Hayden. Mr. Luther followed with his recognition of her past and current achievements. Dr. William Porter, Chapter Vice President was official representative at the Leadership workshop. ♦

HOW MAXWELL FIXED AMPERE'S LAW

Matt Horrer

Introduction

This article requires some introduction, as the Newsletter usually deals with (local) events. Here, I would like to share with you some fundamental topics from our education as Engineers, which you likely have heard before but probably mostly forgot. It is meant to be easy understandable and I do not skip steps as in "it clearly follows ...". This made this particular contribution a little longer, but it is easier to read it without having a Physics Handbook on the lap. I hope you will enjoy it.

Background

You all have used Maxwells equations, and some may be even very familiar with them. Maxwell is credited for a set of 4 equations that where otherwise know before (almost that is, as we will see). He organized and summarized the then voluminous material into those 4 equations through which everything else can be derived.

Gauss's Law for the electric field

$$\nabla \cdot \vec{E} = \frac{\rho}{\epsilon_0} \tag{1}$$

Faraday's Law

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \tag{2}$$

Gauss's Law for the magnetic field

$$\nabla \cdot \vec{B} = 0 \tag{3}$$

Ampere's Law

$$\nabla \times \vec{B} = \mu_0 \vec{J} \tag{4}$$

These are the differential forms of these laws. An integral form exists for each one as well.

The meaning of the symbols is:

B: magnetic field

E: electric field

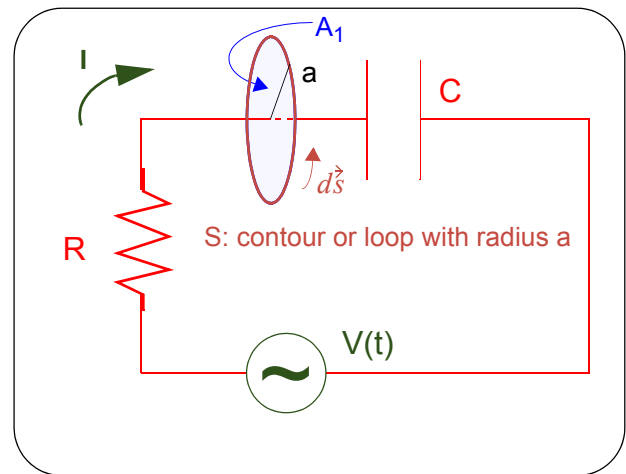
J: current density $\left[\frac{A}{m^2} \right]$

ρ : charge density $\left[\frac{C}{m^3} \right]$

μ_0, ϵ_0 : constant: magnetic permeability, electric permittivity .

Equations (1), (2), and (3) have stood the test of time (so far). As for (4), in 1864 Maxwell realized an inconsistency.

What did he do? Consider the following circuit ():



An AC Voltage source $V(t)$ feeds a capacitor, C via a resistor R , causing a current $I(t)$. The loop radius a is small compared to the length and the distance of the wires in the circuit. This allows us to look at B as if it were caused by a straight wire and thus has only a ϕ component which is also constant on the loop S . ϕ refers to the angular component in a cylindrical coordinate system.

The problem is illustrated in the following way:

In its integral form, Ampere's Law says that the magnetic field is determined by the enclosed currents.

$$\oint_S \vec{B} \cdot d\vec{s} = \mu_0 \int_A \vec{J}(\vec{r}') \cdot d\vec{A}' \tag{5}$$

The left side is just the integration over the loop where B is constant and gives:

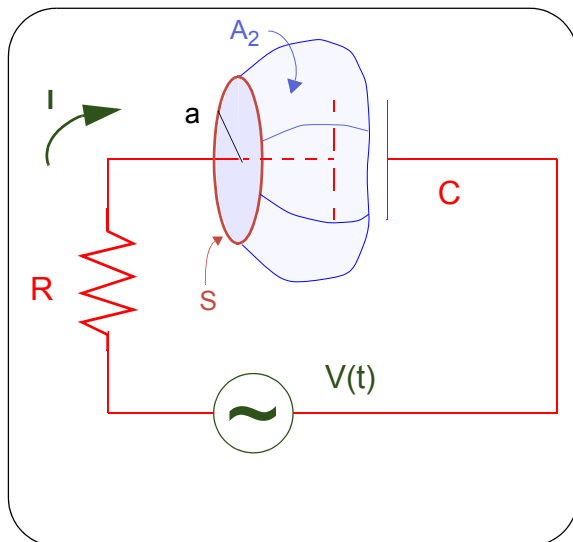
$$B_\phi \cdot 2\pi a, \tag{6}$$

while the right side is $\mu_0 I_{enclosed}$. (7)

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The Problem

Now the problem arises when we realize that the surface A is arbitrary, as long as it shares the same boundary (contour S). Above, we could as well have chosen a surface that goes through the space between the plates of the capacitor, as we will do next (see). Here we do not have a current passing through A_2 . The left side of (5) is still the same, but the right side has no enclosed current. This ends up being a contradiction and needs fixing.



Another way to find the fault is to use the continuity equation:

$$\nabla \cdot \vec{J} = - \frac{d\rho}{dV}, \tag{8}$$

The nabla symbol is used as the “del” (∇) or “del dot” ($\nabla \cdot$) operator for gradient and divergence, respectively.

In equation (4), divergence of the left side is identical zero because $\nabla \cdot (\nabla \times \vec{A}) \equiv 0$ (div grad) is zero for any vector. However, on the right side we find the current density, whose divergence, as we see in (8), is not always zero.

Maxwell’s Solution

We know that

$$I = \frac{dQ}{dt} = \frac{d}{dt} \iiint_V \rho \, dV \tag{9}$$

The differentiation and integration commute, thus:

$$I = \iiint_V \frac{\partial \rho}{\partial t} \, dV. \tag{10}$$

We’ll keep this in mind and look at the current through surface A . Gauss’s Theorem says that:

$$\boxed{\iiint_A \vec{J}(\vec{r}) \cdot d\vec{A} = \iiint_V \nabla \cdot \vec{J}(\vec{r}) \, dV} \tag{11}$$

If the volume is that of , then surface A has to be $A_1 + A_2$. This makes the left side of (11):

$$\iiint_A \vec{J}(\vec{r}) \cdot d\vec{A} = \int_{A_1} \vec{J}(\vec{r}) \cdot d\vec{A}_1 + \int_{A_2} \vec{J}(\vec{r}) \cdot d\vec{A}_2 \tag{12}$$

The first of these terms, we already know (5), (7):

$$\int_{A_1} \vec{J}(\vec{r}) \cdot d\vec{A}_1 = -I \tag{13}$$

The negative sign comes from the normal vector of A_1 pointing in the opposite direction of J . (or I).

And for the 2nd term, because there is no (free) current between the plates is:

$$\int_{A_2} \vec{J}(\vec{r}) \cdot d\vec{A}_2 = 0 \tag{14}$$

The left side of (11) equals (13)+(14), which equals $-I$. Thus the right side of (11) has to also equal $-I$. Then because of (10) => (10) = - (11), using the right side of those equations, we can write

$$\boxed{-\iiint_V \frac{\partial \rho}{\partial t} \, dV = \iiint_V \nabla \cdot \vec{J}(\vec{r}) \cdot dV} \tag{15}$$

The integrand has to be the same.

$$\nabla \cdot \vec{J}(\vec{r}) = -\frac{\partial \rho}{\partial t} \text{ or } \boxed{\nabla \cdot \vec{J}(\vec{r}) + \frac{\partial \rho}{\partial t} = 0}, \tag{16}$$

This is again the continuity equation.

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$$\text{with (1) we get: } \nabla \cdot \vec{J}(\vec{r}) + \frac{\partial}{\partial t} \varepsilon_0 \nabla \cdot \vec{E} = 0 \quad (17)$$

Divergence and time derivative commute. Rearranging some more and introducing $\vec{D} = \varepsilon_0 \vec{E}$,

we can write (17) in the following way:

$$\boxed{\nabla \cdot \left(\vec{J}(\vec{r}) + \frac{\partial \vec{D}}{\partial t} \right) = 0} \quad (18)$$

Maxwell called the term $\frac{\partial \vec{D}}{\partial t}$ the displacement current. He then rewrote (5), which we call the Ampere-Maxwell Law

$$\boxed{\nabla \times \vec{B} = \mu_0 \left[\vec{J} + \frac{\partial \vec{D}}{\partial t} \right]} \quad (19)$$

This is the fix to Ampere's law. The great significance is that it postulates that a changing electric field produces current.

The displacement current is difficult to measure as the related magnetic field is very weak in comparison to the magnetic field of the Earth. Measurements of the displacement current were performed by Bartlett + Corle in 1985. In their setup, B was about $1.4 \cdot 10^{-10} T$, while $B_{Earth} \approx 3 \cdot 10^{-5} T$.

However small, it is the basis for electromagnetic waves.

Before I close, I want to thank Prof. Mowat at NCSU for the helpful conversations in compiling this article.

Source:

- [1] Pollack & Stump, Electromagnetism, Addison Wesley, 2002.
- [2] Lehner, Günther, Elektromagnetische Feldtheorie für Ingenieure und Physiker, Springer, 1996.
- [3] D. F. Bartlett and T. R. Corle, Physical Review Letters, Volume 55, No.1, pp. 59-61 (1985). ♦

IEEE EVENTS THIS SPRING

Wednesday, April 19, 6:30 pm.

Tour of NCSU's Center For Embedded Systems Research

Speaker: Dr. Alex Dean

Location: NCSU Centennial Campus

<http://www.ieee-embedded.org>

May 7 - 11 ANTEC 2006

Location: Charlotte Convention Center

www.4spe.org/conf/antec06

Monday, May 22, 6:00 pm

Embedded Software for Safety Critical Systems

Speaker: Dr. Mike Izquierdo

Location: MCNC (3021 Cornwallis Rd)

<http://www.ieee-embedded.org>

May 22 - 23 BioTech 2006

Location: Benton Convention Center, Winston-Salem, NC

www.cednc.org/conferences/biotech/2006

June 9 - 11

Research Triangle Software Symposium

Location: Marriott RTP, Durham, NC

[www.nofluffjuststuff.com/](http://www.nofluffjuststuff.com/show_view.jsp?showId=55)

[show_view.jsp?showId=55](http://www.nofluffjuststuff.com/show_view.jsp?showId=55)

Sept. 25-29 PCB Design Conference East

Location: Marriott Durham Civic Center

www.pcbeast.com/

CONTACT INFORMATION FOR IEEE EASTERN N.C. SECTION

2006 Officers and Volunteers

Section Officers

Section Chair

Roger Lawrence

[rogerlawrence\(at\)rglsolutions.com](mailto:rogerlawrence(at)rglsolutions.com)

Section Vice Chair

Thomas Jepsen

[tjepsen\(at\)mindspring.com](mailto:tjepsen(at)mindspring.com)

Section Secretary

Dev Palmer

[dev.palmer\(at\)ieee.org](mailto:dev.palmer(at)ieee.org)

Section Treasurer

Jai Singh Arun

[jai\(at\)computer.org](mailto:jai(at)computer.org)

Past Section Chair

Dave Ruden

[druden\(at\)taprootsystems.com](mailto:druden(at)taprootsystems.com)

Committee Chairs

Awards & Recognition

Lee C. Haas

[eelee\(at\)ieee.org](mailto:eelee(at)ieee.org)

Educational Activities

Jai Singh Arun

[jai\(at\)computer.org](mailto:jai(at)computer.org)

Membership Development

Jim Ray

[jim\(at\)NEUSE.NET](mailto:jim(at)NEUSE.NET)

Professional Activities

Charles J. Lord

[c.j.lord\(at\)ieee.org](mailto:c.j.lord(at)ieee.org)

Student Activities

Dan House

[d.house\(at\)computer.org](mailto:d.house(at)computer.org)

Newsletter Editor

Matt Horrer

[mhorrer\(at\)ieee.org](mailto:mhorrer(at)ieee.org)

Chapter Chairs

Computer Society

Chris Siegl

[siegl\(at\)ieee.org](mailto:siegl(at)ieee.org)

Engineering in Medicine and Biology (EMBS)

Thomas Jepsen

[tjepsen\(at\)mindspring.com](mailto:tjepsen(at)mindspring.com)

Electro-Magnetic Compatibility

Glenn Robb

[robb\(at\)compliance-engineering.com](mailto:robb(at)compliance-engineering.com)

Power Engineering / Industrial Applications

Roger Lawrence

[rogerlawrence\(at\)rglsolutions.com](mailto:rogerlawrence(at)rglsolutions.com)

Geoscience and Remote Sensing

Linda Hayden

[haydenl\(at\)mindspring.com](mailto:haydenl(at)mindspring.com)

Communications / Information Technology

Thomas Jepsen

[tjepsen\(at\)mindspring.com](mailto:tjepsen(at)mindspring.com)

Engineering Management Society

Subrotro Bhattacharya

[subroto\(at\)computer.org](mailto:subroto(at)computer.org)

Robotics and Automation

Grayson Randall

[g.randall\(at\)ieee.org](mailto:g.randall(at)ieee.org)

ACME (AP/CPMT/MTT/ED)

Todd Nichols

todd.nichols@harris.com

Signal Processing

Joel Trussell

[hjt\(at\)ncsu.edu](mailto:hjt(at)ncsu.edu)

State Educational Society

Steve Walsh

Computational Intelligence

Mo-Yuen Chow

[chow\(at\)eos.ncsu.edu](mailto:chow(at)eos.ncsu.edu)

Special Interest / Affinity Chairs

Employment Committee

Harold Meder

[hwm\(at\)ieee.org](mailto:hwm(at)ieee.org)

Biotech Job Hunt Collaboration

Walter Heger

[heger_walter\(at\)yahoo.com](mailto:heger_walter(at)yahoo.com)

Embedded Systems Special Interest Group

Steve Lund

[slund-ieee\(at\)pobox.com](mailto:slund-ieee(at)pobox.com)

Women in Engineering Affinity Group

Jana Jenkins

[jljenkin\(at\)hotmail.com](mailto:jljenkin(at)hotmail.com)

K-12 Outreach

Chris Siegl

[siegl\(at\)ieee.org](mailto:siegl(at)ieee.org)

IEEE-ENCS CARE Representative

Lee Griffin

[leedgriffin\(at\)ieee.org](mailto:leedgriffin(at)ieee.org)

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