Systems Signals

IPDPM project to increase efficiency of wafer fab manufacturing operations

A new project, Operational Methods in Semiconductor Manufacturing: Integrating Product Dynamics and Process Models (IPDPM), is enhancing ISR's substantial state-of-the-art research in this area.

The $1.2 million, three-year project is jointly sponsored by the National Science Foundation's Operations Research and Product Systems Division and the Semiconductor Research Corporation's Factory Sciences Division. Its objective is to develop new operational methods for efficient manufacturing operations throughout the wafer fab life cycle.

Associate Professor Michael Fu (BGMT/ISR) is the project director.

Joining him in the initiative are ISR Director Gary W. Rubloff (MNE/ISR); Professor and former ISR Director Steve Marcus (EE/ISR); and Assistant Professor Jeffrey Herrmann (ME/ISR).

The project includes research in Markov decision processes, optimization, planning and scheduling, discrete event simulation, sensitivity analysis, manufacturing process simulation, response surface models, and other operations research and manufacturing systems topics.

The research is proceeding along two thrusts: integrating product and market dynamics into operational

decision making, and incorporating process models into algorithms that optimize manufacturing operations.

IPDPM
Integrating Product Dynamics and Process Models

The IPDPM project aims to improve wafer fab operations by teaming engineers and managers throughout the wafer fab: those who design and control manufacturing processes, those who manage manufacturing operations, those who design and build wafer fabs, and those who design and introduce new products. This project's results will yield specific insights into the structure of optimal operational policies and into the sensitivity of operational decisions to underlying process parameters. Operational and factory integration personnel can use these insights to suggest and justify changes to operational policies and manufacturing processes.

Web links •
For more information, visit the IPDPM web site at http://www.isr.umd.edu/IPDPM/ or contact Michael Fu at (301) 405-2241, mfu@umd5.umd.edu

What's inside

Northrop Grumman Research Review—Eleven ISR and Electrical Engineering Department faculty members, including Professor P.S. Krishnaprasad (EE/ISR), left, presented reviews of their research to Northrop Grumman representatives on August 6. Projects included modeling and optimization of epitaxial growth; a Windows NT version of CONSOL-MaryLin; COW-Watand enhancement and maintenance; integrated product and process design automation tool for manufacturing microwave modules; input control for job shop manufacturing; sheet metal layout operations; surface mount operations; low temperature cofired ceramic filters for miniature digital receiver application; and hybrid vehicle energy/power control topology and systems design.

ISR
INSTITUTE FOR SYSTEMS RESEARCH

Exploring the facets of ISR's mission

ISR's mission is to develop, demonstrate, and teach methodologies for the solution of complex, heterogeneous, and dynamic problems of engineering technology and systems. Developing and demonstrating these advances are clear goals associated with the ISR research program, with success manifested regularly as profound, well-recognized research accomplishments, increasing funding, and the blossoming of a variety of large, innovative cross-disciplinary programs.

The "teach" portion of the mission is more subtle but equally important. Clearly, it includes the content and quality of ISR's educational programs and the profoundly meaningful education conveyed through graduate, undergraduate, and postdoctoral research experiences. "Teach" also includes the transfer of research knowledge and insight to a variety of recipients, including industrial and governmental professionals as well as our academic colleagues. Effective knowledge and technology transfer require concentrated efforts through various media, from personal contact to the Web, emphasizing and clarifying significance and relevance.

But ISR has another, special responsibility to the university and the larger engineering community. Systems engineering is in several senses complementary to other engineering disciplines; for example, in its emphasis on developing and exploiting structured methodology for analysis and design, or in its concentration on measuring the value of products, processes, or operations at higher levels of integration in an enterprise. In its focus on systems research, ISR researchers regularly assess a broad variety of systems engineering application areas and identify, apply and validate advanced systems methodologies appropriate for these areas and others.

Systems engineering is increasingly the perspective and skill set in demand in industry and government, from manufacturing to defense, transportation to business process re-engineering, or communications to health care. Therefore, teaching systems concepts and techniques must and will remain a high ISR priority, from the rigorous quantitative algorithms, concepts and software which typify state-of-the-art systems research to applying these methods in systems engineering across a broad spectrum of complex cross-disciplinary problems which mix engineering with business, science and social science. ISR is well positioned to contribute profoundly to the systems engineering perspective and ability of students, including undergraduates (*see Gemstone, page 8*), graduate students (e.g., the M.S. in Systems Engineering and its impact on engineering Ph.D.s) and working professionals (e.g., the professional master's degree in systems engineering and short courses). ❧

CATS project explores collaborative software agents

Associate professors V.S. Subrahmanian (CS/ISR) and James Hendler (CS/ISR) have been awarded a $3.2 million research grant by the Army Research Laboratory to study Collaborative Agent Technical Systems (CATS). The project is associated with the University of Maryland Institute for Advanced Computer Studies (UMIACS). Professor Dana Nau (CS/ISR) also is collaborating on the project.

The researchers are developing a formal, tangible definition of agent programming, and will research the software needed to implement this communication system.

Software agents can be used to monitor events and provide an efficient means of communication. But to be successful, they must be interoperable —able to support software interoperation between agents. An agent also should be able to take action on any situation it sees, be able to understand diverse terms and ontologies and efficiently use an available network to communicate with others.

This work will build on successful prototypes in the areas of interoperability, knowledge representation, datamining, and multimedia to provide components that can be used across a wide range of agent applications.

This is a relatively new area of study. ARL hopes the research results will be implemented in the field to monitor events such as weather, enemy activity or other new information at the touch of a button. Not only could users immediately access the data, they also could weed out what is not necessary.

This project is the beginning of a technological and research trade between ARL, other government agencies and the university.

Web links • For more information, visit the CATS web page at http://www.umiacs. umd.edu/research/CATS/. Or contact V.S. Subrahmanian at (301) 405-2711, vs@cs.umd.edu or Jim Hendler at (301) 405-2696, hendler@cs.umd.edu

Robot jousters win big; students and advisors become instant celebrities

After the Maryland event in May, local media interview the Lancelot team that would later take it all in Japan. It was a taste of things to come.

When ISR-affiliated Assistant Professor Greg Walsh (ME) and Julio Rosenblatt (UMIACS) conducted the annual robot jousting competition that culminates the ENME 489 course this past May, little did they realize they'd be media celebrities by the end of the summer.

But that's just what happened when the two advisors accompanied the student team that won—Christopher Cowles, Norman McGlothlin, Solomon Marini, Barzilai Spinak and Francisco Rivas—to Tokyo for the Japanese International Robot Grand Prix in July.

Competing against more than 100 other mostly Japanese robots, the team surprised everyone, including themselves, by winning.

"I'm shocked we won," Walsh told a reporter from *The Washington Post.*

In the joust, autonomous robots traverse a 30-foot white-striped track for 100 seconds, attempting to strike various-sized targets with on-board lances and knock over two cylinders to score points, while following the track with infrared sensors. The robot scoring the highest point total in a single run is the winner.

Parts for the robots were donated by Lockheed Martin, Motorola and Electro Corporation.

The tournament presents students with many engineering design and implementation challenges. Should the robot go for speed or accuracy? What mechanism should be used to poke the targets, and should a different scheme be employed to knock over the cylinders?

"It is essentially the capstone of these students' undergraduate careers," said Walsh. "It is also a rare chance to be directly involved in all elements of a design project."

The team took home prizes that included nearly $2,000 in cash. But the real fun was about to begin.

The initial Maryland joust had been covered by local cable television crews, the *Prince George's County Journal* newspaper and the university. But when the team emerged victorious in Japan, not only did *The Washington Post* cover it, they put them on the front page. Soon the advisors and students found themselves sought after by *Good Morning America*, CNN, Maryland Public Television and almost every major newspaper in the country.

"I was totally floored," Walsh said.

Web links • ISR covered the story from start to finish at http://www.isr.umd.edu/ ISR/archivenews.html#robots • Learn more about the ENME 489 course at http://www.class.umd.edu/enme/489/ • The Washington Post's *coverage is at http://www.washingtonpost.com/wp-srv/ frompost/features/aug97/robot06_1.htm*

Research contributes to computer bridge program win

Research by a Computer Science/ISR professor and a Ph.D. graduate helped a local Maryland product become the world champion contract bridge-playing computer program this July.

A new version of Great Game Products, Inc.'s Bridge Baron won the Baron Barclay World Bridge Computer Challenge, hosted by the American Contract Bridge League. The program featured artificial intelligence planning techniques for declarer play, developed through the joint efforts of Professor Dana Nau (CS/ISR), University of Maryland Ph.D. graduate Stephen Smith, and Tom Throop, head of Bethesda-based Great Game Products, Inc.

The five-day bridge competition pitted five computer programs from the US, Japan, and Germany against each other. Bridge Baron won every head-to-head match it played against the other programs.

The advanced AI planning techniques developed by Nau, Smith and Throop emulate the way in which a human might plan the play of a bridge hand. For declarer play, the program uses a technique called Hierarchical Task-Network (HTN) planning to develop alternative strategies for how to play the game. Then it evaluates these alternative strategies to determine which of them is best.

Great Game Products will start marketing the new version of Bridge Baron sometime this fall.

Web links • More information is available at http://www.cs.umd.edu/~nau/bridge/ bridge.html. Or contact Dana Nau at (301) 405-2684, or nau@cs.umd.edu • Both The New York Times *and* The Washington Post *covered the story of the successful partnership between the University of Maryland and industry. (*The Post's *story is archived online at http://www. washingtonpost.com/wp-srv/WPlate/1997-09/15/026l-091597-idx.html.)*

Professors awarded NSF grant for learning and intelligent systems

Professors P.S. Krishnaprasad (EE/ISR), Steve Marcus (EE/ISR) and Shihab Shamma (EE/ISR), along with Maryland's Catherine Carr (Zoology) and Terry Takahashi (Biology, University of Oregon) have been awarded a $775,000 National Science Foundation grant, one of 28 issued by the NSF as part of its $22.5 million program for research in Learning and Intelligent Systems (LIS).

NSF expects the interdisciplinary studies to help researchers understand how learning occurs in humans, animals and artificial systems. Researchers also will explore how to develop new learning methods that integrate linguistic, behavioral, biological, cognitive and educational approaches with new interactive, collaborative and multisensory technologies.

The goal of the Maryland research project is to investigate time coding in the central nervous system, specifically in the auditory system of the barn owl. The project emphasizes the early

development of such codes, the learning of associated maps, and the exploitation of such sound codes and maps in source localization and sound separation.

The approach consists of electrophysiological and anatomical study, coupled with mathematical modeling of neural circuitry, the rigorous investigation of the structure and performance of relevant learning algorithms and the creation of an experimental robotic testbed.

This testbed, a binaural head, will be designed to itself to sound sources in complex acoustic environments through pure auditory servoing. It will utilize the development of control architectures, which learn maps of the auditory space of the robot, drawing upon an evolving understanding of the barn owl auditory system.

The results of this research will provide insights into the design of novel roles for auditory sensing,

interpretation and discrimination in autonomous robotic systems. This research could lead to applications in hands-free human-machine communications in acoustically cluttered environments and in monitoring complex environments, such as highly automated manufacturing plants.

Information: contact P.S. Krishnaprasad (301) 405-6843, krishna@isr.umd.edu; Steve Marcus (301) 405-7589, marcus@isr.umd.edu; or Shihab Shamma (301) 405-6842, sas@isr.umd.edu

Space Systems Lab telerobot to fly on 1999 shuttle mission

The Ranger Telerobotic Shuttle Experiment (RTSX), developed by the ISR-affiliated Space Systems Laboratory (SSL), has earned a place on a Space Shuttle mission in 1999. SSL is headed by Associate Professor David Akin (AE/ISR).

Ranger TSX is a 4-arm telerobot with one arm permanently grappled to a SpaceLab pallet. The arms perform dexterous manipulation, grappling, and stereo video viewing.

During the shuttle mission, Ranger will service International Space Station Orbit Replaceable Units (ORUs) in the Space Shuttle cargo bay for a total of 36 hours, conducted in blocks of four hours each.

Ranger TSX is an Integrated Product Development effort partnered with the Johnson Space Center's Automation Robotics and Simulation Division (ARSD) with participation from other NASA centers, universities, and industry.

Web link • For more information, visit the Ranger TSX page within the Space Systems Lab site at http://www.ssl.umd.edu/homepage/Projects/RangerTSX/RangerTSX.html

ISR's Research Advisory Council, made up of representatives from constituent industries, met with ISR faculty and staff on June 12. The council reviewed current projects and provided input on ISR's research and education plans in its emerging multi-center environment. The council also discussed ways to pattern ISR partner and advisory structures in the coming years.

Faculty news

Associate Professor Leandros Tassiulas (EE/ISR) has been selected as an Office of Naval Research Young Investigator. The program is designed to attract young scientists and engineers who show promise for doing research and teaching. Tassiulas won the award based on his academic achievements, his ability to contribute to the strength of the nation's research and development, and University of Maryland administrators' commitment to him. He previously won the National Science Foundation's CAREER Award.

Assistant Professor Gregory Walsh (ME) received two awards from the National Science Foundation this spring: Faculty Early Career Development (CAREER) and Grant Opportunities for Academic Liaison with Industry (GOALI). The CAREER Award is given to outstanding junior-level university faculty to emphasize the importance of integrating research and education activities in academic careers. GOALI targets high-risk/high-gain research. Walsh is principal investigator, working with Associate Professor David Bigio of the Mechanical Engineering Department on a $200,000 joint project with DuPont and LDM Technologies to study the control of plasticating extruders.

A software tool developed by **Professor Anthony Ephremides** (EE/ISR) and graduate student Dimitrios Stamatelos was a finalist for Invention of the Year at this year's University of Maryland Office of Technology Liaison awards. The tool helps optimally place a base station in an indoor wireless area. It divides the area into cells served by a number of base stations, ensuring that the communications channels between the mobile terminals in the building and the hardwired backbone network are as close to optimal as possible. The team is extending the tool to outdoor environments; a Massachusetts-based firm is negotiating a license to this invention.

Associate Professor Guangming Zhang (ME/ISR) is the University of Maryland's new Principal Investigator for the National Science Foundation-sponsored ECSEL Coalition. He re-

TRW recruiting—ISR alums Aaron Falk (top right) and Greg Surbeck (bottom left) of the Space and Electronics Group in TRW's Electronics Systems and Technology Division hosted a three-day recruiting session for ISR students in early October.

places Associate Dean Thomas Regan (ChE) in the position.

The ECSEL Coalition aims to better prepare undergraduate engineering students for life-long productive careers, and to significantly increase the number of women and under-represented minority engineering graduates. Projects include integrating design throughout the curriculum and developing new ways to attract and retain students through outreach and transitional programs that reduce the barriers to entering and completing engineering

degree programs for women and minority students.

In addition to Maryland, the seven-school coalition consists of the Massachusetts Institute of Technology, Howard University, Morgan State University, The Pennsylvania State University, the City College of New York and the University of Washington.

The Feasible Sequential Quadratic Programming (FSQP) algorithm, developed and refined over the past

Faculty news

10 years by an Electrical Engineering/ISR research group headed by **Professor André Tits** (EE/ISR), is now used at more than 500 sites in 51 countries worldwide. FSQP is a high-quality optimization software tool. Both versions (CFSQP, written in C, and FFSQP, written in FORTRAN) have been tested and run successfully on most platforms, including Sun SPARCs, DECs, and IBM personal computers. *Web link • For more information, visit the FSQP web site at http://www.isr. umd.edu/Labs/CACSE/FSQP/fsqp.html, or the page outlining its worldwide distribution at http://www.isr. umd.edu/ISR/newsletter/sssu97/fsqp50.html*

Professor Ben Kedem (Math) gave a short course on level crossings this summer to physicists at Uppsala University, Sweden, at an International Summer School on Randomness and Nonlinearity.

New faculty members

Professor Christopher Davis, Associate Dean of the A. James Clark School of Engineering and the Glenn L. Martin Institute of Technology, is now a jointly appointed faculty member with the Electrical Engineering Department and ISR. Davis is the new director of the Gemstone program, succeeding Associate Professor Thomas Fuja (EE/ISR) in this role. He is the director of the Laser Sensor Lab, and his research interests lie in biophysics and dielectric measurements on biomaterials.

Assistant Professor Don DeVoe has been added as a faculty member with a joint appointment in the Mechanical Engineering Department and ISR. His research interests lie in MicroElectroMechanical Systems (MEMS), surface micromachined piezoelectric inertial sensors, ultrasonic sensors and actuators based on thin film ZnO and PZT, and TCAD tools for MEMS visualization and simulation.

Assistant Professor Jerome A. Gansman is a new faculty member with a joint appointment in the Electrical Engineering Department and ISR. His research interests are in digital communications theory, fading channel communications, synchronization of communications systems, multidimensional signal processing and sensor array signal processing.

Professor Paul Schonfeld (CE) was selected as an ISR affiliate faculty member in May. Schonfeld has been working with Professor Michael Ball (BMGT/ISR) and Associate Professor Michael Fu (BMGT/ISR) in the FAA NEXTOR Center for Aviation Operations Research. He has a distinguished record in the systems of transportation and civil systems, most notably in intelligent highway systems, where he is closely tied to the Maryland State Highway Administration.

ISR awards—ISR Director Gary W. Rubloff (l) presented outstanding student, faculty and staff awards at ISR's annual May ceremony. Next to Gary (l-r) are Gemstone coordinator Lois Powers (staff award); Farrokh Rashid-Farrokhi and Craig Lawrence (graduate student awards); and Professor Michael Ball (faculty award).

Visitor

Eiji Atsumi, research engineer at the Information Technology R&D Center of Mitsubishi Electric Corp., Japan, is visiting until August 1998. He is conducting research with Professor Nariman Farvardin (EE/ISR), chairman of the Electrical Engineering Department, on image coding methods which yield good rate-distortion performance and provide coding speed, progressive coding capability, and convenience for subsequent image processing.

Post-Doctoral Appointees

Dr. Jason Anderson began his appointment with the ISR on July 1. He is conducting research with **Professor Thomas McAvoy** (ChE/ISR) on applying neural networks to chemical processes.

Mr. Shalabh Bhatnagar began his appointment with the ISR on October 1. He is working with **Professor Steven Marcus** (EE/ISR), **Associate Professor Michael Fu** (BMGT/ISR), **Assistant Professor Jeffrey Herrmann** (ME/ISR) and **ISR Director Gary Rubloff** (MNE/ISR) on operational methods in semiconductor manufacturing.
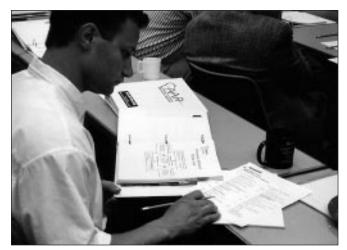
Dr. Michael Hadjitheodosiou is continuing his appointment at the Center for Satellite and Hybrid Communication Networks. He is working with **Professor John Baras** (EE/ISR) on satellite communications networking addressing issues related to Asynchronous Transfer Mode, Broadband ISDN, Multiple Access, Network Performance, Hybrid Personal Communication Networks and VSAT Networks.

Dr. John Kidder continues his appointment with the ISR and Materials and Nuclear Engineering this year. He is conducting research with **ISR Director Gary Rubloff** (MNE/ISR) in electronic materials.

Dr. Jian-Yu Lin is continuing his appointment with ISR and the Psychology Department this year. He is conducting research with **Professor Shihab Shamma** (EE/ISR) on helicopter noise reduction.

Faculty news

CAAR meeting—Representatives from the Navy, six universities, and industry met at ISR this May to formulate strategy for the new Center for Auditory and Acoustic Research, a three-year, $1.2 million DOD MURI consortium. Leading ISR's effort in the center are professors Shihab Shamma, John Baras, P.S. Krishnaprasad and Steven Marcus.

Dr. George Mykoniatis has been appointed to the Center for Satellite and Hybrid Communications Networks. He is working with **Professors John Baras** (EE/ISR), **Michael Ball** (BMGT/ISR), **Nicholas Roussopoulos** (CS) and **Assistant Research Scientist M. Scott Corson** on network management and network modeling and simulation projects.

Dr. E. Vincent Patrick is continuing his part-time appointment with the ISR through June 1998. He is currently conducting research with **Professor Carlos Berenstein** (Math/ISR) on ocean tomography for a joint project with the University of Alaska.

Dr. Julio Rosenblatt is continuing his appointment with ISR and UMIACS. He is working on the development of mobile robotics applications, interfaces for robotics projects, and the pursuit of joint research between the Autonomous Mobile Robotics Lab and the Space Systems Lab with **Associate Professor Jim Hendler** (CS/ISR).

Dr. Jonathan Simon is continuing his appointment with the ISR, working with **Professor Shihab Shamma** (EE/ISR) on signal processing and physiology of the auditory system.

Alumni

Naomi Leonard, who recently obtained her Ph.D. here under **Professor P.S. Krishnaprasad's** (EE/ISR) supervision, will be giving a plenary address at the Nonlinear Control Systems Design Symposium in Enschede, Netherlands in July 1998.

Staff

Susan Frazier, ISR's assistant director for education and personnel, received a University of Maryland 1997 President's Distinguished Service Award in recognition of the many contributions she has made to the university during her career.

NSF: employers rate ERC grads highly

More than 89 percent of employers who hired recent graduates of Engineering Research Centers (ERCs), including ISR, rate those graduates as better prepared than their peers for their jobs after graduate school, according to a recent National Science Foundation (NSF) survey.
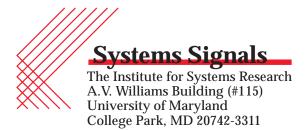
NSF surveyed ERC graduates' supervisors and industry representatives whose firms had hired ERC graduates in the past two to five years. The employers were asked to rate those graduates' performance relative to peers without ERC experience.

Those surveyed consider ERC graduates to be superior to employees without ERC experience in capabilities ranging from working in interdisciplinary teams to applying knowledge and using technology from various sources.

Web link • For more information, see NSF's news story on the survey at http://www.eng.nsf.gov/news/GraduatesERC.htm

FAA NEXTOR Center—The University of Maryland hosted meetings of the Federal Aviation Administration's new NEXTOR center in May and October. NEXTOR is the Center of Excellence in Aviation Operations Research. ISR joint faculty members Michael Ball (BGMT/ISR), Michael Fu (BGMT/ISR), ISR affiliated faculty member Paul Schonfeld (CE) and Larry Bodin (BGMT) are part of the University of Maryland team.

Gemstone students choose long-term projects

In May, the inaugural class of more than 100 Gemstone students chose the team projects they will investigate for the remainder of their undergraduate careers. These long-term projects are a key element of the acclaimed interdisciplinary honors program.

Each of the student teams contain eight to 16 undergraduates from a mix of majors: Engineering and other sciences, business and management, behavioral and social sciences, and the humanities.

The students chose eight different projects: flexible factories; the social and individual impact of computer use; privacy, security and information warfare, genetic testing; the impact of information technology on medicine; commercial space flight in the inner solar system; next generation mass transit; and restoration of the Chesapeake Bay.

The teams will meet regularly to investigate and analyze the assigned problem. Engineering and science majors will investigate both theoretical and experimental technological solutions. Humanities, behavioral science and social science students will address the history and societal impact of the problem. Business and management majors will concentrate on finance and marketing issues.

By the end of the senior year, each team will produce a book-length thesis containing results from the background, analysis, design, testing and implementation studies. They will also include 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.

As it enters its second year, the Gemstone program is expanding and already has been termed a great success. Approximately 165 freshmen entered the program this fall.

Web link • For more information, visit the Gemstone web site at http://www.isr. umd.edu/gemstone/ or contact Lois Powers, the Gemstone administrator, at (301) 405–6564, powers@isr.umd.edu

In May, Gemstone students researched bridges in the Washington, D.C. area, and presented their findings to several groups, including this local fourth grade class.

ISR web site enhancements

ISR's home page now carries breaking news. It's easier to browse research projects. We've put every technical report abstract and the full text of many reports online. Our faculty pointer page locates home pages, e-mail, and research interests. We've also enhanced the search capabilities of our student resume page. *VISIT US OFTEN!*

http://www.isr.umd.edu