

Systems Signals

The newsletter of the Institute for Systems Research

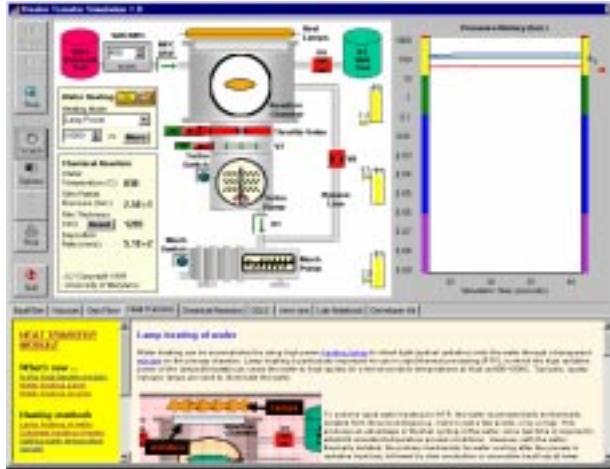
Volume 15 No. 1 Winter 2000

To ISR faculty in 1999

More than \$2.5 million in major research awards granted

ISR faculty members were awarded more than \$2.5 million in grants from the National Science Foundation, the Air Force, the Office of Naval Research and the National Institute of Standards and Technology in 1999.

ISR Director **Gary W. Rubloff** (MNE/ISR) and the NSF/SRC ERC for Environmentally Benign Semiconductor Manufacturing (CEBSM) at the University of Arizona, Tucson, have been awarded a three-year NSF grant. The award will enable the development of a portfolio of interactive, computer-based simulator learning modules to support education in the design for environment. The project is entitled "Simulation-Based Learning Systems for Environmentally Benign Semiconductor Manufacturing."



Computer-based simulator learning modules are being developed for semiconductor manufacturing in a project headed by ISR Director Gary Rubloff.

Managing Technological Innovation." The award focuses on the development of an intelligent product representation for evolvable designs that can determine when new innovation indicates that a change in a previous decision is warranted.

Professor **Dana S. Nau** (CS/ISR) also has been granted a three-year award by the Air Force to study "Information Push Pull on the Digital Battlefield."

Professor **Anthony Ephremides** (ECE/ISR), Associate Professor **Leandros Tassioulas** (ECE/ISR), and Assistant Research Scientist **Scott Corson** have been awarded a three-year NSF grant to investigate "Control and Performance Tradeoffs in the Design of Multi-Hop Wireless Networks."

Professor **Lung-Wen Tsai** (ME/ISR) has won a one-year NSF Small Grant for Exploratory Research (SGER) award. Dr. Tsai will perform a feasibility study on the design of hybrid kinematic machines. The goal of the design is to attain the advantages of both a serial kinematic machine

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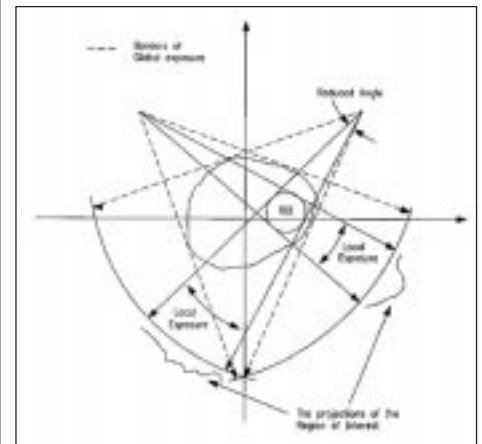
ISR faculty awarded two patents this fall

Professor **Carlos Berenstein** (Math/ISR), Associate Professor **K.J. Ray Liu** (ECE/ISR), and ISR alumni **David Walnut** and **Farrokh Rashid-Farrokh** were awarded US Patent # 5,953,388 on Sept. 14, 1999 for their invention, *Method and Apparatus for Processing Data from a Tomographic Imaging System*.

Computer tomography (CT) imaging has been adopted as standard procedure in medicine because it provides a more detailed analysis of internal body parts than conventional X-rays, it offers more control, and it is faster and less expensive. However, health concerns have emerged because CT requires a larger dose of radiation than conventional X-rays.

This patent is a new data processing method that reduces the amount of radiation exposure needed while maintaining CT's high resolution. The method is based on an algorithm that reconstructs the wavelet coefficients of an image from the Radon transform data. The properties of wavelets are used to localize the Radon transform and reconstruct a local region of the cross section of a body, using almost completely local data. This significantly reduces the amount of radiation exposure and computations. More de-

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US Patent 5,953,388 can reduce radiation exposure during tomography.

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Assistant Professor **Satyandra K. Gupta** (ME/ISR), Professor **Michael O. Ball** (Robert H. Smith School of Business/ISR) and Professor **Dana S. Nau** (CS/ISR) have been granted a three-year NSF award for "Formulating Redesign Strategies for Product Evolution: A Proactive Approach to



Gary M. Hubloff

ISR's primary directions

We welcome the fact that ISR's fundamental systems strengths have blossomed in many directions in the past few years, leading to a diverse collection of major research programs and centers that affect a broad spectrum of applications. Our intellectual coherence and vitality—and our ability to convey it outside ISR—depends in part on developing and maintaining a simple, organized representation. Last year we invested significant effort in clarifying a picture which distinguishes five primary directions in ISR, all of which spring from our foundation and leadership in systems methodologies.

Global Communications Systems—moving information globally and efficiently. This direction is central to the Internet and wireless communication revolutions. It builds on ISR's cutting-edge research in wireless and hybrid communication networks, dynamic information management, heterogeneous databases, and multimedia technology and systems. It includes our NASA Center for Satellite and Hybrid Communication Networks (CSHCN) and major initiatives such as the Advanced Telecommunications and Information Distribution Research Program (ATIRP), an ARL Federated Laboratory; the NSA Laboratory for Telecommunication Sciences; and the ARL Collaborative Agent Technology System project. Substantial industrial collaboration, guidance, and support are derived through CSHCN's Industrial Partners Program.

Sensor-Actuator Networks—connecting, understanding, and controlling the physical world. Sensors and actuators interface between the rapidly growing domain of information technology and the physical world. Researchers from across engineering, computer science, math, and life sciences are addressing problems from robotics to neuroscience, microelectromechanical and materials technologies to control theory and sensor/actuator integration for small smart systems. This direction includes partnership in an ARO Center for Design and Control of

ISR's research and education emphases

<p style="text-align: center; background-color: #e6f2ff; margin: 0;">Connecting, understanding, and controlling the physical world</p> <p style="margin: 5px 0;">Sensor-Actuator Networks</p> <ul style="list-style-type: none"> • Integrated sensor-actuator systems • Sensing and intelligent control • Neuroscience, cognition, and behavior 	<p style="text-align: center; background-color: #e6f2ff; margin: 0;">Developing product streams and manufacturing systems</p> <p style="margin: 5px 0;">Next-Generation Product Realization Systems</p> <ul style="list-style-type: none"> • Product and manufacturing system design • Process and production planning • Rapid development and early tradeoff analysis
<p style="text-align: center; background-color: #e6f2ff; margin: 0;">Moving information globally and efficiently</p> <p style="margin: 5px 0;">Global Communications Systems</p> <ul style="list-style-type: none"> • Wireless and hybrid networks • Dynamic information management • Ultrahigh capacity data systems • Multimedia technology and systems 	<p style="text-align: center; background-color: #e6f2ff; margin: 0;">Supporting people and society through intelligent systems design</p> <p style="margin: 5px 0;">Societal Infrastructure Systems</p> <ul style="list-style-type: none"> • Transportation systems • Collaborative decision making • HCI and learning systems • Environmental systems engineering

Smart Structures, an ONR Center for Nonlinear Active Control of Dynamical Systems, an ONR Center for Auditory and Acoustic Research, an NSF program in Learning and Intelligent Systems and major programs in MEMS and semiconductor process control.

Next-Generation Product Realization Systems—developing product streams and manufacturing systems. This direction is aimed at product design, manufacturing, and enterprise optimization, particularly the dynamics of the product stream and the marketplace. It emphasizes advanced approaches to design languages and planning algorithms, concurrent engineering through integrated process and product design, heterogeneous modeling systems, tightly coupled optimization involving early cost/performance tradeoff analysis, and the changing role of supply chain management in the age of the Internet. Integrating skills from engineering, business, and computer science, it includes major supported programs in design and planning methodologies, and in semiconductor manufacturing.

Societal Infrastructure Systems—supporting people and society through intelligent systems design. This emerging area covers a broad set of topics, all of which have a degree of emphasis on the human element. It encompasses both the study of systems that have a significant public sector impact and the relationships and interfaces between humans and automated systems. One major focus is in transportation systems, supported by NEXTOR, a Federal Aviation Administration National Center of Excellence in Aviation Operations Research, its Industrial Advisory Board, and collaboration with the Center for Advanced Transpor-

tation Technology. Another emphasis is on human factors, learning, and behavior, involving the Human-Computer Interaction Lab and the Center for Engineered Learning Systems, as well as neural and cognitive science research in the Center for Auditory and Acoustic Research and the NSF program in Learning and Intelligent Systems.

Cross-Disciplinary Systems Education—developing technical, business and societal leaders. Since its origin as an NSF Engineering Research Center, ISR has maintained a commitment to systems education, realized through programs for graduate, undergraduate, and pre-college students. Stimulated by major needs identified by industry and government, systems engineering education is a strong focus in ISR's Master's and Professional Master's programs. Continuing development of these programs is accompanied and enhanced by industry support for systems engineering education modules and short courses. There also is a growing commitment by the Systems Engineering and Integration Laboratory to further systems engineering education and its integration with research. Complementing this, ISR has led the Gemstone cross-disciplinary undergraduate honors program since its inception four years ago. Supported by industry, NSF, and the State of Maryland, Gemstone provides a profound experience in systems-driven, cross-disciplinary, team problem solving to more than 600 of the country's finest undergraduates. It is a model for national leadership in education.

These are immensely exciting opportunities and accomplishments. We look forward to enhancing this portfolio and crystallizing our vision for ISR's future contributions.

Farvardin, Atsumi win Invention of the Year award

Professor and Chair of the Electrical and Computer Engineering Department **Nariman Farvardin** (ECE/ISR) and Mr. **Eiji Atsumi** of Japan's Mitsubishi Electric won one of three 1999 University of Maryland Invention of the Year awards from the university's Office of Technology Liaison.



The two have moved compression technology forward by developing an efficient method for

compressing digital images that allows a viewer to quickly and clearly see one or more regions of interest in a picture without having to wait for the full image to be transmitted through the Internet from a remote storage site. The regions of interest

can be selected either by the user of the system that is initially encoding the image, or by the user of the system that receives and decodes the image.

For example, if user A is sending a photograph of five people to user B, user A could select the face of one person in the photograph as a region of interest. The entire image would then begin to be transmitted to user B; however on user B's computer the resolution of the selected face would improve faster than the resolution of the remaining portions of the photograph. Similarly, user B who is receiving the photograph, could identify a second face that would also be transmitted faster and with higher resolution.

Transmission times and storage requirements thus can be reduced. Other applications for this invention include digital cameras and digitally reproduced motion pictures.

Patents

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tailed information is online at <http://www.isr.umd.edu/ISR/accomplishments/Tomography/>.

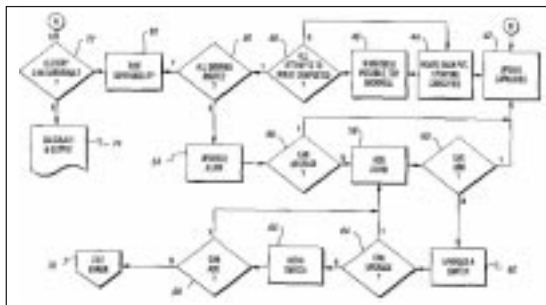
ISR-affiliated Assistant Professor **S. Raghavan** (Robert H. Smith School of Business) was awarded US Patent #5,940,373 on Aug. 17, 1999 for a *Frame Relay Network Planning Tool*. Co-inventors are Steve Y. Chiu, Ronald L. Hansen, and Jiyang Xu, of US West, Inc., Denver.

Frame Relay (FR) is a high-speed, connection-oriented data transfer service. Because FR networks are complex and expensive, their design must be cost-effective, reliable and have sufficient capacity. One of the most pressing problems with FR networks stems from their rapid growth and the lack of network planning tools.

This patented network planning tool can analyze the status of the current network, evaluate the condition of any user-defined configuration, and optimize the expansion

of the network based on demand and costs. It also ensures that the network is cost effective, reliable and has sufficient capacity to meet current and expected customer demand; and optimizes it based on customer demand, equipment used, and the existing network configuration. More detailed information is online at <http://www.isr.umd.edu/ISR/accomplishments/FrameRelay/>.

A complete listing of all ISR patents, with links to the patents themselves can be found online at <http://www.isr.umd.edu/ISR/research/patents.html>.



Part of the decision-making process of US Patent 5,940,373

Major research awards

continued from page 1...

and a parallel kinematic machine. The knowledge base developed by this work will not only benefit the machine tool industry but also the robotics community.

Associate Professor **Leandros Tassiulas** (ECE/ISR) has been granted a two-year NSF award for "From Medium Access to Physical Layer: An Integrated DSP Framework for Wireless Packet Networks." The goal of this research is an integrated approach to wireless packet network design that cuts across the medium access and physical layers. This research involves advanced signal processing, factor analysis, optimization, and queuing tools.

Professors **Shihab Shamma** (ECE/ISR) and **P.S. Krishnaprasad** (ECE/ISR) have won a one-year award from the Office of Naval Research to investigate a "Testbed for Real Time Implementation of Auditory Process."

Assistant Professor **Satyandra K. Gupta** (ME/ISR) is working on a one-year grant from the National Institute of Standards and Technology for "Multi-Level Integration of Design and Process Planning."

Professor **Michael O. Ball** (Robert H. Smith School of Business/ISR) and his colleagues Vallabhajosyu Sambamurthy, Sandor Boyson and Louiqa Raschid have won a three-year NSF award to study "Scalable Supply Chain Infrastructures: Models and Analysis." This research addresses a number of challenges related to the full realization of the potential of supply chain infrastructures (SCIs), which include those software systems used to support enterprise requirements planning (ERP) and supply chain management (SCM).

Practical contributions are anticipated in improvements in the understanding of how information technology impacts organizations and the how organizations should adapt to take advantage of new SCI technology; the development of decision models that both explain how supply chain decision making should take place in organizations and provide new techniques for supply chain decision support; new methods for efficiently implementing scalable web-based applications.

ISR partners with industry for research, recruiting, seminars

Northrop Grumman extends Sustaining Partner membership through 2001

Northrop Grumman's Electronic Sensors and Systems Sector has extended its membership as a Sustaining Partner in the ISR Industrial Affiliates Program through Nov. 30, 2001. Northrop Grumman (formerly Westinghouse) has been an ISR Sustaining Partner since December 1987.

Numerical Technologies CEO and ISR Ph.D. Buno Pati visits College Park

Y.C. "Buno" Pati, president and CEO of Numerical Technologies, Inc., visited ISR July 19 to talk about his company, which supplies solutions for subwavelength integrated circuit design and manufacturing. Pati is a former student of P.S. Krishnaprasad. He earned a Ph.D. in Electrical Engineering in 1992.



Buno Pati, CEO, Numerical Technologies, Inc.

Fellowship recipients

Four fellowships have been awarded to current and incoming ISR students: Sean Gahagan and Sumeet Keswani, the new ISR/Northrop Grumman Fellowships; Vineet Birmani, the new Hughes Network Systems Fellowship; and Zhi (Amy) Yuan, the ISR Fellowship.

Ballhaus joins SAC

Lockheed Martin's Dr. William Ballhaus, Jr., has joined the ISR Strategic Advisory Committee. Bill is Lockheed Martin's corporate vice president, engineering and science, in its Bethesda, Md., office.

GE Corporate Research and Development recruits; explains 'Six Sigma' program



Dr. Paul Houpt, GE CR&D

ISR welcomed two distinguished guests from GE Corporate Research and Development Oct. 21 and 22. Dr. James Loman, Manager, Electronic Reliability and Quality, presented a seminar on how GE's "Six Sigma" quality control program is increasing the competitiveness of the company. Dr. Paul Houpt, Manager, Control Systems Programs, spoke to ISR students about resumes and interviewing. Houpt and Loman interviewed 19 ISR students while on campus, continuing a fruitful practice with ISR that began four years ago. Students can investigate GE career opportunities online at http://www.gecareers.com/BusinessOfGE/in_rnd.cfm. GE Corporate Research and Development is represented on ISR's Strategic Advisory Council.

Northrop Grumman's Reynolds speaks to high school Young Scholars at ISR

Twenty-five high school seniors took the University of Maryland freshman engineering design course during a six-week "Young Scholars" experience.

George Reynolds, Northrop Grumman's Director of University-Industry Programs, was one of many industry participants. He spoke to the students about the challenges of systems engineering.



Northrop Grumman's George Reynolds

Honda engineers in residence as visiting scientists

Team Honda took first, second and third place at the World Grand Prix motocross final round in Maryland, Sept. 12. ISR Visiting Scientist Mr. Yuichi Kato, a Honda R&D Japan motorcycle engineer, attended the event. Mr. Kato and Mr. Naritomo Higuchi, an automotive engineer, are spending a year working with ISR faculty on research projects of mutual interest. Photos and more information are online at <http://www.isr.umd.edu/ISR/newsletter/ssfa99/motocross.html>.



Hoffman now with Metron

Former ISR research associate Robert Hoffman is now a senior analyst for the Aviation Division of Metron Scientific Consulting, Inc., in Reston, Va. At ISR, Hoffman has been involved in NEXTOR (the National Center of Excellence in Aviation Operations Research), working with Professor Michael Ball (BGMT/ISR). Metron is a NEXTOR industry partner. To aid in technology transfer, Hoffman is spending one day per week at ISR, continuing NEXTOR research and coordinating student work.

Varaiya is Distinguished Lecturer

ISR Strategic Advisory Council member Dr. Pravin Varaiya recently spoke on "Demand and Provisioning of Quality-Differentiated Internet Access." Varaiya is a professor in the Department of Electrical Engineering and Computer Sciences at the University of California, Berkeley.

Faculty news

New faculty members

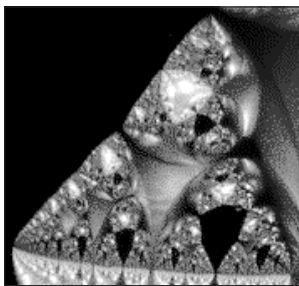
Four faculty members are new to ISR this fall. Assistant Professor **Kaye Brubaker** (CEE) is a new affiliate faculty member who specializes in the field of hydrology. Her main area of expertise is in mechanistic modeling.

Assistant Professor **Timothy Horiuchi** (ECE/ISR), a new joint appointment, directs the Biomorphic Sensorimotor Systems Laboratory. His research is aimed at understanding the details of how neural tissue produces complex and successful interactions with an organism's body and the environment. His engineering efforts are aimed at leveraging this knowledge to develop novel, integrated sensorimotor solutions for highly-constrained autonomous systems.

Professor **Chi Lee** (ECE/ISR), another joint appointment, conducts research into femtosecond lasers and ultrafast optoelectronics. Most of the research is conducted at the Ultrafast Optoelectronics Laboratory and the newly established Laboratory for Atomic, Molecular and Optical Science and Engineering (LAMOS).

Manoj Parameswaran (Robert H. Smith School of Business/ISR) is the final new joint appointment.

Faculty in the news



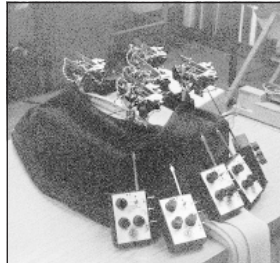
Detail of a simplified model of chaotic scattering in a Hamiltonian system with three degrees of freedom

Nature magazine and was featured on page 342 of the May 28 *Science News*. The *New York Times* ran an article on Dr. Ott's research in the science section of its June 15 edition.

Electrical and Computer Engineering Department Chair **Nariman Farvardin** (ECE/ISR) was featured in a May 17 *Washington*

Professor **Edward Ott's** (EE/Physics/ISR) chaotic scattering research is making national headlines. It was the cover story of the May 27

Post article on engineering B.S. holders who choose lucrative jobs over grad school, and how universities are adjusting to the phenomenon.



Maryland State of Mind, in May. Read our original story on the birds at <http://www.isr.umd.edu/ISR/newsletter/sswi97/robbirds.html>.

New fellows

Professor **Ben Kedem** (Math) has been elected a Fellow of the American Statistical Association.

Associate Professor **James Hendler** (CS/UMIACS/ISR) has been elected a Fellow of the American Association for Artificial Intelligence.

Professor **Anthony Ephremides** (ECE/ISR) recently chaired a panel for foreign technology assessment of wireless communications sponsored by NSF, NIST, DARPA and DoD. The panel consisted of six experts in the field of wireless communications (R. Pickholtz of GWU; W. Stark of the University of Michigan; R. Rao of the University of California at San Diego; T. Itoh of UCLA; L. Katehi of the University of Michigan and J. Winters of AT&T) and conducted a worldwide survey of the field. The work began in November 1998 and was completed in September 1999.

Books and journals



Associate Professor **Mark Austin** (CEE/ISR) and ISR Faculty Research Assistant David Chancogne's book, *Introduction to Engineering Programming: in C, MATLAB, and JAVA*, is entering its second printing, and is the #3-selling MATLAB book in the country. The book has been on the market since De-

ember 1998 and is published by John Wiley and Sons.



Professor Lung-Wen Tsai's (ME/ISR) book, *Robot Analysis: The Mechanics of Serial and Parallel Manipulators*, has sold out of its first printing and is about to enter its second.

The book was first published in February 1999. After reading the book, Dr. Tsai's former advisor, Professor Bernard Roth of Stanford University's Mechanical Engineering Department, wrote him, "There is no doubt that you have produced a very readable, and by far the most detailed and modern account of the mechanics of both serial and parallel systems."



Professor **Steven I. Marcus** (ECE/ISR) has been selected as the new editor in chief of the *SIAM Journal on Control and Optimization*, effective January 1, 2000.

Best paper awards

Assistant Professor **S.K. Gupta** (ME/ISR), along with graduate student **R.K. Arni**, won the best paper award at the American Society of Mechanical Engineers' (ASME) Design for Manufacturing Conference, held in Las Vegas, Sept. 12-16. Their winning paper is titled "Manufacturability Analysis for Solid Freeform Fabrication."

Associate Professor **K.J. Ray Liu** (ECE/ISR) and his students, **Ying-Chang Liang** and **F.P.S. Chin** have received the Best Paper Award from the IEEE 50th Vehicular Technology Conference, Amsterdam, The Netherlands, Sept. 1999. Their work was selected from among 700 papers in the conference proceedings.

Short takes

Visiting researchers

Dr. Stuart Milner was appointed an ISR Senior Research Scientist in the Center for Satellite and Hybrid Communication Networks on Oct. 1, 1999. For the next two years, Dr. Milner, a visiting scientist from the Defense Advanced Research Projects Agency, will be working with CSHCN faculty and students in telecommunications with specific emphasis on broadband wireless networking.

Dr. David Elliott, Professor Emeritus of Mathematical Systems at Washington University, is continuing as a visiting senior research scientist at ISR. He is conducting research on bilinear systems and interacting with ISR students.

Mr. Naritomo Higuchi, engineer in the Research Department of Honda R&D Inc., in Japan, began a 14-month visit with ISR on June 1, 1999. He is conducting research with Dr. Lung-Wen Tsai on improved engine efficiency through advanced cooling/heating transfer techniques.

Mr. Yuichi Kato, engineer in the Research Department of Honda R&D Inc., in Japan, began a 14-month visit with ISR on June 1, 1999. He is conducting research with Dr. William Levine in identifying noise sources and suppression.

Mr. Guglielmo Lulli, a research student in the Computer Science Department at the University of "Tor Vergata" in Rome, began a one-year visit with ISR on July 1, 1999. He is conducting research with Dr. Michael Ball on the development of new optimization procedures classified in the general domain of collaborative routing.

Dr. Richard Salter, Professor of Computer Science at Oberlin College, is continuing his visit with Computer Science, UMIACS, and ISR through the end of the calendar year. This fall he is teaching a course in the Computer Science Department.

Postdoctoral appointments

Dr. Shalabh Bhatnagar is continuing his post-doctoral appointment, conducting research on operational methods in semiconductor manufacturing with Steve Marcus, Michael Fu, Jeffrey Herrmann and Gary Rubloff.

Dr. Mark Fleischer began his PDOC appointment on June 15, 1999. He is conduct-

ing research in production planning, scheduling and design optimization with Jeffrey Herrmann and Michael Ball.

Dr. Theodosia Gougousi is continuing her post-doctoral appointment, working with Gary Rubloff on chemical sensing in semiconductor processes.

Dr. Elena Grassi began her appointment with ISR and the Psychology Department on September 7, 1999. She is conducting research on theoretical formulation and simulations of the localization and tracking of sound in mammals and the barn owl with Shihab Shamma and Cynthia Moss (Psychology).

Dr. Dimitrios Hristu began his appointment on August 9, 1999. He is conducting research with P.S. Krishnaprasad on networked intelligent systems, including distributed wireless-interconnected robots, sensors and exploring control with limited communication and possible applications in telerobotics and unmanned vehicles.

Dr. Eric Justh is continuing his postdoctoral appointment with P.S. Krishnaprasad. He is conducting research on pattern formation, smart structures and control applications.

Dr. E. Vincent Patrick is continuing his part-time appointment as his schedule permits through June 2000. He is conducting research with Carlos Berenstein on ocean tomography.

Dr. Radha Poovendran began his appointment on August 16, 1999. He is working with John Baras in security of heterogeneous networks, multicast security, key distribution systems, security of mobile networks, implementation of security mechanisms in networked systems, security in e-commerce and telemedicine distributed systems.

Dr. Jonathan Simon is continuing his appointment, working with Shihab Shamma on signal processing and physiology of the auditory system.

Dr. Hsuan-Jung Su began his appointment on September 13, 1999. He is working with Evaggelos Geraniotis on developing and evaluating new modulation, coding and signal processing techniques for exploiting diversity in wireless SATCOM and terrestrial channels.

Dr. Ram Venkataraman is continuing his appointment, working with P.S. Krishnaprasad in modeling and control of

smart materials, including magnetostrictive materials

Alumni news

ISR Ph.D. **Naomi Leonard**, now a tenured professor in Princeton University's Mechanical and Aerospace Engineering Department, has received one of three "Automatica prize paper awards" for 1999. Leonard was a student of Professor P.S. Krishnaprasad (ECE/ISR).

Staff news

ISR Assistant Director **Amar Vadlamudi** completed two marathons this fall, including the Marine Corps Marathon on Oct. 24, to benefit the Whitman-Walker Clinic in Washington, D.C.

ISR's annual awards ceremony, held May 11, honored four persons: Professor **Steve Marcus** (ECE/ISR), outstanding faculty; **Haitao Zheng**, outstanding graduate student; **Matthew Impett**, outstanding undergraduate student; and **Rebecca Copeland**, outstanding staff member.

Gemstone news

Fifteen junior-year Gemstone students on the Nuclear Waste Disposal research team presented their findings on "Public Policy in Nuclear Waste Disposal" at the 218th meeting of the American Chemical Society in New Orleans, Aug. 22-27. The presentation focused on the controversy involving public perception of the proposed Nuclear Waste Repository at Yucca Mountain, Nev.

The Institute for Systems Research

The Institute for Systems Research is a permanent state-supported institute of the University of Maryland, within the A. James Clark School of Engineering and the Glenn L. Martin School of Technology. ISR has a continuing affiliation as a National Science Foundation Engineering Research Center.

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