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CMRR Report
Center for Magnetic Recording Research

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CMRR's H. Neal Bertram Wins IEEE Award For Advances In Magnetic Recording Research

San Diego, Aug. 29, 2002 -- UCSD professor & CMRR endowed chair, H. Neal Bertram, a leading researcher in the field of recording physics and micromagnetics, has won the 2003 IEEE Reynold B. Johnson Information Storage Award. The prize is awarded each year for outstanding achievement in the field of information storage, mainly computer storage. Bertram was cited for "fundamental and pioneering contributions to magnetic recording physics research."

Bertram's research includes modeling the thermal instability that occurs as device makers try to pack more bits into smaller areas, a massive computational exercise on which he has teamed up with the San Diego Supercomputer Center, where he is a Fellow.

The IEEE Reynold B. Johnson Information Storage Award was established by the IEEE in 1991 as part of its Technical Field Awards program. The award is sponsored by IBM, in honor of a pioneer of magnetic disk technology: Reynold Johnson, the founding manager (in 1952) of the IBM San Jose Research and Engineering Laboratory, where IBM's storage research and development was centered.

Neal Bertram earned his Ph.D. in physics from Harvard University in 1968. From then until 1984, he worked for AMPEX Corporation. He joined the UCSD faculty in 1985, and now leads CMRR's recording physics and micromagnetics research. He is the author of a highly-regarded textbook entitled "Theory of Magnetic Recording" (Cambridge University Press, 1994). Bertram has been an IEEE Fellow since 1987. In 2000, he was the co-recipient (with Seagate Research's Roy W. Gustafson) of the Technical Achievement Award from the National Storage Industry Consortium for "modeling and system simulations that supplied the insights needed to develop specifications for a realizable 100Gb/sq.in. hard disk drive system."

First Official Users on Asterix Search for Answers to Questions About Magnetic Behavior in Thin Films

Nanotechnology – science of the "small" – will soon revolutionize computer technology and other industrial applications as scientists seek to manipulate and explore novel nanostructured magnetic materials. But before these novel materials can be put into practical use, the magnetic behavior of nanoscale structures that are nearly 1/80,000 the diameter of a human hair must first be understood. In particular, understanding magnetic behavior in ultrathin layered structures is critical, as these structures form the basis for high-density information storage technology.

A team of scientists from the Center for Magnetic Recording Research (CMRR) at the University of California, San Diego (UCSD)–doctoral student Geoffrey Beach and his advisor Prof. Ami Berkowitz, with CMRR affiliated faculty member Prof. Sunil Sinha (UCSD Physics Dept.)–recently performed experiments on the newly commissioned Asterix instrument at the Los Alamos Neutron Science Center (LANSCE) to examine the ultrathin native oxide layers that form at the surface of high-moment magnetic metals (CoFe) at low oxygen exposure. Such native oxide layers play important roles in the metal/native oxide multilayer (MNOM), a nanostructured magnetic material recently developed at UCSD for use as a shield material in the next generation of high data density magnetic recording.

GEOFFREY BEACH, CMRR DOCTORAL STUDENT AT THE UNIVERSITY OF CALIFORNIA, SAN DIEGO MAKES ADJUSTMENTS TO THE METAL/NATIVE OXIDE MULTILAYER SAMPLE ON ASTERIX. THE SAMPLE WAS USED IN RECENT EXPERIMENTS AT LANSCE AIMED AT UNDERSTANDING THE MAGNETIC BEHAVIOR IN ULTRATHIN LAYERED STRUCTURES.

Shielding layers are used in magnetic recording heads (the device that reads bits from and writes bits to the hard disk) to channel stray magnetic fields (e.g., from adjacent bits) away from the read sensor. At high data rates, conventional shield materials are limited by eddy currents, or electrical currents generated in a metal in response to a varying magnetic field.

Eddy currents act to oppose changes in the magnetic field within a material; this makes it difficult for the shield to respond to variations in the stray field and thus reduces the shielding efficiency. In the MNOM, the oxide layers act as high electrical resistance barriers to eddy currents, enabling operation at frequencies up to several gigahertz. In addition, the native oxide layers are magnetic, which both increases the total magnetization of the MNOM (important in the writing process in magnetic recording) and magnetically couples the metallic and oxide layers. This magnetic coupling allows the direction of the MNOM magnetization to be switched very easily (i.e., the material is magnetically soft).

The MNOM structure consists of nanolayers (~ 2 nm) of a high-moment (strongly magnetic) CoFe alloy separated by thin native oxide layers (~ 1 nm), which are formed by exposing each metallic layer to a low pressure of oxygen. In previous experiments, the UCSD team had shown that the native oxide layers are in fact magnetic and that there is a correlation between the magnetic properties of the oxide and the multilayer as a whole. But questions about the native oxide layers remain – namely, why are they magnetically stable (surprising considering their thickness), and how do they couple magnetically to the metal? Answers to these questions are important not only for understanding the MNOM system but also for describing interface effects in nanolayered materials in general.

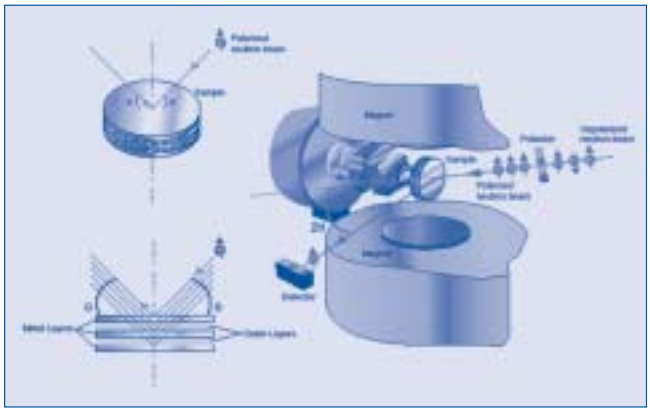

ILLUSTRATION BY SHARON MIKKELSON
THREE-DIMENSIONAL RENDERING OF THE MNOM MULTILAYER STRUCTURE USED IN THE ASTERIX EXPERIMENTS.

The surface atoms of small, thin structures have a greater influence on the surrounding atoms that make up the structure than do the surface atoms of thicker, bulk materials. In thin layered structures, such as the MNOM sample used in the Asterix study, interface effects (i.e., at the metal-oxide interfaces in the MNOM) often dominate the behavior of the material, thus producing novel properties. These properties, which are not often found in naturally occurring materials, may be of significant technological interest. However, studying interfaces and ultrathin layers is extremely challenging. In most experimental techniques, studying the magnetic properties of individual magnetic layers separately is difficult because only the properties averaged over all the layers can be obtained. Polarized neutron reflectometery (PNR) offers a unique advantage in that one can

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FROM THE DIRECTOR

This year marks the 50th anniversary of the founding of the IBM laboratory in San Jose that created the RAMAC disk drive and launched the era of magnetic disk storage. During the intervening half-century, the technology of information storage has certainly seen remarkable scientific and engineering advances.

Next year, we will celebrate another landmark event, the 20th anniversary of the founding of another trailblazing institution: our own Center for Magnetic Recording Research at UC San Diego. In its nearly 20 years of operation, the mission of CMRR has been, and continues to be, the attainment of excellence in research, education, and impact on the technology of information storage, particularly magnetic recording. Indeed, our faculty, researchers, students, and staff strive collectively to make CMRR the premier academic institution in the field of data storage.

The articles in this issue of CMRR Report give evidence of the Center's continuing success in pursuit of its three-fold mission. They confirm that our scientific and engineering contributions are of the highest caliber; that our educational activities attract the brightest students and provide them with the knowledge and tools they need to advance the underpinnings of storage technologies; and that our activities provide real benefit to our sponsors, the data storage industry, and the general public. Let me briefly mention a few highlights of the past six months.

On the scientific front, it is a pleasure to announce that Professor Neal Bertram, holder since 1985 of one of the four CMRR endowed chairs, has been awarded the 2003 IEEE Reynold B. Johnson Information Storage Award, in recognition of his "fundamental and pioneering contributions to magnetic recording physics research, applications and education." You may recall that Prof. Jack Wolf, another chaired CMRR professor, received the 2001 IEEE Claude E. Shannon Award for his profound contributions to the field of information theory (including its application to magnetic recording). We at CMRR take great pride in our record of research accomplishments, a record that has led to such international recognition for our faculty.

On the educational front, CMRR continues to attract students from the top-tier, at both undergraduate and graduate levels. One recent graduate, Dr. Ed Price, received a UCSD Faculty Fellowship, recognizing his academic accomplishments and promise as a future educator; the thesis project of another doctoral student, Geoff Beach, was supported by an award from the NIST Nano-Technology Initiative; and a former ECE undergraduate student, Laurence Zapanta, who worked on a project at CMRR as part of his Cal-$(IT)^2$ Summer Research Fellowship in 2001, has completed his B.S./M.S. and is now pursuing his Ph.D. studies at MIT.

The third front, involving the transfer of human and intellectual capital to the storage industry, is perhaps the most vital to our continuing close relationship with our corporate sponsors. I regard this relationship as a fundamental and distinguishing component of CMRR's identity and raison-d'etre. This year, CMRR proudly graduated six outstanding students - five with Ph.D.s and one with a Masters - and we are very pleased that five of these graduates (the sixth being Ed Price, whose post-graduate activities were mentioned above) have joined the technical staffs of sponsor companies.

CMRR researchers have also continued to be active participants in the International Storage Industry Consortium (INSIC, formerly NSIC), and we have collaborated with sponsors on several projects under the auspices of programs at LANL LLNL, NIST, and the Sloan Foundation. All of these pre-competitive technology efforts have as their goal a rapid transfer of innovation to our sponsors and the marketplace.

CMRR's visitor programs – which I encourage our sponsors to take advantage of - represent perhaps the most effective means toward efficient exchange of new technical ideas and concepts. We are therefore very pleased to welcome new visitors from Hitachi Corporation and Seagate Technology.

Finally, let me emphasize that we at CMRR always welcome feedback and suggestions on how we might create more value for our sponsors, and we take action accordingly. For example, over the past year, we have upgraded the CMRR website, with a more attractive look, enhanced content, and improved navigability. (Please pay a visit, if you haven't already, to http://cmrr.ucsd.edu.) We have also established the CMRR Servo Lab (described in more detail

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Hughes appointed to Data Storage Institute Board

Gordon Hughes, CMRR Associate Director has been appointed to a two year term as a member of the Scientific Advisory Board of the Science and Engineering Research Council (SERC) of the Agency for Science, Technology and Research (A*STAR) in Singapore. The board oversees the Data Storage Institute (DSI) of Singapore. DSI conducts research and development in next generation data storage technologies and supports the growth of the data storage industry in Singapore.

Since it was founded 10 years ago out of the National University of Singapore, DSI has built up core competencies in technology areas that support the magnetic and optical disk drive industries, both of which have large manufacturing facilities in Singapore. DSI has now grown to 257 professionals working on recording media, heads, signal processing/coding, optical disks, recording physics, contamination control, and network storage.

Singapore has the world's largest hard disk drive manufacturing sector, with revenue of $20 billion (U.S.), twice that of Thailand, its nearest competitor.

Prof. Hang Chang Chieh, SERC Executive Director, noted in Dr. Hughes's appointment letter his breadth of experience in the data storage industry, and states "we are confident you will be able to contribute to the growth and success of the institute. We look forward to your advice and guidance."

CMRR Joins the Storage Networking Industry Association

CMRR has joined the Storage Networking Industry Association (SNIA) as a university affiliate. SNIA was incorporated in December 1997 and is a registered 501-C6 non-profit trade association. Its members are dedicated to "ensuring that storage networks become complete and trusted solutions across the IT community".

SNIA works towards this goal by forming and sponsoring technical work groups, by producing (with its strategic partner - Computerworld) the Storage Networking World Conference series, by building and maintaining a vendor neutral Technology Center in Colorado Springs, and by promoting activities that expand the breadth and quality of the storage networking market.

Membership in SNIA will provide CMRR increased access to storage systems industrial partners. This will be of particular benefit to the intelligent disk drive research project, [a CMRR collaboration with UCSD's Information Storage Industry Center (ISIC),] funded by the Sloan Foundation.

CMRR Represented at Seagate Research Grand Opening

Seagate Technology, one of the founding sponsors of CMRR, celebrated the Grand Opening of its new, world-class research facility in Pittsburgh, Pennsylvania on August 21, 2002. Prof. Paul Siegel, CMRR Director, was in attendance, along with several CMRR alumni now working at the new laboratory: Eric Boerner (2000), Hong Zhou (2001), and Jason Goldberg (2002).

The morning program included presentations and remarks by Dr. Mark Kryder, Senior Vice President of Research at Seagate and former Director of our sister institution, the Data Storage Systems Center (DSSC) at Carnegie-Mellon University; Tom Porter, Seagate's Chief Technology Officer, and Seagate CEO Steve Luczo.

Dr. Gordon Bell, computer pioneer and senior researcher at Microsoft's Bay Area Research Center, gave a live keynote telepresentation, entitled "Challenges in Exploiting Exponential Storage Gains," a thought-provoking - and, for those of us in the storage industry, very uplifting - personal affirmation of the fundamental importance of advanced storage systems and technology in our information-oriented world.

As he succinctly expressed it, there are, in his view," 'killer-apps' for storage everywhere we look."

Comments by the Honorable Tom Murphy, three-term Mayor of Pittsburgh, were followed by a ribbon-cutting ceremony, a burst of confetti, and a catered luncheon.

In the afternoon, attendees were invited to tour the new building and its state-of-the-art laboratories, with Seagate researchers providing fascinating demonstrations and explanations of Seagate's cutting-edge research programs.

CMRR Research Review

Fifty-nine persons - including representatives of the CMRR Industrial Sponsor organizations and other invited guests - were in attendance at the semi-annual Research Review and Advisory Council meeting on May 22-23. The two days of talks highlighted the work of CMRR faculty, researchers and graduate students as well as CMRR affiliated faculty members. The Special Session featured a presentation on Magnetic Semiconductors by Profs. Dimitri Basov and Frances Hellman (UCSD/Physics Department). Late afternoon and evening activities began at 4:45 p.m., and included tours of the CMRR labs, private discussions with students and researchers and dinner, culminating with the Advisory Council meeting at 7:30 p.m.

The meetings officially adjourned at 4:30 p.m., Thursday; however guests were invited to stay for additional lab visits, informal technical discussions, and the IEEE's San Diego Magnetics Society Chapter meeting. The guest speaker, Philip E. Wigen, Ohio State University, gave a presentation entitled "Ferromagnetic Resonance Force Microscopy: Probing Ferromagnets at the Micron Level."

CMRR sponsor company employees may access the abstracts and graphs of the Research Review presentations on the CMRR website in the Sponsors' Resource section. The next semi-annual review is scheduled for November 20-21, 2002.

Please contact Cheryl Hacker (chacker@ucsd.edu or 858-534-6563) if you are not on the CMRR invitation list.

Research Highlights

CMRR Servo Lab

Collaboration between CMRR Prof. Frank Talke and CMRR affiliated faculty member, Raymond de Callafon from the Dynamic System and Control Group in the Department of Mechanical and Aerospace Engineering has resulted in the development of a new research laboratory at CMRR. The CMRR servo laboratory provides an environment for studying the interaction between tribology, mechanics and servo control. The laboratory provides an experimental setting where the techniques from the disciplines of system identification, dynamic systems and automatic control are applied to various aspects of magnetic recording technology.

Experimental studies and analysis of electromechanical systems such as hard disk drives and tape mechanisms is the primary focus of the CMRR servo laboratory. To support the experimental work, the laboratory has been equipped with digital data acquisition hardware and software that allows for high speed data acquisition and real time digital control implementation for rapid prototyping. Data analysis, model estimation and servo control design techniques developed within the Dynamics Control Group complement the experimental work of the laboratory.

Current research conducted in the laboratory include experiments with an air-bearing spinstand that is used to study dynamics of dual-stage suspensions and windage-induced disturbances in hard disk drives. The possibility of dual-stage servo control with instrumented suspensions to reduce the effect of non-repeatable runout errors has been tested and verified in the lab. Ongoing and future research include experimental techniques for noise and uncertainty characterization, and dynamic modeling of mechanical systems with the aim to improve the servo capabilities, accuracy, and reliability of future magnetic recording devices.

Director's Message

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elsewhere in this issue) and, in order to facilitate and encourage technology transfer, we have worked with our sponsors and UCSD administration to craft a new CMRR patent policy.

The tragic events of the past year, their impact on the already weakening global economy, and the ongoing restructuring within the storage industry have all had an impact upon CMRR's roster of industrial sponsors. Nevertheless, as you can see from the articles in this CMRR Report, we have worked hard to engage with our current sponsors, attract new sponsors, identify new funding opportunities, and adapt our research program to encompass some of the new and exciting technical challenges in information storage technology. In particular, our partnerships with the International Storage Industry Center (ISIC), the San Diego Supercomputer Center (SDSC), and Cal(IT)^2 on the UCSD campus continue to grow, nurturing CMRR's developing program of research in "intelligent storage devices" and "networked storage systems." You will be hearing much more about these and other new CMRR endeavors in the coming year.

Let me close by expressing, on behalf of the entire Center, my gratitude to CMRR's partners in industry, government, and academia. The "miracle of information storage technology" continues to unfold, and we at CMRR are pleased to be a part of its realization.

I look forward to seeing many of you at CMRR for the Fall Research Review, November 20-21, 2002. In the meantime, enjoy the newsletter!

Paul H. Siegel

— Paul H. Siegel, Director

Recent Gifts, Grants, Awards, and Internships

The National Institute of Standards and Technology (NIST) under the Nanotechnology Initiative has renewed funding for **Ami Berkowitz's** project entitled "Metal/native oxide multilayers: high-permeability, high saturation magnetization thin films with high resistivity for recording write-head applications." **Geoff Beach** is carrying out this research program which is designed both to optimize the properties of metal/native oxide multilayers for high-frequency shield, head, and underlayer applications, and to provide a basic understanding of the origin of the unique properties of these materials.

Neal Bertram has received an award from the **National Institute of Standards and Technology (NIST)** for a project entitled "Theoretical Studies of Non-linear Magnetization Damping: Role of Microstructure in Magnetization Switching Dynamics". The project models large amplitude magnetization dynamics with direct application to understanding the effects of microstructure on magnetization reversal dynamics. A numerical model will be developed that includes spin wave excitations and damping by local microscopic mechanisms. Simple phenomenological models will be examined to test for simple characterization of experimental dynamic measurements. The results are critical to understanding the performance of high-speed applications, such as digital magnetic recording and magnetic RAM (M-RAM).

International Business Machines Corporation (IBM), through its Almaden Research Center, has entered into a subcontract agreement with the University of California, San Diego on behalf of the Center for Magnetic Recording Research under IBM's Cooperative Agreement with **NIST** and IBM's Collaborative Agreement with Dow and **Imation** under the NIST ATP program. The recording physics project headed by **Gordon Hughes**, entitled "Terabit Density Patterned Media Modelling," will study patterned media bit and recording geometry, and will model playback physics and channels to predict bit error rates. This work supports a research project to fabricate patterned disks for a high areal density recording demonstration.

A three-year project was awarded to the University of California, San Diego for continued support of the UCSD Information Storage Industry Center, a **Sloan Foundation Center**. CMRR's Associate Director **Gordon Hughes** is the director of the program on intelligent disk drives (iDrives). The iDrives project goals are to improve storage system performance and to allow product differentiation for drive manufacturers. Computing tasks for iDrives are discussed in an article by Gordon Hughes in the August 2002 issue of IEEE Spectrum.

The **Berkowitz group**, in collaboration with **Drs. Bhanu Chelluri and John Barber** (IAP Research, Inc.) and **Dr. Peter Cho** (Etechno-Group), has been involved in a joint project funded by **IAP Research, Inc**. entitled "Permanent Magnets with Improved Mechanical Properties for Propulsion" The research focus is to produce material by spark erosion with the best mechanical strength and toughness while yielding the best permanent magnet performance.

CMRR Sponsor company, **Hitachi-Maxell**, is supporting and collaborating with the **Berkowitz group** in an investigation of Co-Pd multilayers for perpendicular magnetic recording. **Dr. Fred Spada**, and postdocs **Ed Price** and **Julian Carrey** are carrying out this research, which involves characterizing and modifying Co/Pd multilayers produced by Maxell to identify the basic mechanisms responsible for the magnetic behavior of these materials in order to optimize their properties

The Information Technology Program (ITR) of the National Science Foundation (NSF) has awarded to **Prof. Paul Siegel** and **Prof. Jack Wolf** a 3-year grant in support of their research proposal entitled "Information-Theoretic Limits in Data Storage Systems."

The project objectives are two-fold. The research addresses analytic and numerical limits on achievable storage densities and transfer rates in recording channels. It also develops and evaluates modulation, coding, and signal processing techniques that can approach or achieve these limits. The study will consider both one-dimensional channel models applicable to "track-oriented" storage devices, such as disks and tapes, as well as higher-dimensional models relevant to exploratory storage technologies, such as optical holographic recording and thermo-mechanical recording based upon atomic force microscopy.

Underscoring the significant role of information storage systems in advanced computing and communication networks, as well as the high caliber of research conducted at CMRR, **Cal-(IT)^2** generously contributed matching funds in the form of a one-year graduate fellowship to support this project.

The **National Security Agency (NSA)** has funded a program on the Secure Erasure of High Coercivity Magnetic Tape and Disk Media. The project led by **Dr. Fred Spada** and former CMRR Director **Prof. Shelly Schultz** (UCSD Physics Dept.) will evaluate various erasure instruments and protocols to determine their range of applicability for achieving secure erasure of information stored on the broad range of magnetic media used by the U.S. government.

HONORS AND AWARDS

Edward Price, a recent Ph.D. recipient (Prof. Ami Berkowitz, thesis advisor) was awarded a UCSD Faculty Fellowship in the Department of Physics for academic years 2002-03 and 2003-04. The award is a combined Lecturer and Faculty Fellow Researcher appointment that is given to recent U.C. Ph.D.s who demonstrate promise for excellence in both teaching and research. With Prof. Barbara Jones as teaching mentor, Dr. Price will undertake a revision of the physics 2 labs to emphasize fundamental physical concepts and to make them more relevant to non-physics majors. As a Faculty Fellow Researcher with Prof. Ami Berkowitz as his research mentor, Dr. Price plans to investigate the transport properties, of nanoscale magnetic devices, in particular, the current flow through point contacts (tens to hundreds of atoms wide) between magnetic materials.

Prof. Frank Talke was recently named a Fellow of the American Society of Mechanical Engineers (ASME). The Fellow Grade is the highest elected grade of membership within ASME, the attainment of which recognizes exceptional engineering achievements and contributes to the engineering profession.

Cal-(IT)^2 Shannon Documentary Wins Aurora Award

The documentary "Claude Shannon: Father of the Information Age," which grew out of the Shannon Symposium and Statue Dedication held at CMRR in October 2001 (see the Winter 2002 CMRR Report), has received a 2002 Gold Aurora Award in the biography category. The Aurora Awards are handed out annually as part of an "independent film and video competition for commercials, cable programming, documentaries, industrial, instructional and corporate videos."

The half-hour documentary, which first aired in February 2002, was produced by Cal-(IT)^2 media relations officer Doug Ramsey. A joint production of UCSD's Jacobs School of Engineering and UCSD-TV, "Claude Shannon: Father of the Information Age" traced the life and impact of Shannon, who died in 2001, on engineering and mathematics. Widely hailed as the "Einstein of engineers," Shannon was a Bell Labs mathematician who originated in 1948 the "information theory" on which the fundamental principles of digital telecommunications and information storage are based.

Streaming video and the transcript of the documentary can be found in the Cal-(IT)^2 website at: http://www.calit2.net/news/2002/8-13-award.html

CMRR's Cal-(IT)^2 Undergraduate Research Fellow Enrolls at MIT

Laurence Zapanta, who worked with Profs. Paul Siegel and Jack Wolf of CMRR and Prof. Larry Milstein of ECE as a Cal-(IT)^2 Undergraduate Research Fellow during the summer of 2001, received his combined B.S./M.S. degrees in ECE from UCSD this past June. Laurence will next pursue his doctoral degree in Electrical Engineering and Computer Science (EECS) at MIT, beginning this Fall.

While a Cal-(IT)^2 Fellow, Laurence investigated the performance of iterative decoding for a coded magnetic recording channel, and compared the results to those obtained with a simple post-processing algorithm. Laurence says that the summer project sparked his interest in coding theory and its applications, and he credits the research experience as a factor in his acceptance into MIT's prestigious graduate program.

Ph.D.'s Awarded

Peng Luo was a CMRR graduate student in Prof. Neal Bertram's group from April 1997 until September 2001. Peng's major research area was related to the experimental and theoretical study of magnetic tape media noise. His Ph.D. thesis was entitled "Experimental and Theoretical Studies of Particulate Tape Medium Noise of High-Density Magnetic Recording." Following the awarding of his Ph.D. in September, he accepted a position at Read-Rite Corporation where he is involved in experimental research in both longitudinal and perpendicular magnetic recording (including head design and media evaluation). Peng enjoys his new environs in the Bay area, however he says that housing prices are quite high.

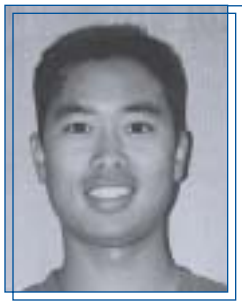
Edward Price, a member of Prof. Ami Berkowitz's research group since May 1999, was awarded his Ph.D. in Physics in October 2001. His thesis was entitled "Characterization of Transport Processes in Magnetic Tunnel Junctions." As a graduate student, Ed's research area focused on magnetotransport mechanisms in magnetic tunnel junctions.

Following the awarding of his Ph.D., Ed taught undergraduate introductory physics courses at California State University, San Diego during the spring semester. Ed received a Faculty Fellowship (a combined Lecturer and Faculty Fellow Researcher appointment) for academic years 2002-03 and 2003-04 at UCSD (see related story on page 7).

Stefan Weissner joined Professor Frank Talke's research group in May 1996 and worked first on his "diploma thesis" for his German degree (Aerospace engineering). In September 1996, he started in the Ph.D. program (mechanical engineering) at UCSD. During his 5 years at CMRR, he was a teaching assistant for several quarters, and also helped in the graduate courses AMES 291 (Design and Mechanics in Computer Technology) and 292 (Computer-Aided Design and Analysis). Some of the classes that Stefan took while at UCSD included Finite Elements, Fluid Dynamics, Structural Dynamics, Math, Lasers and Optics, and Japanese (for his Hitachi internship from April to June 2002 in the Mechanical Research Laboratory close to Tokyo). In 1997, Stefan interned at Seagate, Minneapolis.

At CMRR, Stefan's research focus was on finite element air bearing simulations during loading/unloading of the slider and LDV-measurements of the slider velocity during load/unload. Stefan's thesis was entitled "Numerical and Experimental Investigation of the Load/Unload Behavior of Subambient Pressure Hard Disk Drive Sliders." Stefan defended his thesis at the end of October 2001.

After successfully completing his Ph.D., Stefan spent 4 weeks vacationing in Costa Rica and Panama. He began working for Seagate, Minneapolis in December 2001. Stefan is currently working in the air bearing design department on slider shape characterization. Stefan's first winter in Minneapolis didn't provide enough snow for him to really get into cross-country skiing (which he had planned to do). Now the soccer season has started again and he is going to play on a Seagate team.



Ping Yeh, also a member of Prof. Talke's research group, started at CMRR in the summer of 1997 as an undergraduate researcher. He received his B.S. in 1999, started grad school in 1999, and received his M.S in 2001. Ping's undergraduate projects involved projects of shock testing and reliability of PZT-based microactuators, and his graduate work was in nanotribology. Ping's masters' thesis was entitled "Nanotribology of Hard Disk Lubrication Using Atomic Force Microscopy, Friction Force Microscopy and Nanometrology."
Ping, like Stefan, works at Seagate, Minneapolis and is in a Head Disc Interface Technology Integration group, which is a research group working on technologies that are a couple of years away from production.

Ping's other interests include: serving on the University of California Systemwide Committee on Educational Policy and playing in a jazz group called the Brio Brass. He also plays in Seagate's golf league, and he is on a United States Tennis Association League Team.
Ping took the GMATs in late April with the hopes of attending an evening business program.
Since moving to Minnesota, Ping has purchased his first home (of which he is very proud).

Jason Goldberg was awarded his Ph.D. in June 2002. Jason, whose research interests are accurately described by the title of his dissertation, "Medium Noise Modeling, Spinstand Measurements, and Timing Recovery for Magnetic Recording," was a member of Prof. Jack Wolf's Signal Processing for Recording group since September 1997. Jason accepted a Research Staff Member position at Seagate Research in Pittsburgh, PA, where he will be working in Roy Gustafson's Magnetic Disk Systems group. He began his employment in August 2002.

Zhen Jin, a member of Prof. Neal Bertram's Recording Physics and Micromagnetics research group, was awarded his Ph.D. in physics in September 2002. Zhen's research focused on experimental and theoretical aspects of noise in magnetic recording systems. He did measurements and analyses on medium noise, head noise, and system off-track capabilities for both longitudinal and perpendicular recording. After leaving CMRR, Zhen accepted a Development Senior Engineer position with Seagate, Bloomington, effective mid-October, 2002.

CMRR Faculty and Affiliated Faculty Research Interests

Dimitri Basov, Asst. Professor
UCSD Physics Department
Magnetic Semiconductors

Ami E. Berkowitz, Research Professor
UCSD Physics Department
Magnetic Materials & Devices

H. Neal Bertram, Professor
UCSD ECE Department
CMRR Endowed Chair
Recording Physics & Micromagnetics

Roger Bohn, Assoc. Professor
UCSD International Relations and Pacific Studies
Storage Industry Competition

Walter Burkhard, Professor
UCSD CSE Department
Storage System Algorithms

Raymond de Callafon, Asst. Professor
UCSD MAE Department
Servo Technology

Frances Hellman, Professor
UCSD Physics Department
Magnetic Semiconductors

Dr. Gordon Hughes, CMRR Associate Director
Storage Systems

Kenneth Kreutz-Delgado, Professor
UCSD ECE Department
Disk Drive Failure Prediction

Dr. Frederick Parker, Project Scientist
CMRR
Characterization of Magnetic Materials

Lea Rudee, Professor Emeritus
UCSD ECE Department
Magnetic Engineering

Dr. Vladimir Safonov, Asst. Project Scientist
CMRR
Stochastic Magnetic Dynamics & Micromagnetics

Sheldon Schultz, Research Professor
UCSD Physics Department
Micromagnetics & Instrumentation

Paul H. Siegel, Professor
UCSD ECE Department
CMRR Director
Coding & Modulation

Dr. Frederick Spada, Assoc. Project Scientist
CMRR
Characterization of Magnetic Materials

Sunil Sinha, Professor
UCSD Physics Department
Neutron & Synchrotron Radiation of Magnetic Nano Materials

Frank E. Talke, Professor
UCSD MAE Department
CMRR Endowed Chair
Tribology & Mechanics

Alexander Vardy, Professor
UCSD ECE Department
Coding for Information Storage

Jack Keil Wolf, Professor
UCSD ECE Department
CMRR Endowed Chair
Signal Processing for Recording

CMRR WELCOMES NEW RESEARCHERS

Sharon Aviran joins both the Siegel and Wolf research groups. Sharon started her Ph.D. studies at UCSD in 2001 after a number of years in industry, where she was involved in data compression for wireless communications, as well as in data-mining algorithms for predicting customer defections from telecom companies. Before working, she completed her M. Sc. at the Technion, Israel, where she did some research in combinatorial optimization. Her current research interests are in coding and digital communications. Other than studying, Sharon likes to travel around the world, and between work and studies she managed to squeeze in 8 months of travel, to Southeast Asia, China, South America and New Zealand.

As an undergraduate student at Bilkent University, Ankara, Turkey, **Ismail Demirkan**'s major area of interest was telecommunications, especially coding and modulation. He completed two senior projects about LDPC and Gallager codes. Meanwhile, he was searching for a good university to work on coding theory and modulation schemes. His professors strongly recommended UCSD in wireless communication and coding areas. At UCSD, he has taken almost all course offerings related to coding theory and communications. In his opinion, these courses were great and they have been very beneficial. Currently, Ismail is working with Prof. Wolf's group on coding and signal processing techniques for digital recorders. In his spare time, Ismail deals with computer languages as a programmer. In general, he likes writing codes and implementing algorithms. Sometimes, he goes to the theatre to see a new movie with a friend. His favorite sport is soccer, but nowadays he can't seem to find any time to play.

Julian Carrey joined Prof. Berkowitz's group as a visiting postdoctoral researcher in July 2002. Before that, he spent the last four years in Albert Fert's laboratory in Orsay, France, and got his Ph.D diploma in October 2001. During this period, he especially studied the way metallic clusters behave and grow on an amorphous alumina surface, as well as the transport properties of tunnel junctions containing clusters. He also worked on various ways to elaborate metallic nanocontacts. During his stay at CMRR, he will study the magnetostriction properties of small nickel particles as a function of their size. He will also be involved in work on the magnetic properties of ultra-thin Co/Pd multilayers. When he is not in a physics laboratory, he likes making music and plays the guitar and sitar.

VISITING SCHOLARS FROM INDUSTRY

Kenneth Altshuler, **Seagate Technology,** will spend one to two days a week with the Talke group from July 2002 to July 2003. Ken graduated with a BSME from the University of Vermont in 1990 and then went to work as a highway engineer for the State of Vermont. In 1993, Ken received his MSME from the University of Vermont, graduating at the top of his class. His research interests were in tribology-related areas and testing. From 1993 to 1995, Ken was an R&D tribologist at Read-Rite Corporation before moving to Conner Peripherals from 1995 to 1996. In 1996, Ken joined **Seagate Technology**, in Longmont, Colorado where he is currently Manager of the Head Media Process and FA.

Jun Ohno joined Neal Bertram's group in August 2002 for a 15 month stay at CMRR. Jun is from the **Hitachi Corporation**, Central Research Lab, Tokyo, Japan where he is a senior engineer in disk drive development in charge of the design of magnetic recording systems. Jun's research interest is in the future of advanced storage systems. Jun received both his B. Eng (1993) and his M. Eng in metallurgy (1995) from the University of Tokyo. Jun's hobbies include playing tennis and golf, and skiing. He also enjoys classical music, and he sometimes plays the violin.

Jan Neumann Recognized for 25 years at the UCSD Libraries

Jan Neumann, the library assistant in the CMRR Information Center since May 1986 was recently recognized for her 25 years of service at the University of California, San Diego.

Jan began working in the UCSD Biomedical Library in 1977 and worked there nine years before moving to CMRR shortly after the Center took up residence in its current location. Before joining UCSD Jan worked as a student assistant in the library at San Diego State University while completing her degree there.

A reception to celebrate Jan's UCSD career was held at CMRR on March 7th. Many of Jan's colleagues from CMRR as well as staff from other library units on campus gathered together to recognize her many years of service. Unfortunately the many librarians, scientists and engineers from CMRR's sponsoring companies were not able to join in the celebration since they are scattered throughout the country. They did however express their appreciation of the support Jan has provided them over the past nine years in meeting their information needs.

Our thanks to Jan not only for her years of dedicated service but also for being such a good friend and colleague.

CMRR INFORMATION CENTER MANAGER, DAWN TALBOT (LEFT) PRESENTS JAN NEUMANN WITH HER 25 YEAR SERVICE AWARD

Graduate Students & Researchers Near Completion

STUDENT	LEVEL	ADVISOR	DEPT	RESEARCH INTEREST	COMPLETION DATE
Geoff Beach	Ph.D.	Berkowitz	Physics	Properties and behaviors of nano-structured materials with applications in magnetic recording	December 2002
Kaizhong Gao	Ph.D.	Bertram	Physics	Micromagnetic studies of dynamic write head magnetization	October 2002
Xiaobin Wang	Ph.D.	Bertram	Physics	Thermal reversal of recording media	June 2003
Andre des Rosiers	Ph.D.	Siegel	ECE	Space-time signal processing and coding	December 2002
Henry Pfister	Ph.D.	Siegel	ECE	Theory of turbo-like codes, iterative decoding, capacity of intersymbol interference channels	December 2002
Hugo Tullberg	Ph.D.	Siegel	ECE	Coded-modulation and iterative decoding	December 2002
Eric Jayson	Ph.D.	Talke	MAE	Head/disk interface tribology	Fall 2003
Lin Zhou	Vstg Asst Proj Sci	Talke	CMRR	Head/disk interface tribology	October 2002
Ramakrishna Akella	Ph.D.	Wolf	ECE	Detection	Fall 2003
Vladimir Dorfman	Ph.D.	Wolf	ECE	Signal processing	Fall 2002
Brian Kurkoski	Ph.D.	Wolf/Siegel	ECE	Coding	June 2003
Marcus Marrow	Ph.D.	Wolf	ECE	Coding	Fall 2003
John Miller	Ph.D.	Wolf	ECE	Coding	June 2003

CMRR Report
Center for Magnetic Recording Research

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study magnetism at specific positions within a sample. In the UCSD studies, PNR has allowed the researchers to study the magnetic properties of the metal layers and the oxide layers separately–which, in turn, will help them to understand how the layers interact.

The sample used in the UCSD experiments had a simplified metal/native oxide/metal trilayer structure. The sample was placed in a magnetic field to orient its magnetization in the "up" direction (see illustration on page 2). A beam of polarized neutrons, with spin either parallel to ("up") or anti-parallel to ("down") the sample magnetization, was directed at the sample surface at a particular angle. The angle is related to the position in the sample that the neutrons are reflected from.

The likelihood of a neutron being reflected depends on the magnitude and direction of the sample magnetization at that position. By measuring the numbers of up and down neutrons reflected from the sample at various angles (the reflectivity, shown in the illustration), the magnitude of magnetization in the oxide and in the metal layers could be studied separately.

In the PNR experiments, spin-polarized neutrons are directed at the sample. Both the polarization (i.e., neutron spin direction) and the intensity of the reflected beam are measured. Three measurements were taken: the angle, intensity, and polarization of the reflected beam. The angle of the reflected beam relates to the depth in the sample that is being probed, whereas the intensity and polarization of the reflected beam describe the magnetic structure at that depth. In this way, the magnetization of the metal and oxide layers could be studied separately.

A similar experiment was performed with the sample magnetization oriented nearly perpendicular to the neutron spin direction. By analyzing the reflectivity profile in this case, the directions of the magnetization in the individual layers could be determined and information about the magnetic coupling of the layers inferred. The results of this cutting-edge research will ultimately lead to an experimental basis for modeling the magnetic behavior in MNOM structures and perhaps provide insight into optimizing these ultrathin structures for important industrial applications.

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