IEEE Magnetics Society
NEWSLETTER

Volume 44 No. 4 **October 2005**

Martha Pardavi-Horvath, Editor

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2005-2006

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Roy	Chantrell	Distinguished Lecturers Coordinator	Seagate Research
David	Jiles	Editor in Chief of the Transactions	Ames Laboratory
Diane	Melton	Executive Director	Courtesy Associates
Martha	Pardavi-Horvath	Newsletter Editor	George Washington U.

CHAPTERS CORNER

THREE NEW CHAPTERS FORMED!

Since April this year, ***THREE*** new society chapters have been formed.
The new chapters are:

- **SENDAI, JAPAN** under the chairmanship of **Prof. Hiroaki Muraoka.**
- **SOUTH BRAZIL** under the chairmanship of **Prof. Renato Carlson.**
- **TAIWAN, TAIPEI** under the chairmanship of **Prof. Ching-Ray Chang**

This is really good news for the society as it means that the magnetics community is active in these local areas, and society members and guests alike can meet under the IEEE Magnetics Society banner to their technical and social benefit. We wish them all the best for the future.

IEEE Magnetics Society Chapters

	Chapter Name	Local Chapter Chair	Email Address
1	CENTRAL & SOUTH ITALY	GUGLIELMO RUBINACCI	rubinacci@unicas.it
2	CENTRAL NEW ENGLAND	ADAM TORABI	adam_torabi@maxtor.com
3	CHICAGO	JEAN F OSTIGUY	OSTIGUY@FNAL.GOV
4	DENVER, ROCKY MOUNTAIN	DAVE PAPPAS	pappas@boulder.nist.gov
5	HOUSTON	JEFFERY WILLIAMS	jwilliams@uh.edu
6	JAPAN	SHIGERU TSUNASHIMA	tsunashi@nuee.nagoya-u.ac.jp
7	LOS ANGELES	JACK JUDY	jjudy@ee.ucla.edu
8	MILWAUKEE	MARK JUDS	markajuds@eaton.com
9	PHILADELPHIA	Position Open	
10	PITTSBURGH	MIKLOS GYIMESI	miklos.gyimesi@aNsys.com
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15	SANTA CLARA VALLEY/SAN FRANCISCO	GERADO BERTERO	Gerardo.Bertero@komag.com
16	SEOUL, KOREA	YOUNG KIM	ykim97@korea.ac.kr
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20	UNITED KINGDOM & REPUBLIC of IRELAND	MIKE GIBBS	M.R.Gibbs@sheffield.ac.uk
21	WASHINGTON/NORTHVIRGINIA	CAN KORMAN	korman@seas.gwu.edu

If you are the local chapter chairman reading this, please share with us all that's happening in your chapter and local area (e.g. talks, people activity, magnetics news, company or university news, etc.). Forward a

paragraph (or two), a picture, a reference to an interesting article or something inventive or newsworthy (in your opinion) to me at r.dee@ieee.org so we can include it in the next MagSoc newsletter.

Dr. Richard H. Dee
Magnetics Society Chapters Chair
r.dee@ieee.org

THE DISTINGUISHED LECTURER PROGRAM OF THE MAGNETICS SOCIETY

The Distinguished Lecturer (DL) program of the IEEE Magnetics Society has been in existence for a number of years. On an annual basis, three DLs are nominated and funded by the Magnetics Society to deliver a lecture by invitation of individual institutions or chapters. At the recent AdCom meeting an outline of the formal aims of the program were discussed and approved.

It is hoped that the adoption and pursuance of these aims will enhance the already significant contribution of the DL program to the vitality of the Magnetics Society and the field of magnetics overall.

1. The aims of the DL Programme

- To celebrate achievements in magnetics and honour the finest researchers and communicators in the field.
- To provide outreach to the wider community and promote the trans-national aims of the Magnetic Society.
- To support Chapter activities by providing high profile speakers for local meetings.
- To inspire and enthuse, especially young researchers entering a career in magnetics.
- To advertise and promote the IEEE Magnetics Society as the society of choice for magnetics professionals.
- To act as an engine to recruit new members to the Magnetics Society.

2. Criteria for Selection

Given the aims of the DL programme there are two principal criteria, based on awarding DL's to dynamic individuals with a strong presence in their field. However, the outreach aims of the programme also suggest further secondary criteria.

Principal Criteria

- Excellence in some field of magnetics. This is not limited to excellence in research, but should also recognise the important contributions of individuals in developing the applied/technical aspects of magnetics.
- Excellent communication skills.

Secondary Criteria

- Diversity
  - Technical – coverage of as many aspects of magnetics as possible
  - Geographical
  - Gender and Ethnic

- The DL should also be a member of the Magnetics Society. Under exceptional circumstances a non-member can be considered as long as he/she agrees to become a member.

This year we have an excellent set of DL's giving talks on 3 diverse areas:

- Half-Metals, Spin Torque, and Nanorings (Prof. Chia-Ling Chien, Johns Hopkins),
- Micro Fabrication Techniques for Magnetic Information Storage Devices: From Bubbles to Thin Film Recording Heads to Nano Magnetic Structures (Dr. Robert E. Fontana, Jr. Hitachi Global Storage Technologies), and
- Dynamics in magnetic micro- and nanostructures (Prof. Burkard Hillebrands, Technische Universität Kaiserslautern)

Further details of their talks, in addition to brief biographies, can be found in the following section. The DL's are currently in the process of finalizing their plans for the second half of the year, so if you are interested in having one (or more) talk in your location, now would be a good time to issue the invitation! Please contact the DL's directly for their availability or contact the DL coordinator (Roy Chantrell, rc502@york.ac.uk) for further information or help with arrangements. Roy would also be happy to receive comments on the aims of the program and any suggestions for its further development. He would also be interested in hearing of innovative use of the program, so as to be able to circulate examples of good practice. As one example, the UK chapter has a record of organizing "topical meetings" around the visit of a DL, in which the DL presentation is complemented by a further 2-3 invited talks within the same area. These meetings have proven extremely popular and made the Magnetics Society very attractive to UK magneticians.

Finally, the success of the DL program was founded on the efforts of previous coordinators (Isaak Mayergoyz and Stan Charap). On behalf of the membership, the awards committee chair (Bruce Gurney) and Roy Chantrell would like to record their appreciation of a job well done by Isaak and Stan in creating a lively and effective program with its enormous contribution to the activities of the Magnetics Society.

Roy Chantrell
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IEEE MAGNETICS SOCIETY
DISTINGUISHED LECTURERS FOR 2005

Half-Metals, Spin Torque, and Nanorings

Chia-Ling Chien
The Johns Hopkins University

The exploration of magnetic nanostructures in recent years has resulted in a string of discoveries such as interlayer coupling, giant magnetoresistance (GMR), exchange bias, and tunneling magnetoresistance. Some of these effects were utilized as read heads in high-density magnetic recording and nonvolatile magnetic storage only a few years after the original discovery. In this talk, I will describe several new topics in magnetic nanostructures from inception to realization to potential applications. Most magnetoelectronic properties are the results of the spin polarization of the constituent materials. The ultimate spin-polarized material with 100% spin polarization is called the half-metal. For example, magnetic tunnel junctions with half-metal electrodes would have the largest possible effect, switching between conducting and insulating states. The unique characteristics of halfmetals, the experimental identifications, and the confirmation of half-metals to date will be described. Since electrons have spin in additional to charge, a spin-polarized current carries angular momentum. For a large current density, the angular momentum can exert a substantial torque onto a receiving magnetic entity to excite spin waves or even to switch its magnetization. The spin torque effects are accomplished in the absence of an external magnetic field. The salient aspects of the spin torque effects in different contexts, such as switching and magnetic recording without a magnetic field, will be described. Nanorings are small entities with special attributes. A magnetic nanoring can support vortex state despite its very small size. The two chiralities of the vortex state can be exploited for magnetic recording purposes. Multilayered nanorings have also been proposed as vertical random access memory (VRAM) units. However, fabrication of nanorings using e-beam lithography has considerable limitations in the number of rings, ring size, and areal density. We have developed a new method with which a large number (10^9) of small (100 nm) rings can be fabricated with a very areal density of 45 rings per square micrometer. The magnetic and other characteristics of such arrays of nanorings will be described.

Chia-Ling Chien received the B.S. degree in physics from Tunghai University, Taichung, Taiwan, R.O.C., in 1965 and the Ph.D. degree in physics from Carnegie Mellon University, Pittsburgh, PA, in 1972. He has been a Member of the faculty in the Department of Physics and Astronomy of Johns Hopkins University, Baltimore, MD, since 1976, where he is the Jacob L. Hain Professor in Arts and Sciences. He currently directs the Material Research Science and Engineering Center on Nanostructured Materials at Johns Hopkins. His recent research focuses on magnetic nanostructures including magnetic granular solids, nanowires, multilayers, and arrays of rings and dots, and the exploration of GMR, exchange bias, half-metals, spin torque effects, Andreev reflection, and point-contact spectroscopy. He has written more than 300 journal articles and holds several patents. He is one of the ISI's 1120 most cited physicists. He has served as Meeting Chair and Chair of the Advisory Committee of the Conference on Magnetism and Magnetic Materials. He has been awarded honorary professorships at Nanjing, Lanzhou, and Fudan Universities in China. Dr. Chien is a Fellow and the 2004 recipient of the David Adler Award of the American Physical Society.

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Micro-Fabrication Techniques for Magnetic Information Storage Devices: From Bubbles to Thin-Film Recording Heads to Nanomagnetic Structures

Robert E. Fontana, Jr.
Hitachi Global Storage Technologies

This lecture examines magnetic device structures from the perspective of thin-film processing. Techniques for forming magnetic device structure minimum features will be compared with semiconductor processing. Future storage density growth in both magnetic memories and magnetic recording will be projected using semiconductor roadmaps. The "nano" characteristics (thickness and length scale) of next-generation magnetic thin-film heads and magnetic memory devices will be compared with solid-state semiconductor designs. In the past 25 years, the bit cell size for storage products incorporating magnetic device structures decreased from 156 μm^2 bit cells (IBM 3390 disk drive) to 0.007 μm^2 (Hitachi Travelstar 5K100 mobile disk drive). For the same period, the bit cell size in nonvolatile memory products incorporating magnetic device structures decreased from 625 μm^2 (TI 100 kb bubble memory) to 1.6 μm^2 (Motorola 4Mb magnetic random access memory). These 10 to 10 increases in information storage densities resulted from increased understanding in the physics of magnetic phenomena, from advances in materials science and engineering for magnetic thin films, from development of new magnetic modeling techniques, and from dramatic improvements in the capability to fabricate magnetic device structures with smaller minimum features. The manufacture of cost-effective magnetic device based information storage products requires high-yield processing technologies for the magnetic transducer or memory element in these products. Such processing technologies are now producing devices with 120 nm features (80 Gb/in storage densities) and these same processing technologies are extendable to 30 nm features (1 Tb/in storage densities). The lecture will conclude with discussions on nanoscale processing challenges.

Robert E. Fontana, Jr. received the B.S., M.S., and Ph.D. degrees in electrical engineering from the Massachusetts Institute of Technology, Cambridge, in 1969, 1971, and 1975, respectively. He is a Research Staff Member within the recording head processing function of the San Jose Research Center, Hitachi Global Storage Technologies (GST), San Jose, CA. His technical activities have concentrated on developing and improving thin-film processing techniques for fabricating magnetic device structures, first at Texas Instruments from 1975 to 1981 with magnetic bubbles, then from 1981 to 2002 at IBM with thin-film heads, and from 2003 to the present at Hitachi GST with novel flux detecting sensors and nanostructure fabrication with e-beam lithography. During his career, he has transferred processing methodologies for magnetic bubbles, magnetoresistive thin-film heads, spin-valve giant magnetoresistive thin-film heads, and tunnel-valve thin-film heads from research concepts to manufacturing realizations. He has authored 37 papers on magnetic devices and processes and has 55 patents in thin-film magnetic structures. Dr. Fontana was named an IEEE Fellow in 1996 and he received the IEEE Cledo Brunetti Award for excellence in the art of electronic miniaturization in 2000. He was elected to the National Academy of Engineering (NAE) in 2002 for his contributions in magnetic device processing. He has served as President of the IEEE Magnetics Society (2001, 2002), as General Chair of the 1996 Magnetism and Magnetic Materials Conference, as General Chair of the 2004 Joint International Magnetics Conference and Magnetism and Magnetic Materials Conference, and is serving as an NAE member on the National Research Council's (NRC) Board on Manufacturing and Engineering Design (2003–2005).

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Dynamics in Magnetic Micro- and Nanostructures

Burkard Hillebrands
Technische Universitdt Kaiserslautern

For applications in sensors and in data storage, the dynamic properties of microstructures and nanostructures have gained increasing attention. The fundamental excitations in these objects are confined spin waves, and it is useful in particular to understand their properties in view of the noise spectrum in sensor and magnetoresistive random access memory (MRAM) applications. The lecture addresses the dynamics in homogeneously and inhomogeneously magnetized objects starting with an introduction to spin waves and the effects of finite dimensions. In inhomogeneous systems the excitation spectrum is complex, and new phenomena, such as localization and tunneling of modes, are discussed. The key points are illustrated by results obtained by space- and time-resolved Brillouin light scattering, which allows one to follow experimentally the propagation of spin-wave packets and to present the results in an animated format. To conclude the lecture, the analysis of ultra-high-frequency dynamic properties (2–100 GHz) of small magnetic elements with spatial resolution in the 300 nm range is presented.

Burkard Hillebrands received the diploma and Ph.D. degrees in physics from the University of Cologne, Cologne, Germany, in 1982 and 1986, respectively. After a postdoctoral stay at the Optical Sciences Center, Tucson, AZ, he received the habilitation from the RWTH Aachen, Aachen, Germany, in 1993. He was an Associate Professor at the University of Karlsruhe, Karlsruhe, Germany, in 1994. Since 1995, he has been a Full Professor at the University of Kaiserslautern, Kaiserslautern, Germany. He is the coordinator of the German priority program "Ultrafast Magnetization Processes," the vice coordinator of the German research unit "New Materials with High Spin Polarization," and he coordinates a European network on "Ultrafast Magnetization Processes in Advanced Devices." He is currently the head of the Material Research Center for Micro- and Nanostructures (MINAS) at the University of Kaiserslautern. He is a member of the granting board for collaborative research centers (SFB) of the senate of the Deutsche Forschungsgemeinschaft and a member of the Editorial Board of the *Journal of Physics D: Applied Physics*. His research field is mostly in magnetoelectronics. His special interests are in spin dynamics, material properties of thin magnetic films and multilayers, exchange bias, as well as in elastic properties of layered structures. In the field of spin dynamics, he is particularly interested in dynamic magnetic excitations in confined magnetic structures, magnetic switching, and nonlinear magnetic phenomena using space- and time-resolved Brillouin light scattering spectroscopy and time-resolved Kerr effect techniques. He has published more than 170 articles, five patents and patent applications, seven book contributions, and he is co-editor of the Springer-Verlag book series on "Spin Dynamics in Confined Magnetic Structures."

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CONFERENCE REPORTS

TMRC 2005 REVIEW

The 16th Annual Magnetic Recording Conference (TMRC 2005) was held at the Stanford University, California, from Aug. 15 to 17. The main topics for the conference were **Heads and Systems**. This included Read Head, Write Head, Perpendicular recording heads and systems, Recording systems, Advanced coding/detection and Reliability/Mechanics.

The conference was a huge success with 406 registrants, the largest attendance in the history of this conference. On Tuesday evening, Mark Kryder, CTO ofSeagate Technologies, discussed future technology options for the magnetic recording industry. In his view, conventional Perpendicular magnetic recording is limited to about 0.5 Tbit/sq inch areal density. Heat Assisted Magnetic Recoding (HAMR) and Patterned media options are expected to be required beyond 0.5 Tbit/sq inch areal density point.

The technical sessions were well represented by both the industry and the universities. There were 36 invited talks with authors from 23 institutions: ActionFront Data Recovery Labs, Agere systems, Alps, Anelva, ChannelScience, Fujitsu, Headway, Hitachi, Hutchinson, Matsushita, Maxtor, Panasonic, SAE, Seagate, Sony, StorageTek, TDK, Toshiba, UC Berkeley, CMU/DSSC, UCSD/CMRR, Data Storage Institute Singapore and Harvard. Along with these invited papers, 16 Poster submissions were also presented in two day very popular poster sessions, which accompanied by Bierstube, were highly enjoyed by the attendees. The authors for Poster-only papers were from additional 21 institutions: Universita di Ferrara (Italy), Universita di Brescia (Italy), Akita Institute of Technology (Japan), Waseda University (Japan), Tandberg Storage (Norway), Moscow State University, Kharkov Politechnical Institute (Ukraine), Samsung, The University of Alabama, Unversity of Limerick (Ireland), Ruterges University, Univ. of Cambridge, Stanford Unversity, National Taiwan Unversity, Imago Scientific Instruments Corp., Toshiba, Unversity of Toledo (Ohio), National Unversity of Singapore, Niigata Institute of Technology (Japan), Kogakuin University (Japan). Such a diverse representation from both industry and universities from around the globe confirms the international nature and popularity of this conference.

TMRC 2005 conference clearly showed transition to the CPP sensors and the Perpendicular recording.

The papers A-1 (TDK,"A performance study of next generation's TMR head with advanced design") and F-1 (SAE,"Reliability of Tunneling MR recording head—Lifetime, Failure mode and Production screening") on Tunnel MR heads demonstrated performance and reliability of these heads. One notable result from paper F-1 (SAE) is that the short-lifetime heads can be screened by using appropriate limits for %dMRR change (head resistance change between high and low current). More positive resistance change implies that the TMR barrier has a larger metallic shunt path in the barrier. These are the heads found to have shorter lifetime. Also discussed were reversible resistance change of the head due to charge trapping and then charge release causing time dependent changes in head resistance and output signal. Anelva Corp. (paper A-3,"Huge MR and low RA in magnetic tunnel junctions with crystalline MgO barrier") showed optimization of the CoFeB/MgO/CoFeB type Tunnel MR sensor. It was shown that near zero magnetostriction and TMR near 100% is achievable using Co64Ni11Fe6B19 type free layer. Seagate (paper A-2, "Characterization and integration of TMR heads in high capacity Hard disk drives") demonstrated use of Tunnel MR heads in disk drives and also claimed that these heads can be produced without 1/f type head noise, however, it offered no barrier composition or other design/process details required to eliminate or screen the heads with 1/f noise. There were four papers on CPP GMR heads. Alps (paper A-5,"Narrow track width CPP spin valve heads utilizing Half-Metallicity materials") claimed superior performance, dR/R = 11 %, for the all metal dual CPP GMR heads containing reference/free layers of half-metallicity materials. Extension to smaller area sensors with this structure as compared to the Tunnel MR is the major motivation due to limitations of Tunnel MR for

high data rate applications. Alps also compared performance of this CPP GMR sensor against Tunnel MR made from TiOx barrier and demonstrated that CPP GMR achieves performance similar to Tunnel MR but with much lower RA product. These CPP GMR heads with track width of 70 nm exhibited spectral SNR of 15 dB and bit error rate comparable to CIP GMR heads. A paper from Hitachi (paper B-2,"Mag-noise fluctuations in CPP GMR read heads") on the CPP GMR demonstrated that the reference layer instability caused by the spin torque likely sets sense current limits for the all metal dual CPP GMR operating under large sense current. A paper by Fujitsu (B-6,"Ultra high magnetic moment films for write head"), showed larger saturation magnetization (near 2.57 T) for the Co30Fe70/Pd superlattice films for the write pole application.

Several speakers demonstrated areal density beyond 200 Gbit/sq inch using Perpendicular recording technology. Hitachi (Paper C-1,"Head challenges for Perpendicular recording at high areal density") demonstrated areal density near 230 Gbit/sq inch using Perpendicular recording disk and CIP GMR read heads. Seagate (paper A-2) demonstrated areal density near 254 Gbit/sq inch using Perpendicular recording disk and Tunnel MR heads. Toshiba (paper D-1,"Perpendicular drive integration") described Perpendicular magnetic recording drive integration.

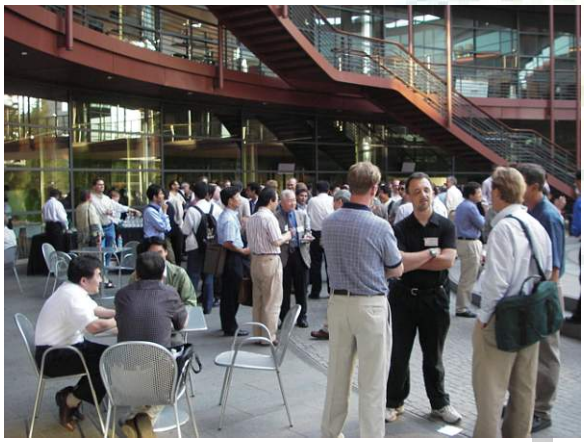
Several other papers discussed important new technologies for the magnetic recording industry. A Poster submission from Akita Institute of Technology titled "Novel shielded single pole head with planar structure " by Ise et al., showed novel head structure exhibiting smaller drop in head field as the shield yoke height is increased compared to conventional single pole heads. Another Poster submission from Akita Institute of Technology and Waseda University,"Controlling magnetic domain structures for the core of the Cusp-field single pole head" by Yamakawa et al., showed yoke/shield design to achieve favorable domain structure which is required for high magnetic stability and high frequency performance. A paper (F-5,"Demonstration of external shock resistance greater than 2000 G during R/W operations on a 0.85 inch HDD with balanced type head suspension") from Matsushita/Panasonic demonstrated suspension design exhibiting greater than 2000 G external shock resistance. A paper (F-3,"Some air bearing slider designs for areal density of 1 Tbit/sq inch) from UC Berkeley showed several slider designs suitable for 1 Tb/ sq inch magnetic recording. Several invited papers on the novel coding/detection schemes were also presented.

Harry Gill
Conference Chairman
TMRC2005

Guests enjoying refreshments outside the Hewlett Teaching Center Auditorium, Stanford University.

Prof. Shan Wang (Local Chair) welcoming guests.

PICTURES OF A CONFERENCE
TMRC 2005



Prof. R.L. White welcoming guests to Stanford University at the opening of TMRC2005.

Mark Kryder giving the keynote speech at the conference Banquet event.

PICTURES OF A CONFERENCE
TMRC 2005

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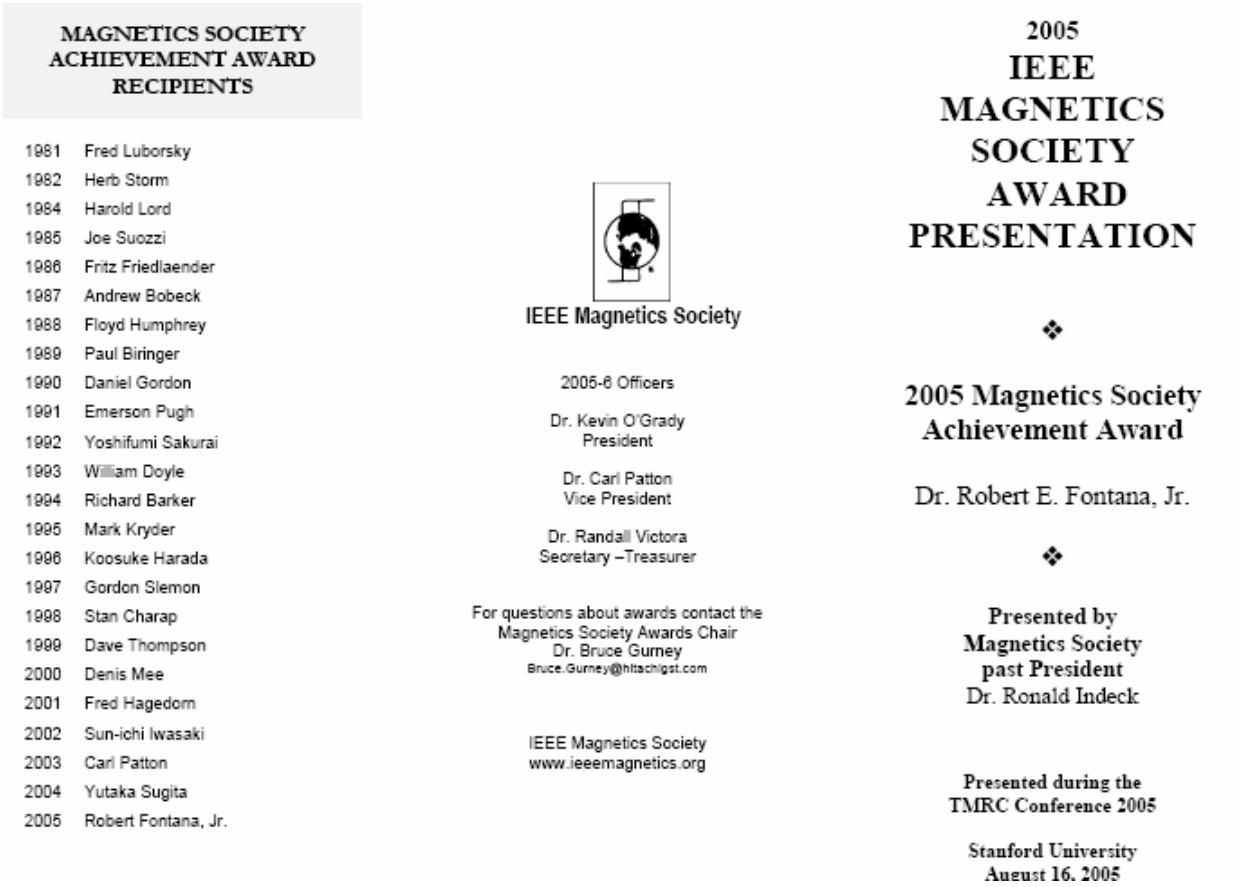
THE MAGNETICS SOCIETY ACHIEVEMENT AWARD

Robert E. Fontana, Jr was presented with the **MAGNETICS SOCIETY ACHIEVEMENT AWARD** at the Magnetic Recording Conference. The Award consists of a $2500 check and certificate.

C. Denis Mee, previous recipient of the award and well known pioneer in magnetic recording, delivered an animated speech, outlining the history of the award and detailing Bob's many contributions to magnetics research and the magnetism community.



MAGNETICS SOCIETY ACHIEVEMENT AWARD RECIPIENTS

1981 Fred Luborsky
1982 Herb Storm
1984 Harold Lord
1985 Joe Suozzi
1986 Fritz Friedlaender
1987 Andrew Bobeck
1988 Floyd Humphrey
1989 Paul Biringer
1990 Daniel Gordon
1991 Emerson Pugh
1992 Yoshifumi Sakurai
1993 William Doyle
1994 Richard Barker
1995 Mark Kryder
1996 Koosuke Harada
1997 Gordon Slemon
1998 Stan Charap
1999 Dave Thompson
2000 Denis Mee
2001 Fred Hagedorn
2002 Sun-ichi Iwasaki
2003 Carl Patton
2004 Yutaka Sugita
2005 Robert Fontana, Jr.

IEEE Magnetics Society

2005-6 Officers

Dr. Kevin O'Grady
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Vice President

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For questions about awards contact the
Magnetics Society Awards Chair
Dr. Bruce Gurney
Bruce.Gurney@hitachigst.com

IEEE Magnetics Society
www.ieeemagnetics.org

2005
IEEE MAGNETICS SOCIETY AWARD PRESENTATION

❖

2005 Magnetics Society Achievement Award

Dr. Robert E. Fontana, Jr.

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Presented by
Magnetics Society
past President
Dr. Ronald Indeck

Presented during the
TMRC Conference 2005

Stanford University
August 16, 2005

THE MAGNETICS SOCIETY ACHIEVEMENT AWARD

On a regular basis the IEEE Magnetics Society honors a member with the Magnetics Society Achievement Award for exemplary technical achievements in the field of magnetics and outstanding contributions to the magnetics community, especially through service to the Society.

IEEE Magnetics Society

DR ROBERT E. FONTANA, JR
2005 Magnetics Society Achievement Award

"For his pioneering technical leadership in magnetic data storage, especially recording head structures and fabrication, and for twenty years of service to the IEEE Magnetics Society."

Robert E. Fontana, Jr. received the B.S., M.S., and Ph.D. degrees in electrical engineering from the Massachusetts Institute of Technology, in 1969, 1971, and 1975, respectively.

He is a Research Staff Member within the recording head processing department of the San Jose Research Center, Hitachi Global Storage Technologies (GST), San Jose, CA.. His technical activities have concentrated on developing and improving thin-film processing techniques for fabricating magnetic device structures, first at Texas Instruments from 1975 to 1981 with magnetic bubbles, then from 1981 to 2002 at IBM with thin-film heads, and from 2003 to the present at Hitachi GST with novel flux detecting sensors and nanostructure fabrication with e-beam lithography. During his career, he has transferred processing methodologies for magnetic bubbles, magnetoresistive thin film heads, spin-valve giant magnetoresistive thin-film heads, and tunnel-valve thin-film heads from research concepts to manufacturing realizations. He has authored 39 papers on magnetic devices and processes and has 70 patents in thin-film magnetic structures. Dr. Fontana became an IEEE Fellow in 1996 and received the IEEE Cledo Brunetti Award for excellence in the art of electronic miniaturization in 2000. He was elected to the National Academy of Engineering in 2002 for his contributions in magnetic device processing, and contributes to the National Research Council. He has served a President of the IEEE Magnetics Society (2001, 2002), as General Chair of the 1996 Magnetism and Magnetic Materials Conference, as General Chair of the 2004 Joint International Magnetics Conference and Magnetism and Magnetic Materials Conference, and in many other posts. He is presently a Magnetics Society Distinguished Lecturer.

Bob Fontana upon receiving the Award:

Thank you, Denis and Bruce for this award. Let me also thank the nominating committee for their confidence in selecting me as the 2005 recipient of the IEEE Magnetics Society Achievement Award. Most important, I want to acknowledge and thank my wife, Barbara, who has provided me support and encouragement for my activities in magnetism and for my volunteer efforts for the society. Thank you so very much, Barbara, for your support!!!

I recently reflected on my magnetism career for the last 30 years when Bruce asked me for a brief biography. I chose magnetism as a career because of an event at MIT in 1970 when an IEEE Magnetics Society representative, Andy Eschenfelder, talked about a new memory technology, Magnetic Bubbles, and showed video tape pictures of bubbles or bits moving around shift registers. So, I traded in the concepts of holes and electrons and "junction physics" for spin and domain walls and here I am today.

Seriously, my career (technical and service) in magnetism has been characterized by the good fortune of having mentors and the good fortune of riding the Moore's Law curve in a technology.

At MIT, Prof. Epstein, my advisor, taught me the meaning of "it is not finished until it is finished" and introduced me to the concept of volume effects in materials, a code word for **not** semiconductors and for magnetism and ferroelectrics and mass transport. Prof. Dennis Buss gave me an industrial perspective for non semiconductor devices.

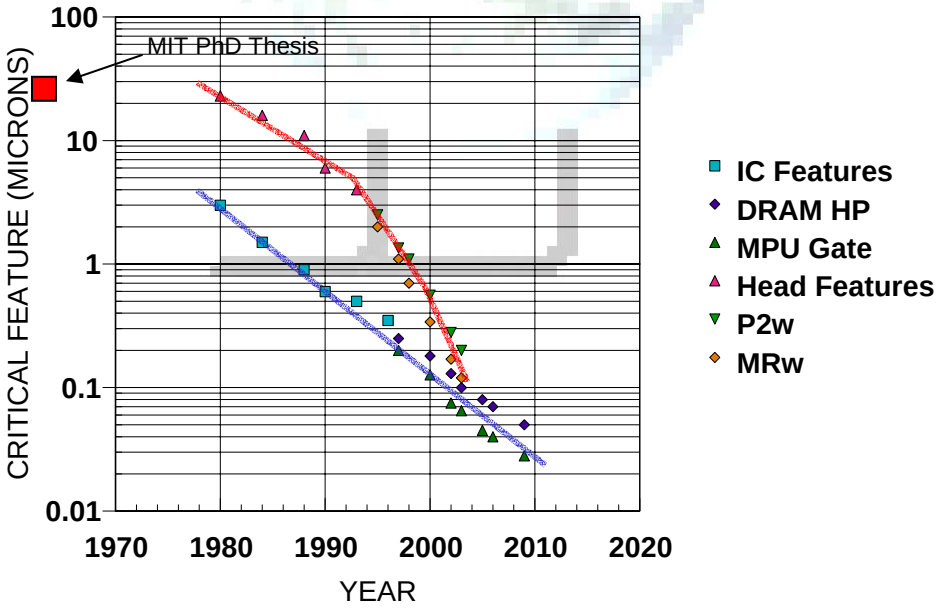
At TI, Dean Toombs, a VP in charge of Bubbles, taught me the concept of the "tyranny of numbers" in device processing. He also said that in this processing business to survive, you only have to be right more than you are wrong (he showed me the transitions he managed from 1" to 2" to 3" silicon) but he said never be wrong two times in a row. Dennis Buss, now a TI VP and the inventor of the CCD concept, taught me to be aware of the capabilities of Si CMOS and scalability as I was leaving for IBM

At IBM, a few mentors come to mind: Ta Lin Hsu who decreed that one will liftoff FeMn and it will not corrode, Ching Tsang who said "thou shalt keep every free layer on a "magnetic leash", i.e. stabilization, Chris Bajorek who said the free layer will be thinner than 300A, Heiner Sussner who said that you can process spin valves in Research, Prakash Kasiraj for asking me to assist Physical Science in building something called an MTJ. Also, thanks to Prakash Kasiraj and Bob Scranton and Rick Dill for helping me in my external technical visibility in the magnetics and engineering communities.

For the magnetics society, my comments are that one should be careful of mentors. Their goal is acquiring your time. A few experiences follow: Fred Haggedorn introduced me to conference work with a request in 1984 to be Publications Chair for Intermag. This was a three year term, and Barbara, thank you for those lost weekends when we jointly typed up, in camera ready form, the table of contents for those three conferences. To Dennis Mee, Mark Kryder, Dave Thompson, thank you for encouraging me to enter into Magnetics Society politics as President of the Society. Under my administration the society lost 30% of its phantom assets (DOT COM investments by IEEE) and spent 30% of the IEEE's retainer lawyer fees due to MMM conference issues. The results of those fees and my administration are that today we (our Society) now have a truly global conference strategy with sound financial underpinnings.

Lastly, it has been a good run with Moore's Law. Here is my favorite slide. My process work in my MIT Thesis used 100 um lithography features and today, 30 years later, my process work involves 50 nm processing or a factor of 2000 or 28% per year.

Thank you again, very much.



INTERMAG 2005
Student Travel Award Winners reports

Student Travel Awardees of INTERMAG 2005 in Nagoya

Intermag Asia 2005
by ***Jia-Yang Juang***

I would like to thank the Awards Committee, Dr. Carey, and Dr. Gurney to offer me the student travel award for attending 2005 Intermag in Nagoya, Japan. It gave me a great opportunity to share some of my research results with top researchers worldwide. The award process worked very well for me and the instructions were very clear. I obtained my reimbursement no later than two weeks after the end of the conference. The conference was well-organized. Over three thousand people attended it. I gave my presentation on Apr. 8 (Session HB, Head Disk Interface II) to a large audience. Meanwhile, I could learn the most advanced scientific and technological developments in my field. It was a special experience for me.

I particularly appreciated the timing of the conference. April is probably one of the best seasons to visit Japan. I enjoyed the beautiful cherry blossoms (the duration was only about two weeks, from Apr.1 to Apr. 15) and the magnificent EXPO 2005. Many countries around the world exhibited their fascinating cultures. *Figure 1* was taken in the Central Asia Pavilion. A young lady was writing near a giant sleeping Buddha, forming an interesting contrast. *Figure 2* shows the Toyota Partner Robot, which was capable of performing instruments. The technical tour to Toyota motor plants was a great

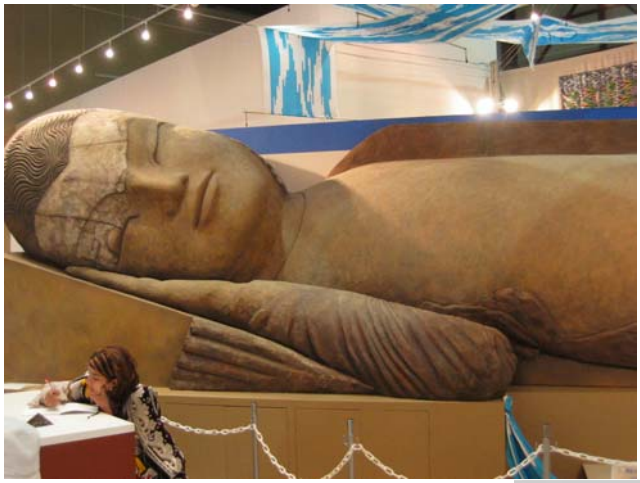


Fig.1

Fig.2

plus to the conference. For the first time I had a chance to visit Toyota's world class manufacturing lines and to learn how efficient the process was. Once again, I would like to thank the Awards Committee for the kind offer.

Best regards,

Jia-Yang Juang
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Dept. of Mechanical Engineering
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URL: http://cml.berkeley.edu/~jiayang/

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Intermag 2005 for me

By ***Rumyana Petrova***

As one of the lucky 25 winners who received the Student Travel Award to go to Nagoya, Japan, I would like to take this opportunity and express my deepest appreciation to the IEEE Magnetics Society. It was such a busy time – finding airplane tickets, arranging for hotel accommodations thousands of miles away from Florida… at the same time working hard for my Intermag presentation, looking for the best images, figures, thinking of the results…I almost forgot I submitted an application for a travel award to the Student Travel Coordinator of the IEEE Magnetics Society! But one lucky day I received the message, confirming that I have won it! Great!

Nagoya, Japan – we arrive in the late afternoon of April 3rd at the airport of this city. The building looks clean, cold and kind of boring – there are no flowers or trees like at Orlando International, no decoration at all. But people are very helpful, although most of them do not speak much English and if they cannot explain you some location, they would physically take you there. We get on the bus and an hour later we are

in a search for our hotel in the sudden rain in the heart of the 2-million people ofNagoya, Japan's fourth most populated city.

The hotel room is small and cozy, very clean and neat, and we get a nice sleep this first night. There is an energy-saving system for the lighting, something I haven't seen before. The next day I find that Japanese implement high-tech everywhere they can, and this seems so advanced and at the same time logical, I wonder why the rest of the developed world is not doing the same! Bullet trains, magnetic levitation vehicles, intelligent transport systems, underground tickets machines and scanners… just a few of the things to mention, normal for the Japanese and so advanced for me!

Most of my stay I spent attending the conference sessions held at the Nagoya Congress Center, a vast building not very far from the heart of the city. There were plenty of presentations to choose from, and I was often running from one end of the building to another, trying not to miss a talk. Sometimes it was hard to decide which presentation would be more interesting, as two intriguing talks were scheduled at the same time. I was particularly impressed by Dr. Theo Rasing who had great findings in the magnetic memory field, manipulating spins with a laser in antiferromagnetic materials.

Since my area of research is FePt nanoparticles, I tried to attend most presentations about this media, thin films and related materials. I was very happy to personally meet Dr. Yukiko Takahashi from the Japanese national Institute for Materials Science, author of numerous papers I have read. Since that was my first attendance of an international scientific conference, I was deeply impressed by the compliment Dr. Takahashi gave me about my talk.

There was one thing, however, that the organizers could think more carefully about – a lot of the poster sessions were held until 12 p.m. and right after that the posters were removed, although that hall was not needed for the rest of the day. Thus people who attended the oral presentations in the morning and were hoping to see the posters during lunch break, got disappointed by the empty poster boards.

Apart from everything interesting at the conference, there was another event, worth to be attended – the EXPO 2005 world exposition, linked by a MAGLEV train to Nagoya's underground system. This way of transportation felt like something between an express train and an airplane, without the rhythm of the first and the turbulence pits of the second. It was new and great! The EXPO was also intriguing – all of the Japanese major technological corporations were represented there and had their own pavilions in which was hard to get, and all of the world countries shared a number of pavilions. It was fun!

EXPO 2005's official mascots –
Kiccoro and Morizo

The famous Sakura cherry trees

Rumyana Petrova
Ph.D. Candidate
Physics Department,
University of Central Florida

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From **Nguyen Thi Hoang Yen**

The award process was done very smoothly for me. The application procedure was simple. I had no problem at all in the whole process.

This was the first time for me to experience an INTERMAG Conference, and it was really interesting. I'm studying Spin Transfer Induced Magnetic Switching. At the conference I attended the sections regarding Spin Torques and Magnetic Tunnel Junctions, MRAMs, both poster and oral, and some others. While in the oral sections I could get useful information from many interesting presentations, in the poster section I had the chance to discuss in details with the authors about their research work which I was interested in. Actually, this was very good opportunity if one wants to learn and get to know something that never appears in publication. The evening Symposium on MRAM was also very informative to me.

Furthermore, Nagoya is a very nice, clean city. It is not crowded at all as I imagined before when I thought of Japanese cities. The Congress Center where the Conference took placed also impressed me with its architecture. This first visit of mine in Japan has left a fine image in my memory.

Finally, I would like to thank the IEEE Magnetics Society and the Committee for having supported me to attend the 2005 INTERMAG Conference, and hope, in the future, more students will have a chance as I did.

Nguyen Thi Hoang Yen
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Trip to Nagoya—INTERMAG 2005

By ***Lui Boadan***

As one of the 25 selected student awards winners worldwide, I was fortunately supported by the IEEE Magnetics Society to attend the INTERMAG 2005 conference, which was held in Nagoya in April'05. Even though the conference has been closed successfully and smoothly, it still left a deep and unforgettable memory in my mind.

In the season of cherry blossoms, the researchers from all over the world gathered together at Nagoya. They presented the exciting talks that were related to magnetics. Not only that, they also introduced the novel research results and the frontier technology in the field concerning magnetics. I suddenly found that magnetics is so profound and attractive, and I was extremely attracted by some peculiar magnetic phenomena. Meanwhile, I was also aware that my knowledge is still poor and needs to improve urgently. The discussion with the famous scientists from around the globe was in a friendly atmosphere; thus it has benefited me with the enhancement and extension of my knowledge in a short time. This also supplied us a valuable opportunity to compare our own research results with others and finally guided us to our future research as well.

The most exciting moment came when it was my turn to present my work. I was a little surprised that my research result has attracted much more attention than I had expected. The researchers from universities

and companies asked me various questions based on my results, and it made me feel rushed. I needed to think carefully and wisely, so that they could accept my explanation and be satisfied with it. Sometimes heated discussion and debate were unavoidable. Each side wanted to establish own position to illuminate their viewpoints, and nobody wanted to withdraw. It was really interesting andunforgettable, and it certainly offered me a valuable opportunity to gain new knowledge.

Besides the scientific communication, we also established good relationships with the researchers from all over the world during this scientific discussion and the subsequent party. Previously unacquainted people from different countries quickly becamefriends. I was so surprised and glad to meet my friends, colleagues, andclassmates from China and other countries during this conference. We could gather tto discuss the scientific questions, to have fun, and to enjoy the good time. The traditional Japanese drum performance during the party was also enjoyable and helped us to release the stress and tension after the day's talk. The technique tour to Toyota Motor Corporation was really enjoyable and memorable. I was really impressed deeply by the modern factory and the automatic advanced technology.

Time passed by so quickly, and soon it was time to come back. However, the 5-day conference impressed me very much with the wonderful talks, advanced technology, pleasant times with my friends, enjoyment of Japanese-style service, and the beautiful scenery in Nagoya. The trip to Nagoya was really an unforgettable experience for me.

Lui Boadan

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Student Awardee Report from TMRC

By ***Lingyan sun***

During my stay in Stanford, California for the TMRC conference from Aug. 15th-17th, 2005, I was able to listen to most of the talks and also made a presentation in the session E. My overall opinion for the conference is that it is among the highest quality within the conferences that I have attended in the magnetic recording area.

First of all, I was very impressed by the scope of the conference and the quality of the presentations. Many advance topics in head/media, Perpendicular recording and advanced detection and decoding were covered. The presentations are all clear and high level. My main interest was in the advanced detection and decoding session. There were six presentations: target design presented by Yuan Xin Lee; LDPC code application presented by Erozan; LDPC code design presented by Jin Lu; tensor product code presented by Paul H. Sidgel; constraints coding presented by Ismail Demirkan; and my own presentation on FPGA for code evaluation. Each topic is a very interesting area for current magnetic recording channel design. I learned a lot from all these presentations. I think the poster session was very valuable too, as many people stopped by at that time and asked many questions. Fewer people asked questiosn after the talks due to the limitation of time.

Many people from the magnetic recording industry --Seagate, Marvell, Maxtor, Agere, Broadcom, etc. -- attended the conference. I was able to talk with many of them and gained a lot about the current read channel problems and design issues. The conference has stimulated communication between people in the magnetic recording area.

Above all, I think TMRC 2005 was a very successful conference. I enjoyed my time staying in Stanford and taking with people from difference companies and universities.

Lingyan sun

Information For future Student Travel Award Winners

Awards Committee

IEEE

Dear *Student Travel Award Winner,*

As part of your student travel award from the IEEE Magnetics Society for Intermag 2005 you are requested to write a brief report on your experiences in going to the conference. This report should be no more than two pages in length , with no more than two figures or photographs, and should give an account of one or more of the following aspects of your attendance at the conference.

- You may use all or some of your report to describe the technical highlight of the conference from your point of view. This may be the particular session that you attended or it may be the Educational committee tutorial or some other part of the conference which you found particularly valuable in a technical sense.
- You may wish to comment on the conference as a whole. We would welcome your opinions on the organisation of our conferences and whether they serve the student population well.
- We know that very often students have an interesting time when going to a conference, both in terms of the travel experience and social interactions with other students or general conference participants. Feel free to use all of your report to describe your overall experience.

This year the Magnetics Society will provide travel awards to approximately 25 students. We expect to collect the student conference reports and publish many of them in the Society Newsletter on our website. This means that a selection of reports will be published in each edition of the Newsletter.

As with most publications of this kind our Newsletter Editor, Prof Martha Padarvi Horvath of George Washington University, will have the right to edit your report.

Please submit your report within the next four weeks to Prof Padarvi Horvath([redacted]) and please carbon copy Matt Carey (matthew.carey@hitachigst.com) and Bruce Gurney (bruce.gurney@hitachigst.com).

We hope you enjoyed your conference experience and that in return you will give the writing of your report a high priority.

Best wishes,

Matt Carey/Bruce Gurney
Student Travel Coordinator/Awards Chairman
IEEE Magnetics Society

Conference report

ISTS'05 International Storage Technology Symposium 2005

September 11-16, 2005, Kalamata, Greece

On the Road to Terabit/in² and beyond

The **International Storage Technology Symposium (ISTS)** began as the International Symposium on Barium Ferrite in 1992 and has, since then, evolved to become an event embracing all storage technologies and media. It is truly international in scope, and counts academic, research, industry and government organizations among its participants. ISTS meets every two years (although, for various reasons, the one in 2003 was not held) in early September in the southern coastal town of Kalamata in the province of Messinia on the Peloponnesus in Greece, an area rich in history and archeological sites, and which is also home, in Pylos, to some of the earliest written records. From 40 to 60 participants gather for the weeklong symposium. Sessions run from 9 am to 1 pm and again from 5 pm to 7 or 8 pm. Visits to ancient and medieval sites, museums, and theaters are part of the program and take place during the ride in the Symposium bus from Athens to Kalamata, on the way back, and on Wednesday morning. This being a Symposium, not as contrasted to a Conference, intellectual stimulation is intertwined with physical enjoyment in the form of traditional Greek dancing, music and food.

The ***objective of ISTS'05*** was to bring together leading scientists and engineers from around the world to discuss:

- the directions, limitations and challenges that face Information Storage Technologies as they strive to reach densities of a Terabit/in^2 and beyond.
- the advantages, difficulties and timing of paradigm shifts into perpendicular recording, patterned media, probe storage, and other alternative technologies
- magnetic, optical, solid state, and other alternative technologies with emphasis on both fundamental and practical limits.

Each session starts with an in-depth overview by the discussion leader followed by contributions, lively discussions, and vigorous debates in which *all* attendees participate.

The Symposium wishes to thank the governments and authorities of the city of Kalamata and the state of Messinia for the reception they organized for the participants, and also for the cultural programs in Kalamata. Symposium participants enjoyed a relaxed morning in Pylos on Wednesday the 14th September, followed by a brief stop in Methoni before riding to Finikundae for a pre-lunch dip and swim in the Mediterranean. On Friday the 16th September, the Symposium bus took participants to Olympia where, in the 7th century BC, the Olympic games started.

The symposium focused on the following areas of storage technology, led by session organizers;

1. ***Advanced Media*** – organized by **Dieter Weller**, Seagate

In his overview, **Dieter Weller** pointed out out a *trilemma* in the dash to higher areal densities: achievable areal densities are limited by trade-offs between SNR, thermal stability and writeability. The path ahead provided a number of trilemma breakers: perpendicular recording, heat-assisted magnetic recording (HAMR), bit- patterned and self-organized magnetic structures (SOMAs). Toshiba has been the first to bring a PMR product to market and modeling suggests that densities of 400-500 Gb/in^2 in four to five years. HAMR will take us at least a step beyond, and tests have shown thermal relaxation time of 100 to 500 ps. SOMA is a strategy to achieve bit-patterned media without lithographically defining the bit. Self-organizing nanostructures will eventually be needed to extend magnetic recording technology. Timing windows are more stringent with bit-patterned media. In summary, Weller stressed the need for self assembly to push AD beyond 1 Tb/in^2 and need for atomistic modeling at grain sizes of 3-4 nm. PMR limit is seen near 500 Gb/in^2 based on micromagnetic modeling. HAMR potential is linked to availability of small grain high Ku media. BPM: Self-Organization methods (bottom up or top down) needed at 1 Tb/in^2 and beyond.

Rosen (HGST):
Main points: (1) sees PMR product limit at 350 Gb/in^2 (2) BPM likely AD enabler beyond 350 (3) TAR (=HAMR) beyond Tb/in^2 densities. In side conversations he mentioned that multi-layer media (presumably composite) would enable grain size reductions of up to a factor of 2.

233 Gb/in^2 HGST PMR demo; -2 Byte error rate at 15% OTC; -4.3 on track Byte error rate; have several head media combinations at ~ 200 ktpi x 1000 kbpi; says that getting to 233 Gb/in^2 happened quickly. They used a shielded head with a gap of 50nm.
233 Gb/in^2 media: granular CoPtCr-SiO2 (did not comment on composite, but likely used multiple layers). Declined comment on corrosion; HMS was about 10 nm; thermal decay between –1%/decade (50 kfci) and ~ 0%/decade (300 kfci); trailing shield writer and GMR reader; BAR = 4-5; jitter 2.4-2.6 nm (rms); write field limited BER (BER vs I_{write} still sloped at highest I_{write});

Richter: PMR can be extended by using composite media (shows phase diagram H/H_{hard} vs coupling); two spin model; gain factor < 2; switching field reduction strongest at small field angles;
dDiscusses requirement for BPM to achieve 10 Tbpsi ($_D$ and $_J$ are critical parameters; timing window extends over full distance between dots); shows preliminary design for 10 Tb/in^2;

Gustafson: INSIC roadmap talk; 40% growth; 500 Gb/in^2 PMR possible; 1 Tb/in^2 with titled fields and tilted media etc. but significantly delayed compared to 40% CAGR (~2013?). Points to STE as time bomb; says that thermal stability needs to include ATE and STE measurements;

Pardavi-Horvath (GWU): Preisach modeling of stability of patterned media; her model system is 40x40x3 μm^3 squares of garnet; discusses domain wall switching with nucleation at defects is dominant reversal mechanism; good physics, however domain sizes are much smaller in modern BPM.

Aoi (Tohoku): formerly Hitachi Ltd – now Tohoku; still works with Hitachi and also with Twente group (NL);

BPM: B=18 nm; TP=36 nm; BAR=2 (9 nm land – 9nm spacing/groove)
PMRL channel
Required patterning accuracy is 6% of bit length or 12% of land length for –5 BER
Co80Pt20/Ru has 1.24e7 erg/cc Ms-1180; θ=2.8 deg
<D>~15 nm polycrystalline, fully coupled films
dot pitch = 600 nm achieved with laser patterning
Co/Pt ML have large KV~1000; switching volume <5% of dots
SFD important; SFD decreases with smaller DIA: at 80nm ~ 21%
Dot size variation about 10% of SFD.
The theoretical part is similarhas similarity to that of Gordon Hughes.
(Iin discussion, Erhard Schreck from Maxtor suggested offsetting neighboring rows of bits to diminish track interference)

Terris (HGST):
Showed previously published work on 300 Gb/in^2 using NIL and Co/Pd ML on topographic media (Hu et al. JAP 95, 7013 (2004)); Discussed reversal modes vs island size: SW vs Kondorsky; uses micron sized dots to characterize SFD (not relevant to BPM); uUses large island measurements to characterize SFD and sigma_Hk; finds sigma Hk=8% for Co/Pd multilayers

Soeno (TDK):
Reported first r-theta recording of DTR media including servo. The media are planarized using their previously described method, i.e. filling trenches with SiOx and subsequent Ar ion milling. Surface roughness Ra<0.6 nm. Media are flyable, but did not know FH. Groove-depth ~20nm. Showed micromagnetic modeling data suggesting large relative gains of order 5-6 dB for small TP compared to conventional recording, e. g., adjacent track writing retains signal to >95% for 160 nm TP, while <85% for conventional.
He showed experimental data for ATE that indicated that ATE is superior for DTM. They can measure on the spin-stand with a closed servo loop.

Kikitsu (Toshiba):
Reported DBCP approach to nanopatterning (as published and presented previouslybefore). What was new is that he is focusing on FePt and/or FePtCu which orders at 300C (as opposed to 600-700C). Showed FePt10nm/Pt10nm/Cr5nm films with ("perfect") square hysteresis and Ra~0.4nm. Said that recording results existed but was not ready to talk about them yet (likely at upcoming MMM or Intermag confs).
He promoted the idea of combining Assisted Self Assembly based BPM with HAMR writing in the future and claimed that at Tbpsi this would already be necessary (we disagree with that!!). It became clear that their understanding of HAMR recording process is rather rudimentary – he stressed that field needs to be on during cooling (which has been obvious to the Seagate HAMR team for a long time).

Thiele (HGST):
Reported previously published results on HAMR media, primarily FePt/FeRh. Made the comment that he does not know how to generate the granular microstructure with this set of materials, which would make HAMR work. Points out, that 200 nm Au heatsink (example) is necessary to suppress lateral thermal spreading. Showed new pump probe data in support of Seagate theory, published by Ganping Ju et al., that FeRh AFM-FM phase transition is triggered by electrons and not lattice expansion.

2. *Metrology* - **Kevin O'Grady**, University of York

I opened this session myself, giving a presentation of magnetic characterisation of perpendicular media. Essentially this concerned the determination of time dependent characteristics of media with an SUL using a highly stable MOKE. The conclusion of this work is that activation volumes determined at the coercivity are

not representative of the minimum size of a written bit since the activation volume at the nucleation field is significantly larger. Of course to write a bit of information, a region of reversal must first be nucleated and hence it is this size that limits the data density rather than that determined at the coercivity.

The second presentation in the session was by Hartmut Rohrmann from Unaxis, who described the latest technology available for the deposition of perpendicular media from his company. His presentation included a detailed description of the deposition of CoPd multilayer stacks which can be produced at very high rate using circulus technology.

The last two talks in the session were provided by Erik Samwell and William Van Drent from ADE Technologies. The first talk was a detailed description by Erik of the highly successful Model 10 VSM. This instrument has a possible maximum applied field of 3T and a full vector capability, including advanced analysis software to determine the actual 2-dimensional direction of magnetic moments. This instrument has become very popular and is probably the main instrument used for the characterisation particularly of perpendicular media and other magnetic systems. The proof of this pudding is the fact that at the time of the Kalamata meeting I had just ordered one!

The last talk in the session by William Van Drent also related to perpendicular media since it concerned the characterisation of such systems using MOKE. William described a fully automated system that ADE now offered in which discs are loaded into the MOKE and then scanned to determine their hysteresis loop. Of course the same system can be used for production testing of head wafers and MRAM as well as media. However, MOKE has particular advantages for characterising perpendicular media since it can be operated in polar mode so that the soft underlayer is not sensed by the instrument.

Thus overall a diverse and highly interesting session relating to leading edge metrology.

It is often said that people remember where they were when momentous historic events occurred. On the 12 September Des Mapps and I will always remember where we were when England won the Ashes! (This is the trophy for the winner of the test cricket series between England and Australia, and has a long and hoary tradition – PCH)

3. *Alternative Technologies* - P C Hariharan

The session on Alternative Technologies featured 9 talks in addition to the overview. Derived from scanning probe microscopy, a number of variants of probe storage have been proposed and prototyped: atomic force by the IBM group in Zurich, and magnetic force by, among others, Leon Abelman of Twente, the Netherlands. There is stiff competition in the market place from both flash memory and microdrives.

Professor **Peter Rentzepis** of UC Irvine presented an interesting account of two-photon recording. Although Maria Goeppert-Mayer had outlined the principle in 1932, practical realization had to await the availablilityavailability of lasers. Both two-photon storage, and holographic storage, fall into the category of volume storage.

Dr Hideyoshi Horimai of Optware outlined a novel collinear holographic storage technique using media of the same format as DVD.

Dennis Speliotis, on behalf of **Jimmy Zhu** of Carnegie-Mellon University, surveyed the field of MRAM. Jimmy likes ring structures for the individual MRAM elements because they are demagnetization-free, they have no sub-minimum features, and they are more tolerant to fabrication. MRAM claims many potential advantages over other electronic memories, but it appearslooks that FLASH is running away from the pack. In part the reason for this is that the technology and the facilities for fabricating FLASH are very similar to

thoseat used for DRAM and SRAM. Therefore, if the market for conventional DRAM and SRAM chips becomes soft, the manufacturers can quickly switch to FLASH. This is proving to be an enormous economic advantage for FLASH.

Theoretical work on bubble domains in disc-shaped ferromagnetic particles was the subject of a presentation by **Stavros Komineas** of Cambridge University. He concluded that magnetic particles with strong perpendicular anisotropy can sustain high symmetry bidomain and multidomain states.

David Pappas, the final speaker in this session, spoke about quantum storage in the solid state.

Dr Dimitris Niarchos, Director of the Demokritos R&D Center in Athens, Greece (the largest research center in new technologies in Greece). They are working on high Ku materials fabrication and characterization, and more specifically on Fe(Co)Pt nanoparticles, using multilayer precursors, cluster gun, chemical synthesis, and SOMA. In addition to the fabrication methods, he described the magnetic and structural properties of these particles. Epitaxial growth of FePt on single crystal MgO at elevated temperatures produced films with perfect perpendicular texture and controlled microstructure.

4. *Head/Media Interface and Tribology* - **Peter Baumgart**, Hitachi Research –

The session dedicated to Head-Disk Interface and Tribology of HDDs was organized by Peter Baumgart of Hitachi GST Research in San Jose, CA. The opening overview presentation by **Peter Baumgart** titled "*Approaching the Physical Limits of Head-Media Spacing in Magnetic Recording: How low can we go?***"** set the stage by describing and motivating the quest for ever- decreasing spacing. The presentation outlined in detail the current state of technology for magnetic spacings approaching 10 nm, as well as future needs and technology options for recording densities in the range of 1 Tb per square inch and beyond.

V. Raman of Hitachi GST summarized the *"Physico-Chemical Aspects of Low Flying Head-Disk Interfaces in Magnetic Recording"* and demonstrated with concrete examples the close relationship and interdependence of mechanics, dynamics, and chemistry when physical spacings approach a few nanometers.

Erhard Schreck of Maxtor delivered a presentation for Dave Fowler of Maxtor, who could not attend, titled "***Challenges for 1 nm Clearance, Non-Contact HDI Designs,*****"** again stressing the issues of extremely small spacings and their challenges for a reliable HDD, especially for new applications of HDDs with extreme environmental requirements, such as automobiles, novel portable applications, etc., but declared the challenge of a reliable 1 nm physical separation as achievable.

In the final presentation of this session, **Erhard Schreck** covered his area of expertise: **"***HDI diagnostics in Disk Drives,***" and** demonstedrating how the disk drive itself can be used as an intelligent self-monitoring diagnostic tool of its own behavior and health. He showed how critical it can be for the longevity and reliability of the head-disk interface to minimize the stress and wear-out by using properly designed algorithms for the actuator while the drive is idle. He closed with an intriguing investigation of Operating System "'personalities"' which issue differing command patterns to HDDs and thus potentially affecting their longevity in different ways. This is an area of future research and optimization, where guidelines for system integrators or HDD read/write buffer designs could be developed.

5. *Advanced Heads for Perpendicular Recording, HAMR, Discrete Track and Discrete Bit* - **Robert Rottmayer,** Seagate Research

This session included talks and discussion on write head designs for perpendicular design. Advanced designs for write heads were covered by three authors who generally agreed that 500Gb/in.^{2} was approximately the

limit for conventional perpendicular recording. To obtain this density, optimized shielded designs (down-track and side) would need to be used. Head design for micromagnetic writing on exchange spring media was also covered. Extensions to perpendicular recording focused on Heat Assisted Magnetic Recording (HAMR). A HAMR head with an optically focused heat source integrated on a slider with field delivery could extend areal density by an order of magnitude. The physics of HAMR writing was also covered.

Read Heads were covered in three of the talks. **Sining Mao** said that TMR is a mature and capable reader technology for Seagate and is being integrated into all product platforms, and that extensions of the technology look promising. It was also generally agreed that at high areal densities (> 500Gb/in.^{2}) new approaches, such as CPP Multi-layer, may be needed.

6. *Micromagnetics* - **Manfred Schabes**, Hitachi –

The session "Micromagnetics" consisted of two presentations.
1."Optimization of advanced perpendicular media by micromagnetic modeling" by **J. Fidler**, and
2. "Frontiers of micromagnetic theory: open questions from multiple scales", by **M. E. Schabes.**

In the first talk, professor Fidler discussed fully integrated micromagnetic simulations, where the magnetization dynamics is solved concurrently for the write-head, the media, and the soft underlayer via advanced finite-element techniques. A study of the energetics of pinned domain walls in percolation media was then presented. These media were constructed to have defects of sizes in the range of 2 to 6 nm. The energy barriers that are created at the defects through domain-wall pinning were generally smaller than 3 kBT at 300 K, except for large film-thickness (16 nm) and large defect diameter (6 nm), where the barrier was computed to be 81 kBT. In general, the size of the defect has to be comparable to the domain-wall width in order to create sufficient pinning barriers.

In the second talk, Dr. Schabes discussed the foundations of micromagnetic simulations for multi-Tera bit/in^2 materials/devices. He pointed out that the ratio of surface-to-volume generally increases for grains and devices at ultra-high bit-densities. Furthermore, it becomes important to better understand the physics at interfaces and defects. Micromagnetic calculations of the magnetization dynamics during flux-rise and flux-decay in a trailing-shield perpendicular pole head demonstrated a large range of spatial and temporal scales and their coupling. It was shown that the write-flux rises relatively slowly with time- constants of order 500-750 ps, and the temporal profile of flux-decay contains regions with reduced slope. In the second part of the presentation, coarse-grained molecular dynamics was proposed as a means to treat multi-scale Hamiltonians for multi-physics problems, i.e. where it is necessary to directly link micromagnetics with atomistic variables.

7. *Magnetic Tape* - **Ted Schwarz**, Peregrine Recording Technologies –

Magnetic tape's demise as a storage medium has been predicted for more than 30 years. Today it still remains the pre-eminent choice for the lowest cost long-term archiving and mass storage. It appears that it will probably remain so in the foreseeable future. The Tape Session presented the status of tape efforts in Europe, advances in the development of thin film media and GMR heads to support much higher areal recording densities, and advances in helical and linear scanning to achieve tens of terabytes of data storage in a single data cartridge.

Europe's technology thrust is embodied in Tandberg Storage's O-Mass storage, originally envisioned as a two-dimensional array of many write heads and an optical reader in which the latter has been replaced with an array of MR/GMR heads for a high data rate competitor to helical scan. Sony described the development of a multi-channel GMR head helical scan system with a demonstrated areal density of 11.5 Gb/sq. inch on ME media with the potential of putting 32 TBytes on a 1/2 inch cartridge. Maxell described the performance of its sputtered thin film media to replace current particulate to achieve much higher longitudinal and

perpendicular areal densities. Advanced MicroSensors then described its development of 15--20 um channel pitch arrays, to ameliorate the effect of the dimensional instability of the tapes' polymer substrates, GMR readers and pancake and helix coil writers. The session closed with the description of a NIST Advanced Technology Program, ATP, to achieve areal densities of 15 - 20 GBytes/ sq. inch using sputtered thin film media, 16 channel arrays of GMR elements and narrow channel writers, Large Angle AZimuthAzimuth Recording, and dual independent actuators. Track following with acceptable Track Misregistration was demonstrated for 25,000 tpi to provide a path to 30+ TByte capacity on a 1/2 inch cartridge.

8. ***New Magnetic Horizons*** **- Dennis Speliotis**, ADE Technologies

Des Mapps of Plymouth University described the fabrication, the properties, and the methodology of using FeBSiC alloy thin wires encapsulated in a glass coating (20 micron wire core and 5 micron glass coating) as magnetic sensors. These structures have moderate coercivities of about 45 Oe, so that they aredo not get easily disturbed by extraneous signals. The advantage is extremely low cost (about 0.0005 Euro for a 5 mm sensor of this type).

David Pappas of NIST/Boulder talked about arrays (up to 256 elements or more) of AMR sensors that can be used for a large variety of applications: a. Magnetic tape forensics, b. Data recovery; c. Biomagnetic imaging; d. Nondestructive testing of chips and devices: map the emanating magnetic fields and determine the currents flowing in the devices by deconvolution. The range of applications is enormous!

Dennis Speliotis of ADE presented a talk prepared by **Bob White** of Stanford University, who is working with Shan Wang, also of Stanford, to apply nanotechnology for high sensitivity DNA fragment detection. They use sub-micron arrays of magnetic field detectors to detect the field generated by small numbers of magnetic nanoparticles. This approach has extraordinary sensitivity and huge potential for the identification of DNA fragments for medical applications. Also, body fluids can be scanned to detect infectious organisms, bacteria, viruses, and terror agents. Applications such as the above can open new and vast horizons for magnetics research, applications, and markets!

9. ***Technology, History, Culture*** **- Giora Tarnopolsky**, Tarnotek and INSIC

Kalamata-everybody at the session Finikounda – everybody at the beach

IEEE Annual Elections

URL: http://www.ieee.org/elections

IEEE MEMBERS SELECT LEAH H. JAMIESON 2006 IEEE PRESIDENT-ELECT

PISCATAWAY, N.J., 4 Nov. -- Leah H. Jamieson, Ransburg Professor of Electrical and Computer Engineering, and associate dean of Engineering for Undergraduate Education at Purdue University in West Lafayette, Ind., has been selected as 2006 IEEE president-elect. Pending acceptance of the Teller's Committee report by the IEEE Board of Directors, Jamieson will begin serving as IEEE president on 1 Jan. 2007. She will succeed 2006 IEEE President Michael R. Lightner, professor of Electrical and Computer Engineering at the College of Engineering and Applied Science at the University of Colorado at Boulder.

Of the 253,788 ballots mailed, 36,576 valid ballots (14.41 percent) were returned. This compares with the 2004 return of 13.99 percent. All results are unofficial until the IEEE Board of Directors accepts the report of the Teller's Committee during the 13 Nov. Board meeting.

The other two candidates for IEEE president-elect were Gerald Peterson, senior manager emeritus at Lucent Technologies Bell Labs, in Holmdel, N.J., and James M. Tien, Yamada Corporation Professor at Rensselaer Polytechnic Institute in Troy, N.Y. Jamieson and Peterson were nominated by the IEEE Board of Directors. Tien was nominated by petition. Of the members who voted, 15,965 selected Jamieson, 10,723 selected Peterson. Tien received 9,301 votes.

Jamieson, an IEEE Fellow, is only the second woman in the history of the IEEE to be chosen for the president-elect position. An IEEE member for 30 years, she presently serves on the IEEE Board of Directors and Executive Committee. She is a member of the Strategic Planning Committee, chairs the New Technologies Directions Committee and holds the position of vice president of the Publication Services and Products Board. Among her many other leadership roles, she has served as vice president of the Technical Activities Board and as president of the IEEE Signal Processing Society.

In addition to her current positions as professor and associate dean at Purdue, Jamieson is co-founder and director of the Engineering Projects in Community Service (EPICS) undergraduate engineering design program, which was initiated at Purdue and has been adopted by 17 universities. For her work with EPICS, she was co-recipient of the U.S. National Academy of Engineering's Gordon Prize for Innovation in Engineering and Technology Education. She has served on advisory committees of the National Science Foundation and on the Board of Directors of the Computing Research Association. She is a member of the U.S. National Academy of Engineering.

Other Officers Named

The following candidate was selected as division delegate/division director for 2006-2007:
The following candidates were selected as division delegate-elect/director-elect for 2006:

- Division II, Thomas G. Habetler
- ***Division IV, Edward Della Torre***
- Division VI, Irving Engelson
- Division VIII, Thomas W. Williams
- Division X, William A. Gruver.

They will take office as division delegate/director on 1 Jan. 2007.

2005 IEEE Annual Elections

The CANDIDATES

FOR IEEE PRESIDENT-ELECT, 2006

Leah H. Jamieson
Gerald H. Peterson
James M. Tien

LEAH H. JAMIESON
(Nominated by IEEE Board of Directors)

Professor
Purdue University
West Lafayette, Indiana, USA

Website: http://www.ece.purdue.edu/~lhj/IEEE

GERALD H. PETERSON
(Nominated by IEEE Board of Directors)

Senior Manager Emeritus
Lucent Technologies – Bell Labs
Flemington, New Jersey

For more information see: http://ghpeterson.home.att.net.

JAMES M. TIEN (Nominated by Petition)

Yamada Corporation Professor
Department of Electrical, Computer and Systems Engineering
Rensselaer Polytechnic Institute
Troy, New York

FOR DIVISION DELEGATE-ELECT/DIRECTOR-ELECT, 2006
DIVISION DELEGATE/DIRECTOR, 2007-2008 – DIVISION IV
(ELECTROMAGNETICS AND RADIATION)

Edward Della Torre
Ralph H. Justus

EDWARD DELLA TORRE
(Nominated by Division IV)

Professor
George Washington University
Washington, DC

RALPH H. JUSTUS
(Nominated by Division IV)

Vice President, Technology and Standards
Consumer Electronics Association
Arlington, Virginia

2005 IEEE Annual Elections Candidates

Candidates whose names will appear on the 2005 IEEE Annual Election Ballot are listed below. Links to candidates's personal web sites will be created as they become available. These links point to a candidate's personal web site and do not necessarily reflect the opinion or position of the Institute.

** Candidate nominated by petition*

Position
Candidate

IEEE President-Elect, 2006

- Leah H. Jamieson
- Gerald H. Peterson
- James M. Tien*

Division IV Delegate-Elect/Director-Elect, 2006

- Edward Della Torre
- Ralph H. Justus

Region 1 Delegate-Elect/Director-Elect, 2006-2007

- Howard E. Michel
- Charles P. Rubenstein

Region 3 Delegate-Elect/Director-Elect, 2006-2007

- Eric S. Ackerman
- William B. Ratcliff
- Clarence L. (Lee) Stogner

Region 5 Delegate-Elect/Director-Elect, 2006-2007

- Francis B. Grosz, Jr.
- David J. Pierce

Region 7 Delegate-Elect/Director-Elect, 2006-2007

- Gerard M. Dunphy
- Eric Holdrinet
- Maike Luiken Miller
- Ferial El-Hawary*
- Vijay K. Sood*

Region 8 Delegate-Elect/Director-Elect, 2006

- Gerhard P. Hancke
- Jean G. (Jean-Gabriel) Remy

Region 9 Delegate-Elect/Director-Elect, 2006-2007

- Enrique E. Alvarez
- Juan R. (Ramon) Falcon
- Enrique A. Tejera M.

Standards Association President-Elect, 2006

George W. Arnold
Raymond Hapeman
Forrest D. (Don) Wright

Standards Association Board of Governors
Member-at-Large, 2006-2007

Paul Nikolich
Carl R. Stevenson

Standards Association Board of Governors
Member-at-Large, 2006-2007

L.B. (Bruce) McClung
T.W. Olsen

Technical Activities Vice President-Elect, 2006

Jose R. (Roberto) Boisson de Marca
Peter W. Staecker

IEEE-USA President-Elect, 2006

Russell J. Lefevre
John W. Meredith

IEEE-USA Member-at-Large, 2006-2007

Burton J. Loupee
Gregg L. Vaughn

IEEE NEWS

SENIOR MEMBERSHIP
Elevate your membership!

Requirements for elevation to IEEE Senior Member

IEEE Bylaw I-105.3 sets forth the criteria for elevation to Senior Member gGrade, as follows:

> "… a candidate shall be an engineer, scientist, educator, technical executive or originator in IEEE-designated fields. The candidate shall have been in **professional practice for at least ten years** and shall have shown **significant performance over a period of at least five** of those years."

There is no cost to convert to a Senior Member. "Senior" refers to professional experience, not age, and you do not need to be a "senior citizen" to be a Senior Member.

For full information visit the IEEE Senior Member Web pages

- Once you determine that you fulfill the **requirements** for Senior Member (SM) grade, identify your three references who must be IEEE Senior Members or Fellows.

- If you have difficulty in locating individuals to serve as your references, contact your local Section or Chapter for assistance. For help in contacting your Section/Chapter Chair, email Denise Howard at senior-member@ieee.org.

- If you have been notified by a Section officer that they intend to nominate you for Senior Member grade, the nominator serves as one reference as long as he/she is a Senior Member or Fellow. Otherwise, the required number of references is still three in addition to the nomination.

- Alternatively, contact your Section Chair and ask if they can nominate you. This will help your Section earn a rebate at the end of the year through the **Nominate a Senior Member Initiative**.

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- Life Fellow Brought the IEEE to Peru

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IEEE-USA Today's Engineer

A Monthly webzine

Online Alert

http://www.todaysengineer.org

+ Demand for Phased Retirement Programs on the Rise
Many professionals nearing retirement age are opting to continue working by taking advantage of one of several phased retirement options. These alternative work arrangements are becoming more and more popular in the American workplace, as they benefit employers and employees alike.
http://www.todaysengineer.org/July04/retirement.asp

+ 10 Thoughts on Innovation
Many modern-day technological advances are remarkable, to be sure, but modest innovations get introduced to the marketplace every day. Whether simple or complex, several general rules of thumb apply to all innovations.
http://www.todaysengineer.org/July04/10rules.asp

+ Exports Hold Potential for Small Businesses, Job Growth
The weak U.S. dollar is making American goods less expensive ? and therefore more attractive ? to international markets. This export environment should provide benefits for American companies and could benefit U.S. workers in the process.
http://www.todaysengineer.org/July04/exports.asp

+ Bush and Kerry Outline Stances on Technology Issues
AlthoughBeyond agreeing on broad technology issues, President George Bush and Democratic challenger John Kerry differ significantly on many of the specific government programs and initiatives in place or needed to reap maximum benefits from advanced technology development. How do their stands compare with IEEE-USA's positions?
http://www.todaysengineer.org/July04/candidates.asp

Also in this issue:
+ Engineering in Pop Culture: Technology and the Olympics
+ Capitol Shavings: Legislators Contemplate Their Own Demise
+ World Bytes: Digital Divide
+ Reader Feedback
*

From Washington, D.C.: IEEE-USA TODAY'S ENGINEER E-MAIL UPDATE for 1 August 2005
Your Monthly U.S. IEEE Member E-Mail Update on "Building Careers & Shaping Public Policy"
http://www.ieeeusa.org

IN THIS ISSUE:

- October 2005 IEEE-USA Today's Engineer Online
- "Leadership for Results" Courses Launched
- U.S. IEEE Members Eligible for Discounted Continuing Education, Certificate, Grad Degree Courses
- IEEE-USA Fund to Support Second Mass Media Fellow in 2006; Applications Now Available Online
- Nominate a Colleague for EWeek 2006 "New Faces of Engineering"
- U.S. IEEE Student Members Encouraged to Apply for 2006 WISE Program

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The **IEEE** is the world's largest technical professional society with approximately 360,000 members in 170 countries. Through its members, the IEEE is a leading authority on areas ranging from aerospace, computers, and telecommunications to biomedicine, electric power, and consumer electronics. The IEEE produces 30 percent of the world's literature in the electrical and electronics engineering and computer science fields, and has developed more than 900 active industry standards. The organization also sponsors or cosponsors more than 300 international technical conferences each year. Additional information is available at www.ieee.org.

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MAGNEWS

From SEAGATE

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http://www.seagate.com/cda/newsinfo/newsroom/releases/

Pushing The Boundaries of Data Storage in the Information Age

Every time you access the Internet, hit "send," trade a stock online, use an ATM or watch a Hollywood blockbuster movie, you create, access and share tremendous amounts of digital information. But what if you woke up one day and couldn't do any of it?

Keeping our networked, digital world up and running depends on storing, accessing and managing tons of data that is multiplying and growing dramatically every day. Where does it all come from? Where does it all go? And what will make sure I can continue enjoying my digital lifestyle? The answer is storage technology, like that found in disc drives. The ability for storage technology to continue its rapid pace of advancement is critical for people around the globe to have the world's information at their fingertips.

The growth of storage in our Information Age has exploded largely because of the ability to continue to deliver it inexpensively. But current technology presents limits to how much information can be stored on a disc drive. This means that eventually people may no longer be able to get twice the capacity each year for the same price as the previous year. With storage demands rising, it is critical that technologists develop the technologies that will continue to allow affordable storage for everyone.

The ability to store a given amount of information on a disc drive is driven largely by a drive's areal density. Areal density refers to both the size and how closely spaced the information bits are on a disc drive. By increasing the areal density on discs through the process of making the information bits smaller and more closely spaced, more data can be put onto the discs, meaning fewer discs and parts can be used inside a disc drive. With current storage technologies, there is an areal density limitation and technologists are working on needed storage breakthroughs for the next millennium. This is critical when considering how much storage people have continued to demand and use.

During the past five years especially, the demand for magnetic storage has grown at a tremendous rate. Key areas such as the Internet as well as networks and databases that create and use information for business have fueled this growth. With the increased need for storage, technologists working in the field continue addressing the challenge of increasing disc drive capacity while also making them faster. The bottom line is that if new breakthrough technologies aren't successfully implemented that can keep up with storage demands while overcoming areal density limitations; an inherent slowdown of information can occur that could inhibit businesses and people throughout the world. Additionally, issues such as much greater storage costs as well as capacity limitations are a part of this scenario. Given the demand and need for electronic information in our digital world, it is critical that this not happen.

Facts About Storage Use

Before examining the different methods that technologists are using to solve areal density challenges, it is important to note and appreciate the amount of magnetic storage people are using each year to produce and store digital content. According to the October 2000 University of California-Berkeley study through the School of Information Management and Systems, 1,693,000 terabytes of information are produced and stored magnetically worldwide each year, with an expected annual growth rate of 55%. To put this in perspective, one single terabyte of information (or 1000 gigabytes) is equivalent to storing a stack of text documents that is more than sixteen times the height of the Empire State Building. Include the additional 1,692,999 terabytes of data and it becomes clear that the world is producing and storing a virtual myriad amount of magnetic data.

Several factors contribute to this demand for storage. Internet traffic is approximately doubling each year, according to the recent 2001 report by Coffman and Odlyzko entitled, "Is there a Moore's Law for data traffic?" And ETForecasts discovered that home Internet use itself has quadrupled since 1995, going from 9 percent to 41.5 percent of all homes in less than 5 years. It was also Odlyzko in an earlier 2000 report, "Content is not King" who wrote that communication such as e-mail was "the killer app" that required an enormous amount of storage capacity, not web content. In fact, the UC Berkley team also affirmed this by reporting that approximately 610 billion e-mails are sent per year.

When moving outside of the Internet arena, storage used for business networks and databases is also expected to grow rapidly. In fact, International Data Corporation estimated that implementations such as Network Attached Storage (NAS) and Storage Area Networks will both grow to a combined revenue of $18.6 billion by 2003. Additionally, storage services worldwide are expected to top $40 billion.

Pushing the Technology Boundaries - The Technical Details

Disc drives at their most basic level work on the same mechanical principles as media such as compact discs or even records, however, magnetic disc drives can write and read information much more quickly than compact discs (or records for that matter!). The specific data is placed on a rotating platter and information is then read or written via a head that moves across the platter as it spins. Records do this in an analog fashion where the disc's grooves pick up various vibrations that then translate to audio signals, and compact discs use a laser to pick up and write information optically.

In a magnetic disc drive, however, digital information (expressed as combinations of "0's" and "1's") is written on tiny magnetic bits (which themselves are made up of many even smaller grains). When a bit is written, a magnetic field produced by the disc drive's head orients the bit's magnetization in a particular direction, corresponding to either a 0 or 1. The magnetism in the head in essence "flips" the magnetization in the bit between two stable orientations. In currently produced hard disc drives, longitudinal recording is used. In longitudinal recording, the magnetization in the bits is flipped between lying parallel and anti-parallel to the direction in which the head is moving relative to the disc.

Increasing areal densities within disc drives is no small task. For the past couple of years, technologists have been increasing areal densities in longitudinal recording at a rate in excess of 100% per year. But it is becoming more challenging to increase areal densities, and this rate is expected to eventually slow until new magnetic recording methods are developed.

To continue pushing areal densities in longitudinal recording and increase overall storage capacity, the data bits must be made smaller and put closer together. However, there are limits to how small the bits may be made. If the bit becomes too small, the magnetic energy holding the bit in place may become so small that thermal energy may cause it to demagnetize over time. This phenomenon is known as superparamagnetism. To avoid superparamagnetic effects, disc media manufacturers have been increasing the coercivity (the "field" required to write a bit) of the disc. However, the fields that can be

approached.

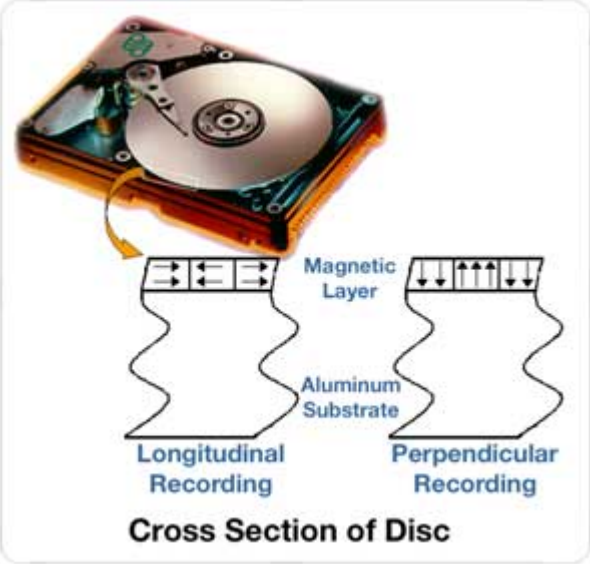
According to Dr. Mark Kryder, senior vice president at Seagate Research, longitudinal recording still has time left before reaching the superparamagnetic limit. "We expect today's longitudinal recording methods to take us beyond 100 gigabits per square inch in density. A great challenge however is maintaining a strong signal-to-noise ratio for the bits recorded on the media. When the bit size is reduced, the signal-to-noise ratio is decreased, making the bits more difficult to detect, as well as more difficult to keep stable."

Perpendicular recording is widely seen as the next method of recording that will be adopted to help push areal densities further. Dr. Kryder estimates that the switch to perpendicular recording will occur sometime between 100 and 200 gigabits per square inch areal density. In perpendicular recording, the magnetization of the disc, instead of lying in the disc's plane as it does in longitudinal recording, stands on end perpendicular to the plane of the disc. The bits are then represented as regions of upward or downward directed magnetization (corresponding to the 1's and 0's of the digital data).

Perpendicular recording enables one to record bits at a higher density than longitudinal recording, because it can produce higher magnetic fields in the recording medium. In perpendicular recording the media can be deposited on a soft magnetic underlayer that effectively produces an image of the recording head and approximately doubles the recording field.

Even though perpendicular recording will take magnetic recording technology much further than the current longitudinal methods, superparamagnetic effects still exist at some point, though it is difficult to predict exactly when this will occur.

"At this time, we estimate that perpendicular recording methods may take us all the way to one terabit per square inch," Dr. Kryder continued. "When that level is reached, a single 3.5 inch disc will store over one terabyte of information."



The Cross Section of a disc shows the difference between longitudinal and perpendicular recording.

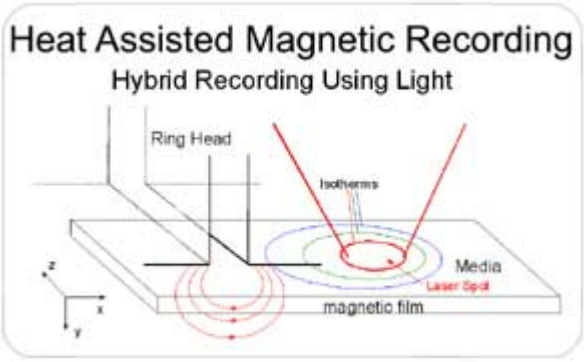
While that amount of storage is a significant advance beyond that of storage capacity available in a single drive today, when put into perspective with the best estimates and forecasts of our current and future storage requirements, the need for technologists to continue to forge ahead beyond that figure is clear. The UC Berkeley study reported that the world produces between 1 and 2 exabytes (one exabyte is the equivalent of one billion gigabytes) of information each year in total, comprising all magnetic, paper, film, and optical data. In addition to that sum, it is conceivable that eventually much of the older media such as those produced on film and paper may also make its way to magnetic data translation, increasing the overall total figure further.

Further Into the Future

Beyond longitudinal and perpendicular recording, technologists are already beginning to explore other possible methods of recording data. Still many years away, optically-assisted (also known as thermally-

candidates for storing the world's information.

Optically-assisted recording involves producing a hot spot (commonly with a laser) on the media, while data is simultaneously written magnetically. The net effect is that when the media is heated, the coercivity or field required to write on the media is reduced, making it possible to write high-coercivity media (which as explained above have higher stability against superparagmagnetism), in spite of the limited fields that can be produced by recording heads.



A diagram on how Heat Assisted Magnetic Recording (HAMR) works.

Technologists such as Seagate Research's Dr. Dieter Weller are also working on patterned media, or what is also being called self-ordered magnetic arrays (SOMA). "A typical bit of information is made up of about 100 grains of material. We are working to convert each grain to a unique bit of information. As a result, a large gain in bit density would be achieved," said Dr.Weller.

Dr. Weller added that Seagate Research is working on ways to make the grains "order" in a regular array so that the bits can be read and written and so that good thermal stability can be achieved. Weller believes that iron platinum (FePt) is the best material to use along with a careful balance of other chemicals.

Probe storage may be one of the more unusual methods of recording proposed since it doesn't involve the use of discs at all. Rather, probe storage technology could be implemented in something the size of a typical semiconductor chip. It works like a scanning microscope, except there is an array of these microscopes or probes that read and write the data. Each probe addresses an array of bits of information, and the probes write and read in parallel. Several media candidates are under consideration, including magnetic media, and, unlike typical silicon chips, they won't lose memory once power is turned off. It is estimated that about 10 gigabytes of information will be able to be stored on a centimeter-sized chip.

While probe storage offers interesting possibilities, Dr. Kryder doesn't view it as a replacement for disc drives. Rather, he envisions probe storage chips working in a large number of consumer electronic devices that require a solid state, low-power storage device with moderate capacity. He even envisions them being put into disc drives to act as a memory buffer to allow faster access to information than the drive alone can provide.

The Information Age Continues

With computers firmly entrenched in our world, the need for more storage has never been greater. While it is difficult to truly estimate how much storage we will need and use in the future, there is no debate that the figure is astronomical. At no other point in the history of mankind has there been such a thirst for so much information. As a result, in this Information Age achieving the goal of allowing the average person access to all recorded information ever produced, is a significant, yet important one. It is information after all, that will ultimately help move us into newer and greater eras of enlightenment and discovery.

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POWER-THRIFTY HITACHI HARD DRIVE MAKES FOR COOL LAPTOPS, "BEDROOM-QUIET" DIGITAL VIDEO RECORDERS

Industry's Best Power Efficiency Offers Benefits for IT and CE Applications

SAN JOSE, Calif. - July 6, 2005 - Hitachi Global Storage Technologies is bringing to market the industry's highest-performing*, yet most power-efficient hard drive for the mainstream notebook and consumer electronic segments. In addition, the Hitachi Travelstar 4K120 is the first 2.5-inch hard drive to provide customers with an option for the AV Streaming Command Set - or Smooth Stream(tm) as introduced by Hitachi - which enhances audio/video streaming capability in digital entertainment devices, such as digital video recorders (DVR). The combination of these attributes makes Hitachi's 120-gigabyte** (GB) Travelstar 4K120 the technology leader in the 4200 RPM 2.5-inch hard drive space.

"While the 4K120 is primarily being used in the mainstream notebook segment, we've created a highly sophisticated hard drive that offers users the greatest value for their money for a range of applications," said Becky Smith, vice president, marketing, Hitachi Global Storage Technologies. "The list of leadership characteristics that the 4K120 has accumulated is representative of the commitment and expertise Hitachi brings to the 2.5-inch segment and our expansion into the consumer electronics space."

As an added benefit, the 4K120's low power-consumption also results in cooler operation and longer battery life in notebook systems, which could result in extended service life for both the hard drive and host product. In CE environments, the cooler-running hard drive can be used in a new category of smaller, entry-level DVRs intended for spaces such as bedrooms, where quieter operation is possible as fans are not required for cooling the host device.

Cool, Fast, Long-lasting

In the notebook space, the 4K120 out-performs all other 4200 RPM 2.5-inch hard drives based on published specifications for seek time, read/write functions and data transfer rates. While higher performance usually comes at the expense of power consumption, the 4K120 actually leads the industry in battery life due to the new Hitachi Voltage Efficiency Regulator Technology (HiVERT) in conjunction with other power management mechanisms. HiVERT works by reducing the power draw of key hard drive electrical components by 30 percent over the previous generation. In Hitachi's energy discharge test, the 4K120 shows between a 29- and 178-percent better power utilization than competitive 4200 RPM hard drives available on the market.

The 4K120's excellent power utilization directly correlates to a significant reduction in heat dissipation. With hard drives among the top three heat producers in laptop computers (behind the processor and graphics card), the 4K120's significantly lower heat dissipation will reduce the overall heat emission of notebooks for greater lap comfort. Thermal imaging tests conducted in Hitachi labs show a marked difference in heat emission between the Travelstar 4K120 and competitive hard drives in similar notebook operations

For Your Enjoyment

The 2.5-inch category is fast becoming a desirable form factor for CE manufacturers due to its smaller size and high capacity. DVR manufacturers, who typically use 3.5-inch drives for video storage, are now looking for a new hard drive to go into devices that are quieter and smaller. With its cool operation and new AV streaming capabilities, the Travelstar 4K120 is the first 2.5-inch hard drive to meet these needs, helping manufacturers to create a new category of fan-less DVRs that are "bedroom quiet." The Travelstar 4K120 continues the leadership established by Hitachi's Deskstar 3.5-inch product line by becoming the first 2.5-inch hard drive to offer the ATAPI/ATA-7 AV Streaming Command Set.

The 4K120 is also ideal for interactive game consoles, set-top boxes, digital jukeboxes and personal media player devices.

Product Availability

The Travelstar 4K120 is now shipping in volume to customers in 40-, 60-, 80-, 100- and 120-GB capacities. Availability in the channel is expected by August. The 4K120 is Hitachi's 30th-generation 2.5-inch product, which is based on the industry's most mature and stable platform for the category.

* based on available specifications
** 1 gigabyte equals one billion bytes

Technical Specifications
Travelstar 4K120
120/100/80/60/40 GB
9.5 mm in height
99/99/99/95/95 grams maximum weight
4200 rpm
7.1 ms average latency
98 billion bits per square inch maximum areal density
2/2/2/1/1glass disk platter(s)
4/4/3/2/2GMR recording head(s)
1000 G/1ms non-operating shock
300 G/2ms operating shock
11 ms average read time/13 ms average write time
0.65 W active idle
0.45W low-power idle
0.15W standby
100 MB/sec maximum interface transfer rate ATA-6 Ultra DMA mode-5

About Hitachi Global Storage Technologies

Hitachi Global Storage Technologies was founded in 2003 as a result of the strategic combination of Hitachi's and IBM's storage technology businesses. Hitachi GST is the industry's second largest hard disk drive manufacturer in revenue.

The company's goal is to enable users to fully engage in the digital lifestyle by providing access to large amounts of storage capacity in formats suitable for the office, on the road and in the home. The company offers customers worldwide a comprehensive range of storage products for desktop computers, high-performance servers and mobile devices. For more information on Hitachi Global Storage Technologies, please visit the company's Web site at http://www.hitachigst.com.

About Hitachi, Ltd.

Hitachi, Ltd., (NYSE: HIT), headquartered in Tokyo, Japan, is a leading global electronics company with approximately 347,000 employees worldwide. Fiscal 2004 (ended March 31, 2005) consolidated sales totaled 9,027.0 billion yen ($84.4 billion). The company offers a wide range of systems, products and services in market sectors including information systems, electronic devices, power and industrial systems, consumer products, materials and financial services. For more information on Hitachi, please visit the company's Website at http://www.hitachi.com.

###

Over the last four years, a new generation of consumer devices has radically changed the way people accumulate, enjoy and store entertainment. At the heart of the latest consumer electronic devices is what Hitachi is affectionately calling the new "Bling" - hard disk drives. These incredible shrinking drives have been instrumental in driving the digital revolution and a series of announcements from Hitachi today will drive future developments:

- Hitachi Presents Miniature Hard Drives As The New "Bling" - New 8GB "Mikey" & 60GB "Slim" Hard Drives To Stimulate New MP3 and Mobile Phone Designs; Mikey" Becomes First Product to Support CE-ATA
- Study Says Average "Generation Y" Consumer Has $2,200 Of Entertainment Stored On Digital Devices and Majority Want 2-3 Times More Digital Storage Than They Currently Have
- Hitachi Uses ESP & Other Shocking Technologies To Protect Hard Drive Data
- Hitachi to Give Away Real Gold/Diamond "Bling" to 25 Lucky Winners - Register for Drawing at http://www.hitachigst.com/portal/site/en/menuitem.fe21afe66959f26ed2e821f0eac4f0a0/
- View "Hard Drive is the New Bling" video at http://www.hitachigst.com/portal/site/en/menuitem.92a9817d39355921fce80bd5eac4f0a0/

###

Hitachi unveils terabyte DVD recorder

TOKYO, Japan (Reuters) -- Japan's Hitachi Ltd. on Wednesday unveiled the world's first hard disk drive/DVD recorder that can store one terabyte of data, or enough to record about 128 hours of high-definition digital broadcasting.

Hitachi, Japan's largest electronics conglomerate, is still a relatively small player in the DVD recorder market, trailing industry leaders Matsushita Industrial Co. Ltd., Sony Corp. and Toshiba Corp.

But it hopes its new line-up, which also includes models able to store 160 gigabytes, 250 gigabytes and 500 gigabytes of data, will help boost its market share and turn its loss-making DVD recorder business profitable in October-March, the second half of the business year.

"We entered the market last year and have only been able to grab about 3 percent of the market. It's been hard to earn a decent return on investment with such (low) volumes," Norio Ogimoto, general manager of Hitachi's storage media group, told a news conference.

"But we plan on being profitable with these new models given the volumes and prices we expect to see from them," he said.

Hitachi said the new models would be the first on the market able to simultaneously record two high-definition programs, and it hopes this will be a key selling point given the spread of terrestrial digital broadcasting in Japan.

The recorders will go on sale in Japan from next month. They are expected to retail from about 130,000 yen ($1,180) for the cheapest model to 230,000 yen for the one-terabyte recorder, which stores data on two 500 gigabyte hard disk drives.

One terabyte is equal to 1 trillion bytes of data. One gigabyte equals 1 billion bytes.

Hitachi said it did not have concrete plans for launching the products in overseas markets, explaining that consumers in Europe and the United States were not as keen on high-end recorders.

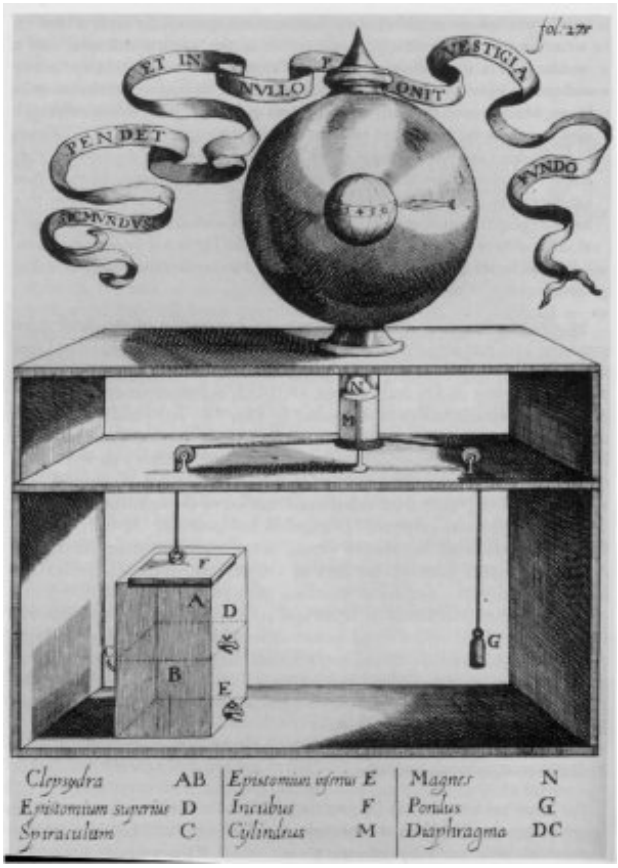
Japan accounts for more than half of the global DVD recorder market. DVD recorders have been slow to take off in other markets such as the United States, where TV set-top boxes with hard drives, such as those made by TiVo Inc., are popular.

MM Research Institute predicts that Japan's DVD recorder market will grow 26 percent to 5.6 million units in the current financial year to next March, up from 4.43 million in 2004/05.

Hitachi said it was aiming to grab 35 percent of the Japanese market for high-definition DVD recorders in the second half of this business year. High-definition recorders currently make up about 15 percent of the overall market, but that percentage is expected to grow strongly over the next several years.

QUIZ

What has this to do with magnetism?



Solution

go to the

END

CONFERENCE ANNOUNCEMENT 1

http://www.magnetism.org

MMM 2005

50th Magnetism and Magnetic Materials Conference

October 30 - November 3 - San Jose, California

Conference Announcement

This conference annually brings together scientists and engineers interested in recent developments in all branches of fundamental and applied magnetism. Emphasis is placed on experimental and theoretical research in magnetism, the properties and synthesis of new magnetic materials, and advances in magnetic technology. The Program consists of invited and contributed papers. Abstract booklets will be made available at the Conference, and Proceedings will be published in the Journal of Applied Physics.

Please click here to submit your article for the Proceedings

Click Here for Itinerary Planner (Program)

Magnetism & Magnetic Materials

MMM 50 2005

CONFERENCE ANNOUNCEMENT 2

Hyatt Regency Irvine
Irvine, California
Oct. 31st - Nov. 3rd , 2005

Organized by the IEEE Sensors Council

General Chair
Andrei Shkel, University of California, Irvine, USA

The conference will be held at the Hyatt Regency Irvine, within 15 minutes of Disneyland, California Adventure, Knott's Berry Farm, South Coast Plaza Mall, Fashion Island, Newport Beach, Huntington Beach, Oak Creek and Pelican Hill Golf Courses, Edison Field (Anaheim Angels) and Arrowhead Pond (Anaheim Mighty Ducks).

Orange County Attractions: http://www.visitorangecounty.net/attractions.html

Abstract Submission Deadline April 20, 2005

Topics of Interest:

1. Sensors Phenomena and Modeling (theory, characterization, CAD modeling, and testing of sensors)
2. Sensor and Actuator Systems (sensor electronics, actuator systems, sensor-actuator systems, multiple-sensor systems, intelligent sensing, sensor arrays, "electronic nose" technology, sensor buses, sensor networks, voting systems, telemetering, internet-based and other remote data acquisition, and control of sensors)
3. Chemical and Gas Sensors (devices, materials, and technology)
4. Biosensors (sensor arrays, lab-on chip, online monitoring, process control, test kits, materials, and technology)
5. Optical Sensors (radiation sensors, optoelectronic/photonic sensors, and fibers)
6. Mechanical sensors (inertial, pressure, and tactile)
7. Physical Sensors (thermal, **magnetic**, and mass-sensitive devices)
8. Applications (automotive, medical, environmental monitoring, consumer, alarm and security, military, nautical, aeronautical and space sensor systems, robotics, and automation)

Further information at

http://ewh.ieee.org/tc/sensors/sensors2005/index.html

CONFERENCE ANNOUNCEMENT 3

ICST 2005 is intended to provide a common forum for researchers, scientists, engineers and practitioners throughout the world to present their latest research findings, ideas, developments and applications in the area of sensing technology. ICST 2005 will include keynote addresses by eminent scientists as well as special, regular and poster sessions. All papers will be **peer** reviewed on the basis of a full length manuscript and acceptance will be based on quality, originality and relevance. The review process will **be double blind** and author details will not be divulged to the reviewers. Accepted papers will be published in the conference proceedings.

Topics will include, but are not limited to, the following:

- Vision Sensing
- Sensors Signal Processing
- Sensors and Actuators
- Sensors Phenomena and Modelling
- Sensors Characterization
- Smart Sensors and Sensor Fusion
- Electromagnetics Sensors
- Chemical and Gas Sensors
- Physical Sensors
- Electronic Nose Technology
- Biological Sensors
- Electro-optic Sensors and Systems
- Mechanical sensors (inertial, pressure, and tactile)
- Nano Sensors
- Acoustic, Noise and Vibration Sensors
- Wireless Sensors
- Optical Sensors (radiation sensors, optoelectronic/photonic sensors, and fibres)
- Lab-on chip
- Sensor Arrays
- Intelligent sensing
- Telemetering
- Online monitoring
- Applications of Sensors (automotive, medical, environmental monitoring, consumer, alarm and security, military, nautical, aeronautical and space sensor systems, robotics, and automation)
- Solid State Sensors
- Internet-based and other Remote Data Acquisition

Paper Submission

Authors are invited to submit the full manuscript (4 to 6 pages including references) of their technical paper, for oral or poster presentation, in **MS Word format** using web (http://icst.massey.ac.nz/)

For further details, please **contact**: Subhas Mukhopadhyay
S.C.Mukhopadhyay@massey.ac.nz

CONFERENCE ANNOUNCEMENT 4

Description: Latin-American Workshops on Magnetism, Magnetic Materials and their Applications are held every two years in different Latin-American countries and open to participants from all over the world. Sessions include: invited talks, oral contributions, poster contributions, advanced topic discussions, round table on collaborations and others. Working language is English. Proceedings will be published as a special but consecutive number of Physica B.

Main topics:

Cooperative phenomena in magnetism
Artificially structured materials
Spintronics: spin injection and detection
Magnetic nanostructures
Transition metal oxides
Magnetic multilayers
Low-dimensional magnetism
Spin glasses and frustrated systems
Giant and colossal magnetoresistance
Molecular and cluster magnetism
Computer simulations of magnetic systems
Applications and interdisciplinary topics

Submission of abstracts will be on-line in a format to be defined on May 31 2005. **Each fully registered participant** will be entitled to submit contributions according to the following rules: (1) There is no limitation in the number of contributions submitted as posters (Acceptance of each abstract is decided by the Organizing Committee). (2) Only one contribution can apply for consideration as an oral presentation (Acceptance is decided by the Organizing Committee). (3) Only one of the actually presented papers (oral poster) can be submitted for the Proceedings in Physica B, following peer review.

Deadlines:

31 July 2005	Abstracts, pre-registration and beginning of hotel reservation.
31 August 2005	Announcement of abstract acceptation
30 September 2005	Deadline for discount registration fee
31 October 2005	Full paper reception for the Proceedings (to be published in Physica B)
11 December 2005	Venue at hotel Conference Town, Reñaca and beginning of LAW3M-05 (www.ctown.cl) There is no deadline for hotel registration but it will be handled on the basis of "first come first served".

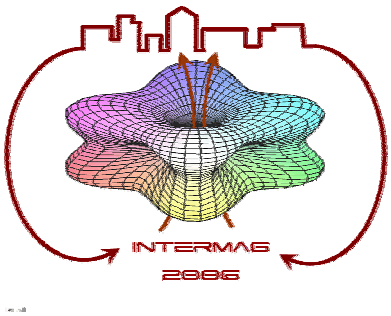
Registration:

Regular	US$ 300.-
Discount fee	US$ 250.- (if paid before September 30, 2005)
Student	US$ 150.-

CONFERENCE ANNOUNCEMENT 5

International Magnetics Conference (INTERMAG 2006)

San Diego, California,
May 8-12 2006
http://www.intermagconference.com/intermag2006/



The INTERMAG 2006 Conference will be held in **San Diego, California, USA**, from **May 8 to May 12, 2006**. All members of the international scientific communities interested in new developments in magnetism and associated technologies are invited to attend and submit their latest findings to INTERMAG 2006. The Program consists of invited and contributed papers and selected papers from the conference will be published in the ***IEEE Transactions on Magnetics*.**

Categories for submission include:

1. Magnetic Recording & Magneto Optical Recording
2. Spin Electronics and Applications (Non-Recording)
3. Soft Magnetic Materials and Applications
4. Permanent Magnet Materials and Applications
5. Magnetic Thin Films and Nanostructures
6. Other Magnetic Materials & Non-Recording Applications
7. Nanomagnetics Theory
8. Characterization and Imaging
9. Sensor, High Frequency and Power Devices
10. Life Science and Applications
11. Physics and Interdisciplinary Topics

Deadlines:
Digest submission: December 19, 2005
Manuscript submission: March 13, 2006.
Advance Registration for the conference begins on **January 30, 2006**.

Advance Registration via the web is the most convenient way to register and is highly recommended.

The City of San Diego offers a wide variety of things to see and do as well as a climate that is mild and pleasant all year. For complete information about traveling to San Diego visit the web site at: www.sandiego.org. There you can obtain a travel and vacation planning guide, current weather information, and maps of the area of both the downtown and the area surrounding the **Town & Country Resort and Conference Center** where Intermag 2006 will be held.

The Town & Country is located in San Diego's Mission Valley, and is served by the new light-rail trolley system. Complimentary parking is also available. All Conference activities are located on one level, with easy access for all.

The Intermag Conference sleeping **room rates** will be $139/single or $149/double plus tax. More complete information and room reservation forms will be available on the Intermag Conference web site in January 2006.

More information will be posted on the **INTERMAG Homepage** at:
www.intermagconference.com/intermag2006

CONFERENCE ANNOUNCEMENT 6

6th International Conference on the

Scientific and Clinical Applications of Magnetic Carriers

May 17 – 20, 2006

Krems, Austria (Vienna Region)

This meeting will discuss all aspects of magnetic nanospheres, magnetic microspheres and ferrofluids. This includes

- **Preparation and analysis** of magnetic microspheres and nanospheres made from all kinds of materials such as polymers, ceramic, biomaterials, biodegradables, including fluorescent ones.

- **Applications** covered are magnetic drug delivery, molecular biology, in vitro diagnostics, contrast agents in MR imaging, stem cell separation, toxic metal removal, magnetic cell sorting, hyperthermia treatment, groundwater decontamination and magnetic particle motion analysis, just to name a few.

* **Daily lecture series** about the fundamental physics of magnetic carriers are given by Dr. Robert Shull, NIST.

* **Deadline** for abstract submission, reduced online registration and guaranteed hotel reservation: Friday, March 10, 2006

* **Registration**: Euro 300 until March 10, Euro 380 thereafter; students/postdocs: Euro 150; this fee includes all lunches, a boat trip, the reception and a dinner in the historic downtown of Krems

* **Proceedings** will be published as fully peer reviewed articles in the online journal "Biomagnetic Research and Technology"

* **Travel grants**: We will provide 10 participants with a travel grant of 500 Euros plus free registration. Recipients will be chosen within one week after the abstract deadline, based according to the scientific quality of their abstract. Applicants must either be doctoral and postdoctoral students, or come from an economically disadvantaged country (e.g., former Soviet Union, South America, Eastern Europe, Africa).

You are cordially invited to our next and 6th Conference by:

Urs Häfeli
University of British Columbia
Vancouver, Canada

Maciej Zborowski
The Cleveland Clinic Foundation
Cleveland, U.S.A.

Wolfgang Schütt
IMC University of Applied Sciences
Krems, Austria

Mirka and Ivo Safarik
Academy of Science
Ceske Budejovice, Czech Republic

For more information, please visit our website www.magneticmicrosphere.com

BOOK REVIEW

New Book Announcement:

Boundary Element Methods for Electrical Engineers

Billerica, MA. - This is the first text on Boundary Element Methods that is produced specifically for electrical engineers. Written in the form of a primer, it presents the BEM in a simple fashion that will help beginners understand its very basic principles. The authors begin by deriving the BEM for the simplest potential problems, before building on these to formulate methods for a wide range of applications in electromagnetics.

Introducing boundary element fundamentals in a way which will enable readers to solve complex problems on their own, the book is designed for undergraduate and graduate students of electronics and/or electrical engineering. It will also be useful to researchers and professional engineers who wish to exploit the full potential of the BEM in electrical engineering.

Boundary Element Methods for Electrical Engineers is Volume 4 in WIT Press's Advances in Electrical Engineering and Electromagnetics book series.

Full contents details can be found at http://www.witpressusa.com/acatalog/0330.html

Book Information

Title: **Boundary Element Methods for Electrical Engineers**

Edited by: A D. POLJAK, University of Split, Croatia and C.A. BREBBIA, Wessex Institute of Technology, UK

Publisher: WIT PRESS - www.witpress.com

Availability: Immediate

ISBN: 1-84564-033-0

Pages: 240pp

Price: US$126.00 / £79.00 / Euros 118.50

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and outside North America from

WIT Press, Ashurst Lodge, Ashurst, Southampton SO40 7AA, UK
Phone: 44 (0) 238 029 3223; Fax: 44 (0) 238 029 2853; E-mail: marketing@witpress.com;

IEEE PUBLICATION NEWS

Members who would like to volunteer their services as technical reviewers are needed. Society members with **ideas for new books** or candidates for the ***Classic Re-Issue*** series are urged to get in touch with:

John T. Scott,
Magnetics Society Liaison to IEEE Press
E-mail: john.scott@physics.org

For ***new books in data storage***, the contact is

- "Gordon F. Hughes" gfhughes@ucsd.edu

For ***new books in other areas***, the contact is

- John T. Scott john.scott@physics.org

IEEE XPLORE(R) RELEASE 1.5:

The IEEE Xplore(R) Release 1.5 provides free abstract/citation records for guests and enhanced linking to complete abstract/citation records for IEEE members and subscribers, as well as:

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In addition, through IEEE Xplore 1.5, subscribers to the IEEE Member Digital Library can now sort information in their personal file cabinets by publication name, primary author and original filing date.

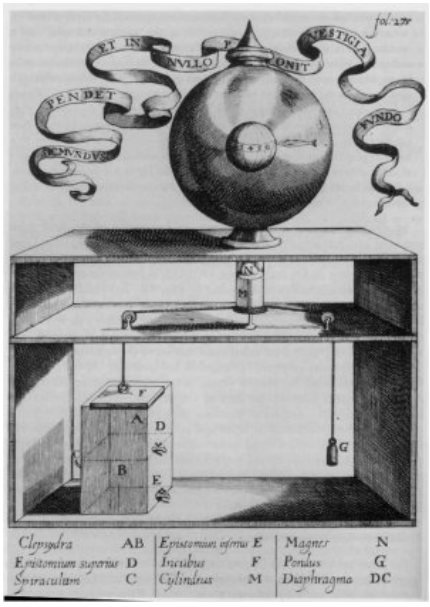
For more information on this release, visit
<http://ieeexplore.ieee.org/xpl/ReleaseNotes.jsp>

Starting in 1965 with *vol*. 1, now all papers published in **IEEE TRANSACTIONS ON MAGNETICS** are available at ***IEEE Xplore,*** as well as the searchable **Cumulative Index 1985-2000, Volumes 21-36**

Ron Goldfarb
Publications Chair
r.goldfarb@ieee.org

QUIZ – Solution

It is the magnetic clock



Site map
Timeline
Reconstruction
Acknowledgements

A Timeline

This timeline traces the origins of ***Athanasius Kircher's magnetic clock*** from theoretical and practical studies of magnetism in the early seventeenth century.

View an interactive map of the transmission of information about the magnetic clock

1600 William Gilbert publishes *De Magnete* (On the Magnet), in which he puts forward the hypothesis that the Earth is a great magnet. Experiments carried out with a "terrella", or small spherical magnet, convince him that the earth rotates around its poles because of terrestrial magnetism.

1609 Johannes Kepler publishes his *Astronomia Nova* (New Astronomy), in which he puts forward the hypothesis that the planets were moved by a magnetic force.

1618-21 Kepler publishes his *Epitome astronomiae*

Copernicanae (Epitome of Copernican Astronomy), which further develops his hypothesis that the planets are carried around the sun by a magnetic force emanating from a rotating sun.

1632 Galileo publishes his *Dialogo sopra i due Massimi Sistemi del Mondo* (Dialogue on the Two Chief World Systems). He includes an argument against Gilbert's assertion that a spherical magnet will rotate every twenty four hours.

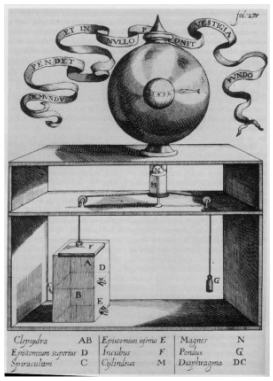
1633, 15 June: Godefrid Wendelin writes a letter from Brussels to the Minim scholar Marin Mersenne in Paris to inform him of a magnetic clock invented by a Jesuit professor in Liège, Fr. Francis Line. The clock contains a wax globe that appears to rotate in imitation of the sun's motion.

1633 22 June. Galileo is sentenced by the Inquisition of being "vehemently suspected of heresy" for teaching the Copernican doctrine in his *Dialogo* and is forced to make a public abjuration in the Dominican Church of Santa Maria sopra Minerva in Rome.

1633-4 Line's magnetic clock comes to the attention of the Papal Nuncio of Cologne, Monsignor Pierluigi Caraffa. Caraffa has the clock brought to his home, where he observes it for several days and finds it to keep good time. His Jesuit confessor, Father Sylvester Pietrasancta, publishes a description and illustration of Line's clock in a book of emblems published in Antwerp, Silvestro Pietrasancta's *De Symbolis Heroicis*.

1634 December: Monsignor Caraffa and his confessor travel to Aix-en-Provence, where they visit Nicholas Claude Fabri de Peiresc at his home, the Château de Beaugencier. Peiresc is shown the description of Line's magnetic clock given in Pietrasancta's work.

1634, December 18: Peter Paul Rubens, responsible for designing the frontispiece to Pietrasancta's book, writes to Peiresc to say that he has "talked with men of ingenuity who have seen and operated it with ease, and have the greatest admiration for it". Rubens even offers to ride from his home in Antwerp to Liege to visit Line and obtain more details of the clock.



1635, 1 April: Peiresc writes from Aix to Galileo (under house-arrest in Arcetri, near Florence), describing the "hydraulic clock" in enthusiastic terms. He believes that the instrument could provide a demonstration of the Copernican theory, writing that "it seems to be a proof and testimony that has fallen from heaven into the hands of a Jesuit father, rather than those of somebody of another calling, to leave no room for suspicion against the testimony of the Father who invented it or the other who published it, to demonstrate the error of those who find such repugnance in the Copernican doctrine and in that which Your Lordship proposed about it as a problematic joke (i.e. Galileo's *Dialogo*)". According to Peiresc, Caraffa had examined the clock in his own home for several days and found it to be very accurate.

1635, 17 April: Peiresc writes again to Galileo informing him that he is attempting to use the magnetic clock in his efforts to convince Cardinal Francesco Barberini, the papal nephew, to have the charges against Galileo reduced, and to free him from imprisonment.

1635, 12 May: Galileo writes a letter to Peiresc, explaining that he had made a similar invention many years before, and suggesting that the base of Linus's device contained a hidden magnetic clock, whichthat moved another magnet hidden in the hollow copper sphere. The sphere, in Galileo's version, was suspended at the boundary between salt water

and fresh water due to its intermediate specific gravity.

1635, 18 June: Peiresc writes to Gassendi to say that he has heard more information about the machine from an eyewitness, Dormalius, who claims that the inner sphere was originally made of wax, but that Linus then chose a hollow copper globe. The fact that the globe moved back to its position when displaced horizontally led Peiresc to be very suspicious that a hidden mechanism, like that described by Galileo, was responsible for the rotation of the globe.

1640: 8 March: Responding to hisKircher's request for magnetic observations, the Jesuit Lorenz Mattenkloth writes to Athanasius Kircher from Münster to ask him if he has heard about Line's magnetic clock, and if he has an explanation for its mechanism. On the same day Grégoire de Saint-Vincent also writes to Kircher telling him about the invention of the machine by "some English Father"

1641: Athanasius Kircher publishes his *Magnes, sive de arte magnetica* in Rome. The work includes the first published description and illustration of the secret mechanism of the magnetic clock, and a lengthy attack on the magnetic arguments in favour of Copernicanism put forward by Gilbert and Kepler.

Website created by Michael John Gorman, April 2001.

Comments, questions or suggestions to mgorman@stanford.edu

http://shl.stanford.edu/Eyes/kircher/intro.html
http://shl.stanford.edu/Eyes/kircher/timeline.html
http://shl.stanford.edu/research/artificial_eyes.html

ABOUT THE NEWSLETTER

The objective of the **IEEE Magnetics Society Newsletter** is to publicize activities, conferences, workshops and other information of interest to the Society membership and technical people in the general area of applied magnetics. Manuscripts are solicited from the Magnetics Society membership, organizers of conferences, officers of the Society and local chapters and other individuals with relevant material.

The Magnetics Society Newsletter is published electronically at the IEEE Magnetics Society webpage http://www.ieeemagnetics.org/
The Newsletter is published in January, April, July and October.
Submission deadlines are January 1, April1 1, July 1, and October 1, respectively.
Please send articles, letters and other contributions to the editor:

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