

# SYSTEMS SIGNALS

Newsletter of the Institute for Systems Research at the University of Maryland and Harvard University

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## ISR Playing Key Role in Army Research Lab Project

The Institute for Systems Research, the Center for Satellite and Hybrid Communication Networks and the University of Maryland Institute for Advanced Computer Studies are key participants in one of the Army Research Laboratory's three new cooperative research agreements with industry and university consortia.

The agreements, valued at a total of \$122 million over a five-year period, establish external centers for research in telecommunications and information distribution, advanced sensors, and advanced and interactive displays. Each area is both important to the Army's digitization efforts and of major commercial interest.

ISR is playing a prominent research and education role in the \$46 million Advanced Telecommunications and Information Distribution Research Program. This program emphasizes wireless battlefield communications;

tactical and strategic interoperability; information distribution and multimedia concepts.

The Institute hosted members of the federated laboratory consortium working on the telecommunications program March 4 and 5 at the University College Conference Center on campus. More than 100 individual researchers and project leaders from the Army, industry and academia attended to finalize the project's research plans. Since that time, ISR has hosted working meetings for many of the sub-areas of the project.

"This project is an ideal vehicle for building closer relationships between ISR and the other partners in the consortium," said ISR Director Steven Marcus.

In addition to the Army Research Laboratory and the University of Maryland, consortium members include Bell

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## Director's Message

# It's been a privilege directing ISR

Last fall, I informed Dean William Destler of the Clark School of Engineering at the University of Maryland that, upon completion of my five year term as ISR Director on August 16, 1996, I would step down as Director and return to full time teaching and research. Dean Destler moved expeditiously to appoint a committee to conduct an international search for the next Director of the ISR.

I am very proud of the success and distinction of the ISR over the past five years; these have been the result of vision, creativity, and hard work by the faculty, staff, students, and industrial partners. The ISR and its faculty and students have continued to receive recognition for their outstanding research program. Our successful recent research programs include the NASA-funded Center for Satellite and Hybrid Communication Networks, the new Advanced Telecommunications and Information Distribution Research Program funded by the Army Research Laboratory, and the program in semiconductor manufacturing funded by a supplemental grant from NSF. After a major strategic planning effort and success in an open competition, the ISR was re-established as an NSF Engineering Research Center, and we

are in the process of transitioning to "self-sustaining ERC" status within the NSF ERC program.

I feel great pride in the quality of our education programs and the recognition they have received. Our comprehensive education program was highlighted both in the NSF publication "Highlights of Engineering Research Centers Education Programs" and in the 1994-1995 Annual Report of NSF to the President of the United States. Our Master of Science in Systems Engineering has increased in size and quality and has become a strong and vibrant academic program. The Master of Engineering in Systems Engineering, designed for the practicing engineer, began in 1995. This year, the ISR offered a series of short courses, developed from critical elements of the MSSE courses, for engineers at NASA/Goddard. At the undergraduate level, we are launching the ambitious and pioneering Gemstone program. I am delighted that we have continued to receive NSF funding for our summer Young Scholars Program for high school students.

Our Industrial Partnerships program has grown significantly, and has recently included the addition of such companies as Advanced Micro De-

vices, Silvaco, TD Technologies, and Bentley Systems. We have continued to work closely with our Sustaining Partners, Northrop Grumman and Lockheed Martin, and I am grateful for their support. ISR research is increasingly having a significant impact in industry, and our students are highly sought after by companies. For example, projects with industry involving ISR faculty have won a number of "best project" awards from the Maryland Industrial Partnerships Program.

I feel privileged to have been able to work with the ISR community to continue to make the ISR the dynamic and exciting organization that it has become. I look forward to working with the new Director to meet the challenges and opportunities facing the ISR and to maintain its excellence and leadership in research, in education, and in industrial collaboration.  
—Steven I. Marcus, Director

*Editor's note: Shortly before Systems Signals went to press, Gary W. Rubloff was appointed the Institute's next Director. Dr. Rubloff had just recently joined ISR and the Dept. of Materials and Nuclear Engineering as Professor. He was previously at North Carolina State University and at IBM Research. We'll formally introduce Dr. Rubloff to you in our next issue.*

## ISR's Key Role in Army Research Lab Project

...continued from page 1

Communication Research (Bellcore); GTE Laboratories; Motorola; Sanders, a Lockheed Martin Company; the City College of New York; Howard University; the Massachusetts Institute of Technology; and the University of Delaware.

The award brings more than \$5 million in funding to the University of Maryland over the next five years. Fourteen UMCP faculty members from the Electrical Engineering, Computer Science and Business and Management Departments will be participating, and the agreement allows the university to fund five research scientists or post doctoral

candidates as well as support 17 graduate students.

The proximity between the College Park campus and Army Research Laboratory facilities, as well as ISR's technical excellence in the four key factors and its laboratory resources will facilitate the research exchange.

The University's location also allows it to lead the consortium's educational efforts, an important part of the federated laboratory concept. Initiatives include advance degree programs for visiting Army research-

ers and short courses and workshops for consortium members.

ARL scientists will be able to pursue advanced studies without having to physically relocate, and staff rotated to ARL from the industrial members of the consortium also will be able to pursue graduate studies at the University during their stints.

The University has added a new staff position to coordinate the educational efforts associated with both the telecommunications and the second of the three ARL projects on advanced sensors. ♦

# ISR Hosts National Industrial Conference on Semiconductor Manufacturing



More than 30 representatives from industries that manufacture, supply or depend on semiconductors attended an ISR industrial conference on the subject May 16. The program was held in Van Munching Hall on the campus of the University of Maryland at College Park.

Recently, effective manufacturing processes have emerged as a key to helping U.S. companies maintain their leadership role in the highly competitive semiconductor industry. ISR's national conference evaluated the promise of integrating advances in sensing, modeling and control into the manufacturing process.

Participants concentrated on four areas in eight lively half-hour sessions: the current status of semiconductor manufacturing and its prognosis for the future; process and equipment modeling; sensors; and model-based control. Topics included:

- State of the art in sensing and control in semiconductor manufacturing
- Elements of process control solutions for implementation in semiconductor manufacturing
- View from the equipment suppliers

- Process modeling and process control in metallo-organic chemical vapor deposition (MOCVD) and molecular beam epitaxy (MBE) growth of compound semiconductors
- Sensing and simulation for process optimization, control and environmentally-conscious manufacturing
- Thermo-electro-mechanical structures: opportunities in sensing and control for manufacturing

- Chemical vapor deposition (CVD) modeling and control
- Run-to-run control: methods and applications in plasma etching

After the program, John Gragg, program manager of the Manufacturing Technology Group in Motorola's Semiconductor Products Sector, said he felt the number of participants was ideally suited to promoting lively discussion and the mix of representatives from the university,

government agencies, and industry was very good.

"I was particularly pleased to find representatives from the semiconductor manufacturing equipment suppliers in attendance," he said, "because these suppliers and their products are the vehicles by which much of the technology developed by the ISR will get transferred to the semiconductor industry."

"There are also many opportunities for collaboration between the ISR and semiconductor manufacturers like Motorola, particularly through participation in programs like those sponsored by SEMATECH which address precompetitive requirements of the industry as a whole."

Participants came from Texas Instruments; SEMATECH; Motorola; LAM Research; Sandia National Laboratories; the National Institute of Standards and Technology; Air Products and Chemicals, Inc.; Applied Materials; IBM; Integrated Systems, Inc.; the National Science Foundation; Northrop Grumman; and Science Applications International Corp. ♦



*In a moment typical of the conference, Steve Spain of Integrated Systems, Inc., compares notes with Texas Instruments' Jimmy Hosch.*

# CSPL Researches the Communication Process

The Communication and Signal Processing Laboratory (CSPL) is an ISR constituent laboratory researching speech, image and video compression; combined source and channel coding for mobile radio networks; error control coding techniques; adaptive filtering; parallel architectures; high-speed VLSI architectures for signal processing applications; distributed inference and various elements of communication networks including routing, multiple access, protocols and network management. CSPL has joint affiliation with ISR, the University of Maryland at College Park's Electrical Engineering Department and its Engineering Research Center.

CSPL research focuses on the many aspects of the communication process. CSPL efforts have focused on two important, complementary directions: real-time signal processing and communication networks with emphasis on wireless networks.

CSPL has investigated various techniques in source and channel coding in signal processing, developing a method for constructing "nested" families of robust trellis codes that have different rate/performance characteristics, but all use a single encoder and decoder. Its researchers also have designed an adaptive source-channel coding system that dynamically varies the compression and transmission rates depending on the quality of the transmission medium.

In quantization, CSPL has designed an optimal entropy-constrained, successively refinable scalar quantizer; designed multi-stage pruned tree-structured vector quantizers; developed a channel-optimized vector quantizer for finite-state Markov channels; and developed a method for designing joint trellis-coded quantization/modulation systems that use two-dimensional modulation schemes.

In image coding, CSPL has developed two new classification schemes: equal mean-normalized standard deviation classification and spectral

classification, which improve the performance of DCT and sub-band coding systems up to 1.3 dB.

Through applying its knowledge in still image coding, CSPL developed a real-time implementation of a wavelet-based video coder. This video system was selected as the American Division winner of the 1995 Texas Instruments DSP Solution Challenge and competed for the final prize at the 1996 IEEE ICASSP in Atlanta.

CSPL research in communication networks has concentrated on the wireless multimedia environment. It has evaluated the performances of virtual circuit switched and multicasting multimedia networks. At the present, wireless ATM networks are being reviewed.

CSPL also is investigating ways to design broadcast schedules for broadcast data delivery in a wireless communication environment as well as memory management strategies for a mobile user in a wireless broadcast data delivery system.

In a mobile environment, CSPL researchers have developed channel capacity and cutoff rates of DPSK on fading channels; error concealment of coded speech received from fading channels by use of channel side information combined with appropriate interpolation; and power control for broadcast and fading channels.

For multi-user networks, optimal policies for hand-off and channel assignment in CDMA cellular and LEO satellite networks have been developed. In addition, CSPL has defined methods for accurate evaluation of cell coverage areas for CDMA hard and soft hand-offs.

Professor Nariman Farvardin directs the Communication and Signal Processing Laboratory. Tasuki Hirata is the lab manager.

*For more information, contact Nariman Farvardin at 301-405-3643; e-mail: farvar@eng.umd.edu, or Tasuki Hirata at 301-405-6589; e-mail: sukes@eng.umd.edu ♦*

## DSPL Becomes ISR Affiliate

This spring the Digital Signal Processing Laboratory (DSPL) became ISR's seventh affiliated laboratory. DSPL is the research lab for the signal/image processing and communications group led by Professor K.J. Ray Liu. There are 15 graduate research students and one postdoctoral research associate.

DSPL research areas range from theoretical analysis and algorithm development to design and implementation of signal processing systems. There are three principle areas of research.

The design and implementation of signal processing systems group studies VLSI design, parallel algorithm, concurrent architecture and low-power systems. Image and video processing researchers concentrate

on video coding, motion estimation, wavelet, computed imaging and medical image. The statistical and array signal processing group researches wireless communication and networking, channel equalization, array processing and spectral estimation.

Research has been supported by the National Science Foundation, the Office of Naval Research, the National Institutes of Health, the Army Research Laboratory, Maryland Industrial Partnership, Micro Star Co., Westinghouse, Watkins Johnson, Allied-Signal, and the Minta Martin Foundation.

*For more information, contact Professor Liu at (301) 405-6619; e-mail: kjrliu@isr.umd.edu ♦*

## Pioneer 'Gemstone' Program May Change Undergraduate Education

This fall, the Institute for Systems Research will begin administering a brand-new education program for the University of Maryland that may rewrite the way undergraduates are taught across the nation.

The Gemstone program places students in multidisciplinary teams for their undergraduate years. Each team undertakes a long-term research project addressing a crucial societal problem such as energy-efficient transportation, urban housing, waste management or biological engineering.

ISR was the natural organization to lead the effort, says Gemstone program director Dr. Tom Fuja, an associate professor with a joint appointment at ISR and the Electrical Engineering Department.

"We are the largest unit on campus dedicated to interdisciplinary research and education, and we already have a number of complementary programs in place for high school students, undergraduates and graduate students," Fuja says. "The Gemstone program will be a new and exciting part of our 'educational pipeline.'"

ISR faculty and staff are involved in designing the Gemstone program in addition to their administrative duties. "ISR faculty will be helping to develop and teach the Gemstone courses, and I'm sure that ISR faculty will serve as project managers," Fuja says.

More than 100 entering freshman students were selected on the basis of academic promise and their potential to interact effectively. All are honors students with an average SAT score of 1400. Each team contains approximately 12 undergraduates from engineering and other sciences, business and management, behavioral and social sciences, and the humanities.

The teams will take special courses that emphasize the relationship between technological innovation and social change from the perspectives of sociology, political science, history and

business. Student teams will meet regularly during the academic year to investigate and analyze their assigned problem. By the end of the senior year, each team will produce a book-length thesis containing results from background, analysis, design, testing and

**One Gemstone goal is to incorporate "real life" experience relevant to the students' research focus by providing internships or other work opportunities in industry and government. If you are interested in exploring this possibility, or want further information about Gemstone, please contact Lois Powers, program coordinator, at 301-405-6564; e-mail [powers@isr.umd.edu](mailto:powers@isr.umd.edu)**

implementation studies as well as a description of the proposed solution, its potential societal impact and a business plan for implementation. Faculty advisors and selected industry experts in the field will evaluate each team's proposal.

Students will address an aspect of the problem related to their undergraduate major. Engineering and science majors will investigate both theoretical and experimental technological solutions. Humanities and

behavioral and social sciences students will address the history and societal impact of the problem, while business and management majors will concentrate on finance and marketing issues.

Students completing the program are awarded a Gemstone designation on their baccalaureate degree.

University officials hope the Gemstone concept will help Maryland stake out a national presence as a leading innovator in undergraduate education.

William Destler, dean of the A. James Clark School of Engineering, originated the Gemstone idea. He says it addresses two of the most common criticisms of modern undergraduate education—the lack of an integrative experience to provide a context for learning, and the failure to provide meaningful interactions between students in different disciplines.

"Society has not been as effective as we might have been at bringing such diverse talents together toward the solution of major societal problems," Destler says. "The University of Maryland is a pioneer."

Core funding comes from General Electric and AT&T, which are investing a combined total of \$370,000 over four years. Additional support comes from IBM through its Total Quality Program at the University of Maryland. ♦

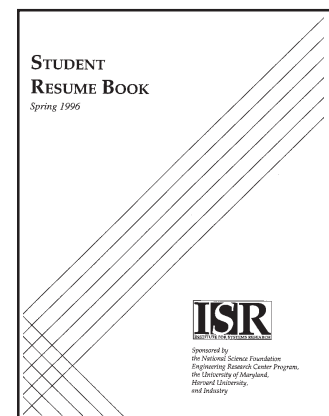
## Resume, Poster Books Available

ISR currently has two free books available that will help industry representatives get better acquainted with its graduating students and their research areas and interests.

The 1996 ISR Student Resume Book presents ISR students to industry for permanent employment, collaborative research and internship opportunities.

The book contains resumes for 31 Ph.D. and 32 M.S. and B.S. students.

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# ISR Faculty and Student Highlights

## Faculty news

**Professor John Baras** (EE/ISR) and **Aaron Falk**, a graduate of the ISR MSSE program, received the Engineering Research Center Awards of Excellence for outstanding contributions in advancing Maryland industry at a ceremony on April 9. The award was given for their work with Hughes Network Systems. They won the MIPS Large Company Award for their "Broadcast Internet Access" project. Dr. Baras was the principal investigator and Mr. Falk was the student researcher.

**Professor Dana Nau** (CS/ISR) was elected a Fellow of the American Association for Artificial Intelligence in May. He was one of only five fellows elected nationwide.

**Professor Carlos Berenstein** (Math/ISR), **Associate Professor K.J. Ray Liu** (EE/ISR), **Farrokh Rashid-Farrokhi** and **David Walnut** received a finalist plaque for Wavelet-Based Multiresolution Local Tomography at the University of Maryland's Office of Technology Liaison Invention of the Year competition this April. Using wavelet algorithms, a physician interested in viewing the cross section of a small region of the body could reduce radiation exposure to the patient by focusing the scanner on the local region of interest. In addition, the time needed to produce the CAT images is reduced. The University holds U.S. Patent rights on the invention.

**Professor Carlos A. Berenstein's** (Math/ISR) research on the Nullstellensatz problems of complexity has led to his work on this classical subject being recognized in the latest edition of Serge Lang's *Algebra*, the standard textbook on the subject.

**Professor Anthony Ephremides** (EE/ISR) received the 1995 NRL Alan Berman Research Award for a paper on admission control published in the *Journal of Discrete Event Systems*. His co-authors on this paper were Jeff Wieselthier and Craig Barnhart.

**Professor Benjamin Kedem** (Math/ISR) is a 1996 NASA Summer

Fellow. He also was a NASA Summer Fellow in 1995.

**Professor William S. Levine** (EE) is the editor of the new *Control Handbook*, published by CRC. He also spent a week in April in residency at Texas Tech University as the ESA Distinguished Lecturer, where he gave a series of presentations on control.

**Professor Michael Pecht** (ME/ISR) received the American Society for Quality Control Reliability Division's 1996 Austin Bonis Award for the Advancement of Reliability Education "for outstanding achievement in the advancement of reliability education." He also received the Institute of Environmental Sciences' 1996 Reliability Test and Evaluation Award "for vital contribution to the development and promotion of physics-of-failure modeling and analysis as a valuable reliability design and test process in the government, commercial and academic communities."

**Assistant Professor Jeffrey Herrmann** (ME/ISR) presented research results by himself and **Associate Professor Ioannis Minis**

(ME/ISR) at the Fifth National Agility Conference in Boston this March. His presentation was titled, "Integrating Design Evaluation and Partner Selection."

**Professor John Baras** (EE/ISR) recently received two awards. His paper, "ATM in Hybrid Networks," received the outstanding paper award at the Design Supercon 96 Conference, as judged by a selection committee of design engineers. As a result, the paper was featured in the Jan. 15, 1996 issue of *Electronic Engineering Times*.

Dr. Baras also received the Outstanding Contribution to Seniors award from the University of Maryland's Vice President for Student Affairs, in recognition of his work to help undergraduates outside the classroom with projects, teaching and career development.

**Associate Professor Evangelos Zafiriou** (ChE/ISR) was guest editor of a special 1996 issue of *Computers and Chemical Engineering* containing selected papers from the 1994 International Federation of Automatic Control Workshop on the



Outstanding faculty, students and staff display their awards at ISR's annual ceremony in May. Left to right: Associate Professor K.J. Ray Liu, outstanding faculty; Diane Ihasz, outstanding staff; ISR Director Steven Marcus; Eric Justh, outstanding graduate student; and Narin Suphasindhu, outstanding undergraduate student.

Integration of Process Design and Control.

Professor Thomas McAvoy (ChE/ISR) was selected as a recipient of the 1995 Harry C. Bigglestone Award for Excellence in Communications of Fire Protection Concepts. The award was in recognition of a paper Dr. McAvoy wrote with James Milke on "Analysis of Signature Patterns for Discriminating Fire Detection Multiple Sensors" that appeared in *Fire Technology*.

Professor Michael Ball (BMGT/ISR) coordinated the efforts of the University of Maryland as part of a four university team that successfully competed to jointly set up a National Center of Excellence for Air Transportation Operations Research. The center is expected to operate for at least 10 years; the FAA expects to use it as its principal vehicle for conducting air transportation operations research.

**Student news**

Student research into "Real-Time Implementation of a Wavelet-Based Video Compression System" was the best project "in the Americas," winning one of eight 1995 Texas Instruments Digital Signal Processing Solutions Challenge semi-final awards. TI received entries from more than 230 teams. The ISR team competed for the \$100,000 world-wide grand prize at the 1996 International Conference on Acoustics, Speech and Signal Processing in Atlanta in May. Professor Nariman Farvardin (EE/ISR) supervised EE students Ruplu Bhattacharya, Hamid Jafarkhani and Jerome Johnson in the project.

ISR graduate student Stanley Ng was selected to participate in the NSF 1996 Summer Study in Japan program. Ng's research involves an in-process monitoring system for assessing surface integrity of machined surfaces. Ng will work at the Mechanical Engineering Laboratory (MEL), AIST, MITI, to develop a model for in-process surface roughness evaluation from the geometric form of a milling tool, obtained by the in-process laser-based 3-D tool geometry monitoring system developed at MEL. ♦

# ISR, Electrical Engineering Combine Poster Sessions

On May 3, ISR teamed with the University of Maryland's Electrical Engineering Department to offer a combined poster and demonstration session that featured more than 100 examples of student engineering research.

Research from each of ISR's constituent labs—Communication and Signal Processing, Intelligent Servosystems, Systems Engineering and Integration, Computer Integrated Manufacturing, Chemical Process Systems and Computer Aided Control Systems Engineering, Neural Systems and VLSI systems, was featured, along

with two of ISR's affiliated labs, Advanced Design and Manufacturing, and Digital Signal Processing.

The event was part of ISR's annual Research Advisory Council meeting and EE's Research Review Day. More than 100 representatives from industry and government attended in addition to the Research Advisory Council members John Decaire, National Center for Manufacturing Sciences; P.K. Rajaselaram, Texas Instruments; Leonard Golding, Hughes Network Systems; Douglas Bowman, Lockheed Martin; and Victoria Haynes, BFGoodrich. ♦



Professor Dana Nau (l) outlines the results of recent research in the Computer Integrated Manufacturing Laboratory to ISR Research Advisory Council member John Decaire (second from left) of the National Center for Manufacturing Sciences.

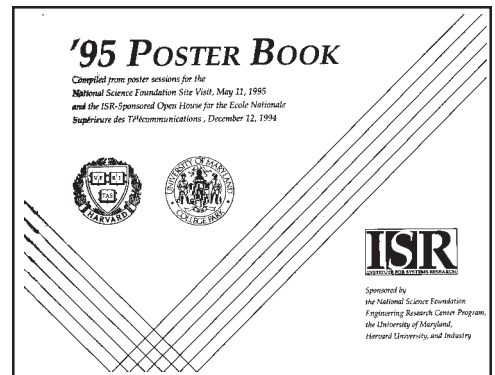
## Resume, Poster Books

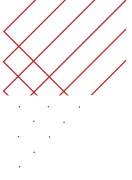
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An index at the end of the book identifies the students by their areas of expertise and interest.

The 1995 Poster Book contains 58 posters depicting ISR student research projects. Each project description contains a complete abstract of the research.

To obtain either of these publications, contact Rebecca Copeland, (301) 604-0676 or e-mail [rebeccac@isr.umd.edu](mailto:rebeccac@isr.umd.edu) ♦





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## ISR Hosts Silvaco Software Training Session

On Feb. 19 and 20, ISR's computer laboratory facilities hosted a software training workshop for Silvaco International, which produces integrated software core tools for semiconductor technology CAD.

Silvaco's workshop to help process and device engineers improve their knowledge of simulation. David Geder's, Peter Michelson's and Bob Cottle's instruction included a significant amount of one-on-one time with participants.

Close to 20 engineers from National Semiconductor, NASA, Harris Semiconductor, Sensitron Semiconductor, LORAL, the Naval Research Laboratory, and Science Applications International Corp. (SAIC), along with University of Maryland students, learned how to use Silvaco's ATHENA process simulation and modeling and ATLAS device simulation and modeling tools.

ATHENA training covered GUI, post processing and interfacing to IC layout; meshing, adaptive meshing, grid refinement; ion implantation, diffusion, etching, deposition, optolithography and CMP models; optimization of process and electrical parameters; and process model calibration.

ATLAS training explained structure files (simulated, arbitrarily drawn



*Silvaco's Peter Michelson (left center) explains a key feature of his company's ATHENA program to engineers during the training workshop held at ISR February 19 and 20.*

structures); defining a structure with devedit and regriding; proper selection of material parameters for III-IV compounds using blaze; choosing numerical methods and meshing; 6 equation solver (poisons, electron and hold continuity, energy balance electron and hole, thermal); curve tracing and parameter extraction;

obtaining solutions and interpreting results; device model calibration

Silvaco International's software is installed at more than 1,000 sites in about 300 commercial companies. In addition, more than 2,000 copies of its software are in university use. ♦