

# CMRR Report

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Center for Magnetic Recording Research

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## CMRR Plays Key Role In President Clinton's Defense Reinvestment and Conversion Initiative

In a February 23, 1994 White House press release, President Clinton and Defense Secretary Parry announced a fourth round of awards in the President's Defense Reinvestment and Conversion Initiative. Among the winners announced was the UCSD M.S. Program in World Class Manufacturing Engineering. The three year award, including state and private industry matching funds, has a total estimated cost in excess of \$6 million over the three year start-up period.

The new program is an innovative two year master's degree program designed to produce manufacturing engineers who are knowledgeable about state of the art manufacturing technology, management, and international issues. The program is designed to maintain and improve the manufacturing competitiveness of the U.S. and to encourage the development of high-quality manufacturing jobs at home. Displaced defense industry engineers will be preferentially selected into the program, and after graduating will play a key role in expanding U.S. competitive manufacturing and, in that process, help create many thousands of new jobs.

The program combines the resources of several UCSD departments. These include: the School for International Relations and Pacific Studies (IR/PS), the School of Engineering, the Project for Information Engineering (PIE) the Department of Linguistics, the San Diego Supercomputer Center (SDSC), the Center for Magnetic Recording Research (CMRR), and the CMRR Information Center and the UCSD Library.

CMRR will play a major role in the program by arranging for CMRR students to obtain a 6-to-9 month on-site internship at U.S. and Asian manufacturing plants affiliated with the Industrial Sponsor Companies. The CMRR Information Center personnel will also provide training in the use of international data bases which will provide access to extensive U.S. and Asian databases patents and technical papers.

## Lemke Receives Revelle Medal



JAMES U. LEMKE

his doctorate from UC Santa Barbara and holds many patents in magnetic recording methodology and devices, as well as other areas of technology.

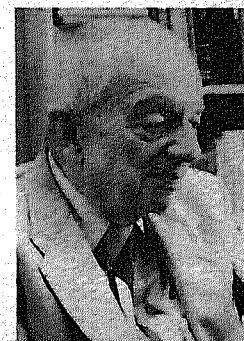
Credited with being the "nucleating force" behind the founding of CMRR, Lemke was cited for envisioning a center that would educate students and support interdisciplinary research related to magnetic recording. He was also commended for obtaining the corporate donations for the construction of the CMRR building, securing the funding to establish four endowed professorships at CMRR, and for acquiring scientific equipment for the new facility.

The Revelle Medal, UCSD's highest honor given in recognition of distinguished and sustained service to UCSD was bestowed on James U. Lemke in May 1993. The medal was presented to Lemke by Chancellor Richard Atkinson and George Backus, chairman of the San Diego Division of the Academic Senate, at the tenth anniversary celebration of the founding of CMRR.

Currently James Lemke is chief executive officer of Recording Physics, Incorporated and a UCSD adjunct professor of electrical engineering. He received

## Lauer at CMRR

In September 1993 Professor James L. Lauer joined CMRR as a research scientist after retiring from Rensselaer Polytechnic Institute. He



JAMES L. LAUER

was at Rensselaer since 1978 and most recently was Professor of Mechanical Engineering and Director of the Institute for Wear Control and Tribology.

Professor Lauer is a chemical physicist who has gained an international reputation by

applying optical and spectroscopic techniques to the solution of problems encountered in lubrication systems. His most recent work deals with the application of infrared emission spectroscopy to operating bearings and magnetic recording devices in order to study mechanisms of failure.

Dr. Lauer is the author of over 150 scientific and technical publications and holds over 30 patents. At CMRR he will study tribology of magnetic tapes.

## CMRR Industrial Sponsors

There have been a number of changes over the last twelve months to the CMRR Advisory Council membership. Listed below are the current members together with their corporate affiliations:

PAUL FRANK	APPLIED MAGNETICS CORPORATION
LOU SHRINKLE	CONNER PERIPHERALS
JIM CRAZE	DEPARTMENT OF DEFENSE (NSA)
ROY GUSTAFSON	DIGITAL EQUIPMENT CORPORATION
ROBERT SWANSON	EASTMAN KODAK COMPANY
CHARLES MOREHOUSE	HEWLETT-PACKARD
ROGER WOOD	IBM CORPORATION
STANLEY SKIDMORE	OMEGA CORPORATION
HARLAN MATHEWS	MAXTOR CORPORATION
DAN SOO	METRUM INFORMATION STORAGE
THOMAS HOWELL	QUANTUM CORPORATION
GORDON HUGHES	SEAGATE TECHNOLOGY
WATSON HENDERSON	STORAGE TECHNOLOGY CORPORATION
ROBERT YOUNGQUIST	3M
ARTHUR GEFFON	WESTERN DIGITAL

## From the Director

It is a pleasure to comment on each of the three articles on our cover page. We welcome Professor James L. Lauer who has joined the Center following his retirement from Rensselaer Polytechnic Institute. Jim (as we all know him) is really not a newcomer to CMRR, since he has been here on sabbatical and on many prior visits. Jim has been busy getting a new Raman system up and running, and we have already pressed him into service for a recent Tuesday seminar titled "Raman Spectroscopy Applied to Magnetic Recording." (The seminar series is videotaped and, as always, a copy may be obtained by contacting the CMRR Information Center staff at 619-534-6199).

Another "Jim," our own Dr. James Lemke, was the well-justified recipient of the UCSD Revelle Medal at the tenth anniversary celebration way back in May 1993. Of course, Jim is well known to all of us as the "father of CMRR" and when needed, even as the "godfather" of CMRR! We apologize for having taken so long to get this hot news item out in the CMRR Report, but better late...etc. Most seriously, I want to take the opportunity of this forum to offer my personal thanks to Jim for all the contributions he has made, and continues to make, to CMRR.

Coincidentally, the third article, concerning the recent TRP (Technology Reinvestment Program) award to UCSD for the development of a new master's degree in world class manufacturing, also had its origins at

the tenth anniversary celebration in May 1993. As part of the activities we held a symposium, "MSM-2000," which was the abbreviation for "Magnetic Storage Manufacturing by the year 2000." The symposium and an associated meeting was attended by key executives from all our industrial sponsor companies, and set the stage for a subsequent workshop on advanced manufacturing. Many of the novel ideas for the proposed new master's degree curriculum came out of both the symposium and workshop, which emphasized the critical need for United States university educational programs to catch up with the many advances in manufacturing practices that have been implemented by the magnetic storage industry. We at UCSD are grateful for the advice and suggestions from the many participants, and while we can't list them all in this brief space, we can say a sincere thank you to all. You obviously did a great job, because we did get one of the very few awards!

Yes, we got the award, but now we must join with our colleagues at UCSD to create an entirely new degree program in world class manufacturing. This important challenge will require a lot of work by us all, plus the continued guidance and support of our industrial sponsors to achieve our goal—to become the best such program in the world. We will settle for nothing less, and with everyone's help we will succeed. I look forward to reporting on how this exciting program develops in subsequent issues. We welcome suggestions from all of our readers who have an interest in this aspect of our magnetic storage industry.

## IEEE Communication Society Stephen O. Rice Award to Viterbi

**Professor Andrew J. Viterbi** of the Department of Electrical and Computer Engineering (ECE) is the co-recipient of the Stephen O. Rice Award for the best original paper which appeared in the IEEE Transactions on Communications during 1993. The paper so recognized, titled "Performance of Power-Controlled Wideband Terrestrial Communication," was co-authored by Dr. Audrey M. Viterbi and Dr. Ephraim Zehavi, both engineers at QUALCOMM Incorporated. Both also have had past UCSD affiliations: Audrey Viterbi was an EECS and Mathematics graduate of the Class of 1979, and Ephraim Zehavi was affiliated with CMRR while he completed his doctorate under Professor Jack Wolf.

The paper, which deals with power-controlled CDMA modulation and coding, presents and analyzes the physical layer performance of the wireless digital cellular communication system\*, developed at QUALCOMM, which is the basis for the IS-95 Standard of the Telecommunication Industry Association.

Among the many awards received by Viterbi since coming to UCSD, five bear the names of renowned communication pioneers and scientists. Successively, these have been the Christopher Columbus, Alexander Graham Bell, Guglielmo Marconi, Claude Shannon and Stephen Rice Awards, virtually spanning the history of communication, from transportation to wired to wireless.

Steven Rice's distinguished research career of 43 years at AT&T Bell Laboratories produced many fundamental results, including the groundbreaking 1944 paper, "The Mathematical Analysis of Random Noise," which established the universally accepted stochastic process model for signals and noise in all electronic systems and preceded Shannon's celebrated publication by four years. Rather than retiring professionally after Bell Labs, he extended his high research productivity for another decade at UCSD, publishing with faculty and mentoring graduate students. The Stephen O. Rice Endowed Chair in CMRR, presently held by Jack Wolf, recognized Rice's many contributions to communication and signal processing theories, including magnetic recording, as well as his well remembered association with UCSD.

## CMRR Hosts Industry Sponsors at Semiannual Research Review

May 11–12, 1994 marked the dates of the CMRR Semiannual Research Review and Advisory Council Meeting. Fifty-seven representatives from the CMRR industrial sponsor companies attended the two-day meeting featuring presentations on recording physics and micromagnetics (Neal Bertram group), micromagnetics and instrumentation (Sheldon Schultz group), micromagnetics simulation (Donald Fredkin group), signal processing (Jack Wolf group), mechanics and tribology (Frank Talke group), and materials research heads and media (Ami Berkowitz group). In addition, attendees had the opportunity to visit the labs for demonstrations of on-going research activities and to engage in scientific discussions with faculty, researchers, and students.

The meeting was highlighted by a mini-tutorial "A Review and Tutorial of the Head Disk Interface by Numerical Methods" introduced by Frank Talke, with a special report, "Finite Element Modeling and Air Bearing Simulation," presented by Michael Wahl.

Abstracts of the presentations have been bound into a booklet and are available on request, to all industrial sponsor employees by contacting Cheryl Hacker at CMRR at (619) 534-6563 or address e-mail requests to [chacker@ucsd.edu](mailto:chacker@ucsd.edu).

CMRR semiannual research reviews are open to all members of the Center's sponsoring companies. Please mark your calendar for the fall research review which has been scheduled for Wednesday and Thursday, November 30 and December 1, 1994. If you were not on the mailing list for this past May review, and would like to receive the invitation/announcement that will go out in September, please contact Cheryl Hacker as listed above.

\*See background article on wireless CDMA technology appearing in *UCSD Engineering*, vol. 4, no. 2, Winter 1994.



## Students Graduating from CMRR

On these pages short descriptions are given of the recent graduates from CMRR. In all cases, copies of their papers and theses—whether master's or doctoral—are available to members of the center's sponsoring companies. Please contact:

Jan Neumann

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### Jim Fitzpatrick

September 1993 saw **Jim Fitzpatrick** successfully defend his thesis and graduate with a doctorate from UCSD's Department of Electrical and Computer Engineering. His thesis title is "Analysis of and Coding for Partial Response Magnetic Recording Systems." Jim received his bachelor's degree in electrical engineering from Tufts University in 1985.

From there he went to work for the Kodak Research Labs in Rochester, New York as a research scientist. While at Kodak, Jim worked on coding and signal processing for optical recording.

In 1988 Jim was accepted into the graduate program at UCSD, working with Professor Jack Wolf at the Center for Magnetic Recording Research. While here Jim has studied coding for magnetic recording, evaluation of partial response detectors, and most recently, the effects of transition noise on detectors and modulation codes.

During the summers Jim returned to Kodak Research Labs, and in 1992 also worked for Seagate Technology. He has also consulted for Cirrus Logic and International Test Instruments, Inc.

In October 1993, Jim began working for Quantum Corporation in the Head/Media Technology group. At Quantum, Jim is working closely with two former students from CMRR - Carl Che, who spent eighteen months as a post doctoral fellow with the Bertram group, and Tim Reiner, who completed a master's degree in 1988 with Professor Frank Talke.

Jim will be presenting an invited paper at the joint MMM/Intermag Conference in Albuquerque in June. The paper titled "The Relationship of Medium Noise to System Error Rate in a PRML Channel" is co-authored with Neal Bertram, Carl Che, Lineu Barbosa, and Herbert Lin.



tation offers a reduction in complexity over the state metric implementation. The second part of the dissertation describes an error-event detector which corrects minimum distance error-events at the output of a Viterbi detector for a partial response channel of the form  $(1-D)^p(1+D)^q$ , where  $p \in \{0,1\}$  and  $q \in \{0,1,2\}$ .

Kelly received her bachelor's degree in physics from UCLA in 1988 and her master's in electrical and computer engineering from UCSD in 1990. She was awarded an IBM graduate Fellowship which provides for tuition on an annual renewable basis after the initial one-year award. Kelly was successful in having the fellowship renewed each of three years while she was at CMRR.

Kelly is currently working as a design engineer for Quantum Corporation, Milpitas, CA. She is working on advanced channel development, specifically channel coding and detection for partial response channels.

### Tom Silva

**Tom Silva** came to UCSD in 1987 to begin work on his doctorate after having completed his undergraduate degree in engineering physics at UC Berkeley. He started at CMRR working with Professor H. Neal Bertram and then switched in his third year to work with CMRR's Director, Sheldon Schultz.

In 1987 Tom was awarded a National Science Foundation "Creativity in Engineering" fellowship. This three-year award was given for a proposal to study the feasibility of a transverse record/magneto-optic read, recording system. The research topic was "Application of Scanning Near-field Optical Microscopy (SNOM) Techniques to Magnetic Domain Imaging Studies." As a result of his research, Tom was able to image magnetic domains in optically opaque magnetic samples using the novel use of light scattering from 30 nm silver particles. During his studies Tom has worked for six months at IBM, San Jose, on a contact recording test stand. He also held a six-month engineering internship with Seagate Technologies during which time he worked on a magneto-optic hysteresis "looper."

Tom was awarded his doctorate in electrical and computer engineering (applied physics) in January this year. Members of his committee were Professors Schultz and Bertram of CMRR, Professors Fainman and Chang of ECE, and Professor Gail Massey of San Diego State University. His thesis topic was "A Scanning Near-field Optical Microscope with Magneto-Optic Kerr Effect Contrast for the Imaging of Magnetic Domains in 200 Angstrom Resolution."

Currently Tom has a two-year postdoctoral position at the Superconductivity and Magnetic Measurement Group in the Electromagnetic Technology Division of the Electronics and Electrical Engineering Laboratory at NIST. While there, he is building a scanning near-field optical microscope for their magnetic technology device fabrication, and testing of giant magneto resistive (GMR) read-back elements for magnetic recording systems.



### Kelly Knudson

**Kelly Knudson** successfully defended her thesis "Detection and Error Correction for Partial Response Channels" in February 1994. Her doctorate was awarded in electrical and computer engineering (communication theory and systems). Her advisers were Professor Jack Wolf of CMRR and Professor Laurence B. Milstein of ECE.

Kelly's dissertation is divided into two parts. The first part describes a new alternative implementation of the Viterbi detector for an arbitrary binary input partial response channel. The new technique involves updating difference metrics rather than state metrics. By performing the Viterbi algorithm in a slightly different manner, the difference metric implemen-



## New Post Doctoral Students from CMRR

### Thomas Mittelholzer

**Thomas Mittelholzer** came to CMRR in December 1993 to take up a one-year postdoctoral fellowship with Professor Jack Wolf, which is being funded by the Metrum Corporation. Thomas' research here involves channel modelling for tape recording which will contribute to the federally funded tape program administered by NSIC, which CMRR is collaborating on along with other academic and industry participants.

Thomas' association with Professor Wolf began with meetings at various professional conferences. Most recently Thomas took on the job of secretary of the technical program committee for the 1993 International Conference on Communications held in Geneva. With 800 papers submitted to the technical program committee, this was a significant time commitment.

In Switzerland, Thomas is a research associate in the Signal and Information Processing Laboratory which is directed by James L. Massey. This laboratory is located in Zurich at the Swiss Federal Institute of Technology (ETH-Zentrum). Thomas earned his doctorate in mathematics from this institute in 1987 as well as a degree in computer science in 1988, which allowed him to move into more applied research areas. After completing his doctoral thesis on "Quaternionic Bundles Over the Real Projective Plane," Thomas worked as a postdoctoral fellow at ETH for a year prior to his appointment to the Research Associate position.

Thomas can be reached at CMRR at (619) 534-5317.



### Tom Liew

**Tom Liew** received his bachelor's degree (Hons.) from the National University of Singapore in 1986. He then took up graduate studies in the area of surface magnetism with Professor Gwo-Ching Wang at Rensselaer Polytechnic Institute, New York, completing his doctorate there in 1992. His thesis was on "Morphology and Magnetic Phase Transitions of Ultrathin Fe/Au(001) Films: A High Resolution LEED and SMOKE Study."

In 1991, at the spring meeting of the Materials Research Society in Anaheim, Calif., Tom was honored with the Materials Research Society Graduate Student Award. This award is the result of a national competition honoring the work of a graduate student in the area of materials science.

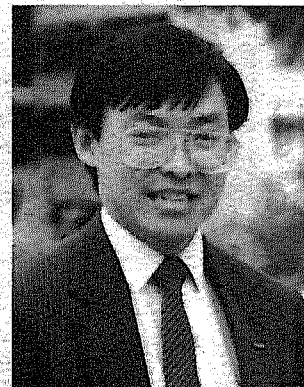
Upon completion of his doctorate, Tom worked for six months at Rensselaer's Anderson Center for Innovation in Undergraduate Education and also the Robert Resenick Center for Physics Education. There he was involved in the development of multimedia undergraduate laboratories under the Comprehensive and Unified Physics Learning Environment (CUPLE) project. The CUPLE project, funded by both federal and private foundations, is a consortium of several universities involved in the development of multimedia software for physics education and interactive learning. The CUPLE software is available to all educational institutions free of charge.

Shortly after accepting Tom for a post doctoral position at the Institute of Wear Control and Tribology at Rensselaer, Professor J. L. Lauer retired and took up a research scientist position at CMRR. Tom followed him to CMRR and will continue to work on an NSF funded project concerned with the tribology of high temperature ceramics.

Within the Talke group at CMRR, Tom is involved in the study of tribochemistry at head-medium interfaces. He is currently working on the analysis of brown stains found on magnetic tape heads. Head staining is becoming a more serious problem in today's recording environment where near contact recording is required to achieve higher and higher recording densities. Preliminary work in this area has been recently presented in the annual CMRR Tribology workshop and NSIC Head-Tape meeting. A paper titled "Analysis of Friction Deposits at Head Tape Interfaces by Raman Spectroscopy" has been submitted for the October 1994 STLE conference in Hawaii. The group hopes to gain a better understanding of this head staining problem to suggest preventive and control measures.

Tom is also co-authoring a paper with C. V. Nadimpalli on the tribology of carbon coated sliders on magnetic disks.

He can be reached at CMRR at (619) 534-5854 or by electronic mail at [tomliew@talkevax.ucsd.edu](mailto:tomliew@talkevax.ucsd.edu)



### Hong Wan

Before coming to the United States, **Hong Wan** attended Peking University where she completed her doctoral degree in physics in 1988. Her thesis topic was "Magnetic Phase Transition of Rare Earth and Transition Metal Alloy Thin Films." In 1988 Ms. Wan was awarded the Yeqisheng prize for the most outstanding science student at Peking University. This award is given to one student each year in recognition of excellence in both course work and research. She continued at Peking University as an assistant professor until 1989 when she accepted a post doctoral position at the University of Delaware. There, she worked on thin films and multilayers and hard magnetic materials in the Magnetic Materials Lab of Professor Hadjipanayis.

In October 1993, Hong arrived at CMRR to take up a post doctoral position with Professor Ami Berkowitz. Here she is working on the fabrication of fine particles of rare earth-transition metal compounds by spark erosion. She is characterizing these particles using X-ray diffraction, transmission electron microscopy (TEM) and scanning electron microscopy (SEM), and measuring their magnetic properties. Fine particles of these hard magnetic materials have not been fabricated previously. They are of particular interest for high energy permanent magnets and for high density recording. She will present a paper on this work at the MMM/Intermag joint meeting in June 1994, in Albuquerque, New Mexico.

Hong Wan's office number at CMRR is (619) 534-2268.





## Dan Wei

**Dan Wei** joined the Bertram group in March this year after having completed her doctoral degree in condensed matter physics from UCSD under the supervision of Professor Daniel Arovas. She received her bachelor's degree in high energy physics in 1988 from Peking University.

As a postdoctoral student Dan will be looking at the micromagnetics of ultra high density tape recording.

This work is being funded by a grant from the federal government's Advanced Research Projects Agency (ARPA).

Dan has already successfully modeled high density signal and over-write phenomena in current tape media. This work was funded by StorageTek, Colorado, and a paper reporting these results is in preparation. She has also developed a computer program using the San Diego Supercomputer Center to model ultra high density recording where the record gap is not much larger than particle size.

A related project will look at the effect of surface roughness on output voltage in current tape media. She will then examine the performance of new multilayer tape.

Dan can be reached at (619) 534-5855.

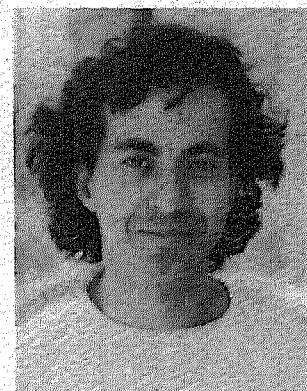


## Lluís Balcells

Lluís Balcells was awarded a NATO one-year postdoctoral fellowship which he took up in September 1993 in the Berkowitz lab at CMRR. Here he will study exchange interactions among cobalt clusters in a copper matrix. He will also investigate giant magnetoresistance in these systems. His number here is (619) 534-2268.

Lluís completed his bachelor's degree in Physics at the University of Barcelona, including some computer science courses in artificial vision. He went on to graduate studies at the same university, earning his doctorate in condensed matter in 1992. His thesis topic was "Magnetic Process of Relaxation and Quantum Tunneling of Magnetization."

While completing his graduate studies, Lluís worked during his last year for Enter, Spain's electric company. He stayed on at Enter for a year after finishing his doctorate, working on magnetic fluids research.



## Haesung Kwon

Having earned a scholarship to support his undergraduate studies at Yonsei University, Seoul, Korea, **Haesung Kwon** went on to complete graduate studies, also at Yonsei. He received his master's degree in mechanical engineering in 1986 and his doctorate in 1994. His thesis topic was "A Finite Element Analysis on Flying Characteristics of Thin Film in Magnetic Recording Device."

During his graduate year, Haesung was required to serve in the Korean army. However, the normal three years was reduced to six months since he was able to serve as a second lieutenant as a result of his successful examination results.

Much of Haesung's graduate research at Yonsei was supported by a grant from the Goldstar Corporation—a large Korean manufacturer of consumer electronic products.

While at CMRR, Haesung is working with Professor Frank Talke. He will be looking at experimental and numerical aspects of the helical scan read/tape interface and other tribology related problems.

His office contact number is (619) 534-5854.



## Weilong Cai

**Weilong Cai** completed his bachelor of science degree in physics with a minor in education at the Shanghai Normal University in 1982. He then worked for four years as the chief editor of the journal *University Science and Technology*.

In 1987 he came to the United States and enrolled at Clarkson University, New York. He was awarded a master's degree and then in 1992 a doctorate in physics, specifically in solid state physics and materials science. His thesis topic was "Preparation of Nanostructured Materials and Conductivity in Complex Physical Systems." In his final year, Weilong was honored with the Outstanding Graduate Student Award in physics.

While pursuing his graduate studies Weilong taught undergraduate physics courses at Clarkson. After graduation he accepted a postdoctoral position in the School of Engineering at Clarkson University with the dean of engineering, Dr. Wilcox. There he conducted research in crystal growth and semiconductors.

In September 1993, Weilong Cai took up a one year postdoctoral position in the Berkowitz laboratory at CMRR. Here he is working on nanostructured particles for high density magnetic recording media.

Weilong can be reached at (619) 534-2268.



## CMRR Welcomes Two New Staff Members

The smiling face at the CMRR reception desk belongs to Rosetta Fuller who joined CMRR in November, 1993. Rosetta has been a UCSD employee since June, 1989 and came to the CMRR from the Lab for Math and Statistics. Rosetta says that she is somewhat of a movie buff and also enjoys traveling, although she hasn't the time or financial resources to do much traveling at the present time. Her solution is to combine her two interests by traveling vicariously through the "big screen." Rosetta also enjoys spending her free time with her two grandchildren, Brian, 11, and Courtney, 6.



Cheryl Hacker joined CMRR in March, 1994 as the new MSO. She, too, came to UCSD in June, 1989 after having moved from the Los Angeles area to Ramona. Cheryl was previously in the Department of Radiology at the UCSD Medical Center and most recently was the MSO for the Institute for Pure and Applied Physical Sciences. Cheryl enjoys cooking, baking, reading, and going for walks on the many trails in Ramona with her husband, Joe and 90 pound dog, Molly. She also enjoys traveling and this past January returned from a four week trip to Fiji, New Zealand, and Australia.



## CMRR Professor Authors Textbook

H. Neal Bertram, chaired professor at CMRR recently completed a new textbook titled *Theory of Magnetic Recording*. Published in 1994 by Cambridge University Press, the book is being published simultaneously in hard cover and paperback editions.

The book is a comprehensive text on the theory of the magnetic recording process. It provides a fundamental, in-depth understanding of all the essential features of the writing and retrieval of information for both high density disk recording and tape recording. This is a timely addition to the literature of magnetic recording, given the rapid advancements in systems capacity and data rate.

This text gives a thorough grounding in four basic areas of magnetic recording: structure and fields of heads and media, the replay process, the recording process, and medium noise analysis. In addition to these fundamental issues, key systems questions of non-linearities and overwrite are also discussed. A complete chapter is devoted to the emerging technology of magneto resistive heads. A parallel treatment of time and frequency response is given to facilitate the understanding and evaluation of signal processing schemes. Using the information presented in this text, the reader should be able to design and analyze key experiments for head and medium evaluation and for overall system testing.

The table of contents is reproduced below:

Chapter 1	Overview
Chapter 2	Review of Magnetostatic Fields
Chapter 3	Inductive Head Fields
Chapter 4	Medium Magnetic Fields
Chapter 5	Playback Process: Part 1—General Concepts and Single Transitions
Chapter 6	Playback Process: Part 2—Multiple Transitions
Chapter 7	Magneto resistive Heads
Chapter 8	Record Process: Part 1—Transition Models
Chapter 9	Record Process: Part 2—Non-linearities and Overwrite
Chapter 10	Medium Noise Mechanisms: Part 1—General Concepts, Modulation Noise
Chapter 11	Medium Noise Mechanisms: Part 2—Particulate Noise Introduction
Chapter 12	Medium Noise Mechanisms: Part 3—Transition Noise

## MMM-Intermag Conference Papers

There will be a number of papers presented by CMRR faculty and students at the forthcoming 6th Joint Magnetism and Magnetic Materials - Intermag Conference which will be held in Albuquerque, New Mexico from June 20-23.

They are listed by group according to the faculty supervisor:

### H. Neal Bertram

G. H. Lin and H. N. Bertram, *Noise Spectral Analysis in Thin Film Media*

J. Fitzpatrick, X. Che, G. H. Lin, L. C. Barbosa, and H. N. Bertram, *The Relation of Medium Microstructure to System Error Rates in PRML Channels* (Invited)

Samuel Yuan and H. N. Bertram, *Exchange Biasing Schemes for MR Disk Heads*

### F. E. Talke

F. E. Talke and M. H. Wahl, *Numerical Simulation of the Steady State Flying Characteristics of a 50% Slider with Surface Texture*

T. C. McMillan and F. E. Talke, *Ultra Low Flying Height Measurements Using Laser Interferometry and Fringe Intensity Interpolation*

M. Yang, F. E. Talke, D. J. Perette, T. A. Morgan, and K. K. Kar, *Application of Phosphazine Lubricants in Hard Disk Drives*

E. Baugh and F. E. Talke, *Two-Dimensional Interferometric Head/Tape Spacing*

S. S. Varanasi, F. E. Talke, and L. Shrinkle, *Tribological Investigations of Specially Zoned Textured Glass Substrate Thin Film Hard Disks*

K. Lue, C. Lacey and F. E. Talke, *Measurement of Flying Height on Carbon Overcoated Sliders*

### A. E. Berkowitz

R. S. Beach, D. Rao, and A. E. Berkowitz, *Magnetoresistance of CuNiCo Ternary Alloys*

R. S. Beach and A. E. Berkowitz, *Field Dependent Impedance Spectra of Amorphous CoF/SIB Wire and Ribbon* (Invited)

E. N. Abarra, K. Takano, F. Hellman, and A. E. Berkowitz, *Head Capacity Measurements of antiferromagnetic CoO/Ni CoO Superlattices*

H. Wan and A. E. Berkowitz, *Structure and Magnetic Properties of Nd<sub>2</sub>Fe<sub>14</sub>B Fine Particles Produced by Spark Erosion*

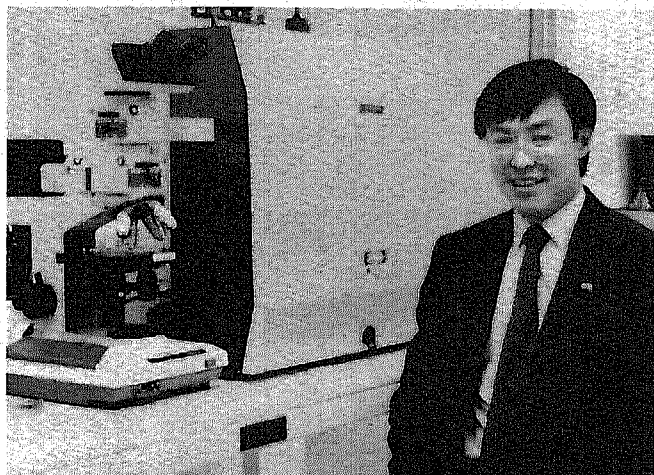
K. Takano and A. E. Berkowitz, *Exchange Anisotropy Field Dependence on Antiferromagnetic Film Thickness in Ni CoO/Ni<sub>8</sub>Fe<sub>16</sub> Exchange Couples*

### S. Schultz

T. J. Silva and S. Schultz, *High-resolution Imaging of Magnetic Domains in Reflection by Scanning Near-Field Optical Microscopy* (Invited)



## New Equipment Donations



The Talke Group at CMRR acquired a Renishaw Micro-Raman spectrometer, and is in the process of studying the materials properties and transfer products in the head/tape interface (brown stain). In addition, the composition and materials properties of thin film carbon-coated disks are being investigated.



Recently the Signal Processing Group at CMRR acquired a new piece of test equipment, a high-speed, deep-memory sampling oscilloscope. The LeCroy 7200A has a 500MHz analog bandwidth and supports sampling rate up to 2 Megasamples/sec on two channels simultaneously, or 1 Megasample/sec on four channels simultaneously. In addition, single-shot samples up to 1 Megasample per channel may be acquired. The long sampling length, combined with the high sampling rate and advanced triggering capabilities of the scope facilitates the work the group is doing for NSIC. It will now be possible to oversample long sections of the readback voltage from disk and tape channels using the scope, and download the waveforms to a PC. Once on the PC, signal processing algorithms such as various timing recovery schemes, equalization targets, and detector algorithms may be evaluated using the sampled data as input.

## Contact Numbers for CMRR Faculty and Staff

### Administrative / Support Staff

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<b>DIRECTOR'S ASSISTANT</b>		
Cheryl Hacker, MSO	534-6563	chacker@ucsd.edu
<b>CENTER CONTACT</b>		
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## Tribology Workshop

The eleventh annual tribology workshop was held at CMRR March 21-March 22, chaired by Professor Talke. Over 30 people from sponsor companies and universities were in attendance. The main topics of the workshop centered around materials limitations in magnetic recording, instrumentation, and head/disk modelling. One special session was devoted to head/tape interface problems.

As in previous years, a lab tour was organized for one evening to give all participants a chance to see first-hand the projects in the lab and meet the students in the tribology and mechanics area.

# Future Conferences

This section includes forthcoming conferences, meetings, symposia, special courses, etc., of interest to the recording industry.

- |                   |   |                      |  |
|-------------------|---|----------------------|--|
| Jun. 20-23, 1994  | 6th Joint MMM-Intermag Conference,<br>Albuquerque, N.Mex.<br>For info: Courtesy Associates<br>655 15th St., NW, Suite 300<br>Washington, DC 20005<br>Phone: (202) 639-5088; Fax: (202) 347-6109                         | Sept. 28-29, 1994    | DISKCON '94, San Jose, Calif.<br>For info: IDEMA, (408) 720-9352; Fax: (408) 720-9380  |
| Jul. 14, 1994     | IDEMA Dinner meeting<br>Red Lion Inn, San Jose, Calif.<br>Speaker: Charles Haggerty, Western Digital Corp.<br>For info: IDEMA (408) 720-9352; Fax: (408) 720-9380   | Oct. 16-19, 1994     | ASME/STLE Tribology Conference '94, Maui, Hawaii<br>For info: ASME Dept. TR192A<br>22 Law Drive<br>Fairfield, NJ 07007-2900<br>Phone: (800) 843-2763, ext. 930; Fax: (201) 882-1717  |
| Aug. 14-17, 1994  | TMRC '94 The Magnetic Recording Conference,<br>San Diego, Calif.<br>University of California, San Diego<br>For info: Roger Hoyt, IBM, (408) 927-2118 or<br>Bob Swanson, Kodak Research Labs (619) 535-6923              | Oct. 20, 1994        | IEEE Magnetics Society Meeting, San Diego Chapter,<br>La Jolla, Calif.<br>Speaker: Jim Brug, Hewlett-Packard Laboratories<br>"Towards 10Gb/in2: the NSIC Recording Head Project"<br>For info: Cheryl Hacker (619) 534-6563 |
| Sept. 12-15, 1994 | 18th Annual Conference on Magnetics in Japan<br>Yohoku Gakuin University, Japan<br>For info: Koji Ando<br>Secretary of the Planning Committee<br>Magnetics Society of Japan<br>Tel: 81-298-58-5455; Fax: 81-298-58-5434 | Nov. 3, 1994         | IDEMA Dinner meeting<br>Red Lion Inn, San Jose, CA<br>For info: IDEMA (408) 720-9362; Fax: (408) 720-9380  |
|                   |   | Nov. 14-18, 1994     | COMDEX/Fall '94, Las Vegas, Nev.<br>For info: The Interface Group, Needham, Mass.<br>Phone: (617) 449-6600; Fax: (617) 449-2674  |
|                   |   | Nov. 30-Dec. 1, 1994 | CMRR Fall Research Review, La Jolla, Calif.<br>For info: Cheryl Hacker (619) 534-6563<br>Fax: (619) 534-8059   |

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