The Institute for Systems Research

2015 Review Report

INSTITUTE FOR
SYSTEMS RESEARCH
A. JAMES CLARK SCHOOL OF ENGINEERING

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Executive Summary

This report details the current status of the Institute for Systems Research (ISR) at the University of Maryland (UMD).

ISR is a permanent unit within the A. James Clark School of Engineering, with a mission of promoting and facilitating interdisciplinary research in systems science and engineering. Traditional research foci of ISR involve communication, computation and control.

As of the writing of this report, ISR oversees more than 25 different externally funded interdisciplinary research projects.

ISR was founded in 1985 as one of the first cohort of Engineering Research Centers funded by the National Science Foundation. Current funding sources include the State of Maryland, through the Clark School; industrial grants and gifts; and federal research projects.

The Institute has several graduate and undergraduate efforts, including the Masters in Science in Systems Engineering; the Professional Masters in Systems Engineering (offered in conjunction with the UMD Office of Advanced Engineering Education); and engineering capstone courses for undergraduate engineering students. A cross-cutting minor in Systems Engineering is being developed for undergraduate engineers.

Several research centers have been incubated within ISR, including the Maryland Robotics Center; the Center for Advanced Life Cycle Engineering; the Federal Aviation Administration Center of Excellence in Aviation Operations Research; and the Maryland NanoCenter.

The Institute's outreach efforts include an industrial affiliates program and a number of collaboration agreements with international universities and research institutes.

In addition to summarizing the status of ISR, this report also contains several recommendations for further enhancing the Institute's profile and operation.

A. Introduction

A.1. Background of the self-study

The University of Maryland Policy on the Review of Academic Units (*www.president.umd.edu/policies/i600a.html*) states that "Periodic review of an academic unit's pursuit of excellence can contribute significantly to the enhancement of the unit's progress and respond to the University's responsibility for efficient use of resources." It mandates that every academic unit on campus undergo a review at no more than seven-year intervals. The primary goal of the review is to improve the unit's effectiveness and quality. Each dean is responsible for initiating such reviews and for reporting to the Provost on the results.

The review process consists of "an internal self-study including the accumulation of relevant data, external review of the unit, and proper utilization of the results of the review." This ISR internal self-study was produced by a committee chaired by Professor Steve Marcus. Members of the committee included Professors Michael Ball and Rance Cleaveland; Rebecca Copeland, director of public relations and information management; and Timir Datta, graduate student.

The committee received its charge from Associate Dean Peter Kofinas on Sept. 5, 2014 and immediately began its work. During 2015 the committee met weekly, and completed its work at the end of the summer of 2015.

A.2. Overview

The Institute for Systems Research (ISR) is a unit within the Clark School of Engineering at the University of Maryland. As of July 2015, the institute comprises 37 joint appointment faculty, 26 affiliate faculty, and five research faculty from four colleges and 14 units across the university. Within the A. James Clark School of Engineering, these include: Aerospace Engineering, Chemical and Biomolecular Engineering, Civil and Environmental Engineering, Electrical and Computer Engineering, the Fischell Department of Bioengineering, Materials Science and Engineering and Mechanical Engineering.

Within the College of Behavioral and Social Sciences, ISR has faculty in the Neuroscience and Cognitive Science Program. In the College of Computer, Mathematical and Natural Sciences, ISR has faculty in Biology, Computer Science, UMIACS (University of Maryland Institute for Advanced Computer Studies) and Mathematics.

Within the Robert H. Smith School of Business, our faculty are part of Decision, Operations and Information Technologies; and Logistics, Business and Public Policy.

ISR research currently encompasses eight major areas:

- Communication systems and networks
- Control systems and methodologies
- Neuroscience and biology-based technology
- Micro and nano devices and systems
- Robotics
- Design, operations and supply chain management
- Systems engineering methodologies
- Computing, speech, artificial intelligence

ISR faculty currently advise approximately 200 Ph.D. students. In addition, ISR serves some 35 M.S. Systems Engineering students, 70 M.S. students, and 25 Professional Masters in Engineering–Systems Engineering students.

ISR has 15 administrative staff. The institute's annual research expenditures totaled $20 million in 2014.

The institute began in 1985 as one of the six original NSF Engineering Research Centers (it was named the Systems

Research Center, or SRC, at the time). ISR received funding from NSF from 1985 through 1998, including funding in a re-competition, and has been a fully self-sustaining graduated ERC since that time. Permanent base budget funding from the state of Maryland of around $3 million per year was awarded in 1989, and in 1992 the SRC was renamed the Institute for Systems Research and became a permanent institute in the Clark School.

Evidence of the high quality and the interdisciplinary nature of the institute includes the many honors and awards gained by the faculty (*Appendices 4–9*), the publications and patents of the faculty (*Appendices 10–11*), the many collaborative projects and publications involving faculty from more than one department (*Table 5*), and ISR alumni who have gone on to academic positions (*Appendix 20*).

Over the years, ISR leaders have consulted about the institute's structural model with academic and research entities around the world. The ISR model was emulated in the formation of the following programs, centers and institutes:

- The ACCESS Center in the Royal Institute of Technology (KTH), Sweden
- ELLIT-Excellence Center at Linköping-Lund in Information Technology, Sweden
- Linköping University—Control, Autonomy, and Decision-making in Complex Systems, CADICS—Linnaeus Center, Sweden
- Lund University—LCCC—Lund Center for Control of Complex Engineering Systems – Linnaeus Center, Sweden
- Computer and Automation Research Institute (CARI), Hungarian Academy of Sciences, Hungary
- Research School of Information Sciences and Engineering, Australian National University, Australia
- The Division of Systems Engineering across departments at the Massachusetts Institute of Technology (with joint appointments for the first time in the history of MIT) in 1999.

In addition, ISR has been used as a model for institutes within the University of Maryland. The latest example is the Institute for Bioscience and Biotechnology Research (IBBR). When the University of Maryland Biotechnology Institute in Baltimore was dissolved and the researchers came to the University of Maryland's College Park campus, Provost Nariman Farvardin recommended forming an institute like ISR, which led to talks with ISR leadership and the IBBR being organized along the lines of ISR.

A.3 Most recent review (NSF 25th Anniversary site visit, 2010)

While it was not an official University of Maryland review, ISR was reviewed by a team of outside experts in November 2010. This review was initiated by the National Science Foundation on the occasion of the 25th anniversary of ISR's founding. A list of the members of the review team can be found in *Appendix 26*. Here is a summary of the review's conclusions, and the current status of several of its recommendations.

Strengths

- "The core mission of ISR—closing the gap between systems science and systems engineering—will remain a hugely important, high value domain of fundamental research for decades to come."
- "ISR can be very proud of its large collection of excellent faculty who pursue high impact, well sponsored research."
- "ISR has achieved a sustained, highly interdisciplinary research culture that features strong collaboration between very diverse academic communities in a patient, welcoming, inclusive atmosphere."
- "ISR has gathered together an impressively large number of industrial partnerships at a variety of levels in areas of direct relevance to their missions."

Weaknesses

- "The penetration of systems science into systems engineering as practiced in the larger community and even within ISR itself remains limited." *This is still an issue.*
- "Opportunities for undergraduate involvement seem limited." *There has been significant progress. In particular, ISR has been offering a very successful capstone design course that is taken by students from a number of engineering departments (see Section C.3).*

Opportunities

- "A gap remains between the discoveries (made both within ISR and beyond) of systems science and the practices of systems engineering. If it can balance the imperatives of specific projects and the broader intellectual problem domain, ISR has the opportunity to cement its present position of leadership to create the best-in-class systems engineering program." *This is still an opportunity.*
- "ISR has many future opportunities to stimulate the creation of new companies and even new industries." *This is still an opportunity.*
- "ISR has the opportunity to establish even greater diversity." *There have been significant efforts in this direction. For example, the current ISR Director led a large interdisciplinary team from a number of universities that submitted a proposal for an NSF Engineering Research Center on "Engineering Systems for Mental Health." He has also led the effort to create a new Brain and Behavior Initiative on campus. This effort includes faculty from most of the colleges on campus.*
- "There seems to be a great opportunity to increase the revenue from dues-paying industry members." *This is still an opportunity.*

Threats to continued self-sufficiency and impact

- "There is friction between ISR and other academic units." *Over the past five years, the current ISR Director has been proactive in building relationships with other academic units. In addition, ISR has initiated and worked closely with*

engineering departments to recruit new faculty with joint appointments between ISR and departments.

- The necessary project- and disciplinary-specific focus of new ISR Centers might blunt its core mission." *The core ISR basic research in systems is continuing strongly with funding from a large number of individual research grants from agencies such as the National Science Foundation.*

Additional detailed comments from the review team's report include:

"By any reckoning, the past scientific achievements of ISR have been impressive. ISR has also been quite successful in attracting, over the years, a stellar collection of researchers. The reports, both oral and written, conveyed a wonderful set of achievements by a highly diversified group of professors and students. Among the papers cited in these presentations are a large number of very high quality and influential publications by excellent researchers at the very top of their fields. While it is theoretically possible that the same or similar set of individuals would have joined the University of Maryland even in the absence of ISR, it is beyond dispute that the existence and continued growth of ISR greatly enhanced the University of Maryland's ability to attract and retain such talent."

"Intellectually, we believe the policy of giving three-year appointments to ISR, with roughly a 20 percent turnover rate of those under review, ensures that the faculty complement of ISR remains contemporary and forward-looking. The practice of encouraging multi-investigator research projects, especially those involving multiple disciplines, and locating graduate students in physical proximity, has clearly fostered an intellectually vibrant atmosphere. Some of the original 1985 "class" of NSF ERCs did not survive even the initial mid-term review! Against that backdrop, the mere fact that ISR has managed to retain its identity and to reinvent itself as technology evolved is striking."

"The site visit committee was impressed by the significant industrial impacts and sponsorships cited in the report."

"The faculty and programs of ISR have very high stature. Members and alumni are world-renowned leaders in control, signal processing, communication, MEMS, neuroscience, networking, operations research, and manufacturing.…The faculty is first-class: creative, original, brilliant with a proven record of research."

"ISR has been remarkably successful in maintaining and enhancing industry collaborations after the NSF ERC funding."

A.4 Financial overview

ISR receives income from a number of sources to fund its operations. Base budget funding comes from 1) the State of Maryland; 2) Designated Research Initiative Funds (DRIF) associated with a return of part of the indirect costs generated on research funding; 3) the Engineering Professional Masters (ENPM) program; 4) the Strategic and Associate Partners Programs; and 5) additional short-term commitments from other units at the university. *Table 1* is a breakout of ISR's planned income and expenditures for FY2015.

The largest expenditure by far is faculty salaries, which make up more than 66 percent of all expenditures and 79.25 percent of the state budget. As can be seen in *Table 1*, the state budget is the largest source of income and covers 83.5 percent of income (not including research income).

As the table illustrates, ISR balances its budget from a variety of sources. Two important sources are faculty full-year sabbaticals and DRIF. When a faculty member takes a full-year sabbatical, ISR saves 50 percent of the nine-month state salary. Even though the amount varies annually, these significant savings help balance the budget. Unlike an

ISR 2015 Functional Budget	**FY15 Income**	**FY15 Obligation**	**Balance**
State Budget - Faculty Salaries	$ 2,518,666	$ 2,518,666	$ 0
State Budget - Staff Salaries	$ 700,313	$ 960,674	$ (260,361)
State Budget - Grad Asst Salaries	$ 23,067	$ 0	$ 23,067
State Budget - Labor & Assistants	$ 10,000	$ 111,790	$ (101,790)
Turnover Expectancy	$ (86,145)	$ 0	$ (86,145)
Total Salaries	**$ 3,165,901**	**$ 3,591,130**	**$ (425,229)**
Operational Costs	$ 12,226	$ 206,250	$ (194,024)
Total Budget	**$ 3,178,127**	**$ 3,797,380**	**$ (619,253)**
Other Sources of Income			
Soft Money Support (Provost, Dean, VPR & Etc.)	$ 222,166		$ 222,166
Sabbaticals	$ 92,401		$ 92,401
Other Income (Foundation & Philanthropic)	$ 90,000		$ 90,000
Budget Cut	$ (43,646)		$ (43,646)
DRIF	$ 172,185		$ 172,185
ENPM - Professional Masters	$ 95,000		$ 95,000
Total	**$ 3,806,233**	**$ 3,797,380**	**$ 8,853**

Table 1: ISR 2015 Functional Budget

academic unit, ISR has no teaching requirements and thus cannot reap the benefits of allowing faculty to "buy out" of teaching courses.

Additionally, ISR sees an average DRIF return of $350K. Fifty percent of this DRIF is returned directly to the faculty for use as discretionary funds, but the remainder helps ISR balance its budget. In tight budget times, the 50 percent has been reduced to ensure ISR can balance its budget.

Another large piece of balancing ISR's budget involves philanthropic funding. ISR has multiple programs and abilities for individuals and companies to partner with it. The details of these initiatives are outlined in Section E of this report.

Notes on ISR's state budget

The data in *Table 2* show how the ISR state budget has fluctuated over the past 12 years, and in FY 2015 is at approximately the same level as it was in FY 2003. Note the following:

- During this time period, research expenditures managed in ISR rose more than 50 percent.
- During the great recession, ISR's state budget funding fell from $3.4M in 2009 to $2.9M in 2011, a loss of more than six percent. A similar budget reduction period occurred from 2003 to 2005, when the state budget fell from $3.2M to $2.9M.
- In both these periods, ISR managed its budget cuts by laying off staff, cutting operation costs and increasing reliance on "soft money" income.
- Faculty salaries—the largest portion of the ISR state budget—were not affected during the periods of budget reduction. As a result, (see *Figure 1)* between 2003 and 2015 faculty salaries as a percentage of the budget increased by almost 20 percent. This category now comprises more than 75 percent of the budget.
- While ISR's state budget has increased since 2011, this is a result of new joint faculty hires, not restorations to staff or operations.

ISR State Budgets 2003–Present

Year	ISR State Budget
FY03	$ 3,202,333
FY04	$ 3,039,569
FY05	$ 2,928,473
FY06	$ 3,058,616
FY07	$ 3,221,604
FY08	$ 3,349,599
FY09	$ 3,435,157
FY10	$ 3,186,258
FY11	$ 2,901,164
FY12	$ 2,910,164
FY13	$ 2,938,999
FY14	$ 3,038,598
FY15	$ 3,178,127

Table 2: ISR State Budgets 2003–present

The larger picture beyond the 2003–2015 period mirrors the increased research funding/decreased administrative support trends reported here. The scope and magnitude of ISR's overall research program have grown fairly steadily since the institute's 1996 graduation from the NSF ERC program. In 1996, funding was $10 million; in 2015, it is $20 million. In 1996, ISR had 34 staff positions. There are 15 ISR staff today.

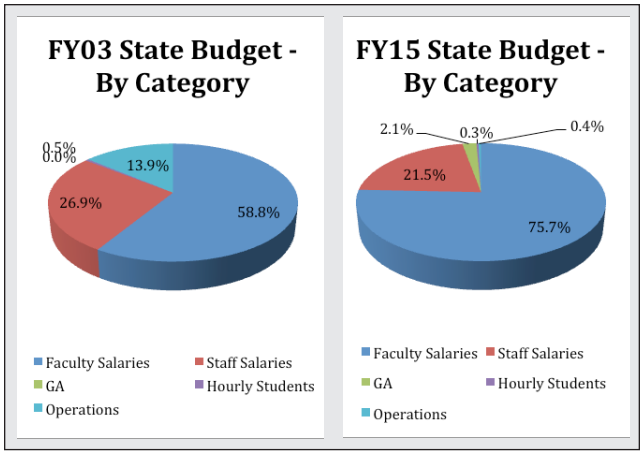


Figure 1: ISR Faculty Salary, as a Fraction of the State Budget, 2003 Compared with 2015

Over the years, ISR has responded to staff and operations cuts in a variety of ways (see the discussion in *Section A.5)* in an attempt to maintain the administrative support to which its faculty has become accustomed. This has posed significant challenges.

A.5 Administration

Organization and charge

ISR includes the director, administrative and technical staff, joint, research and affiliate faculty, and elected faculty committees. The ISR Director is responsible for the overall operation of ISR, including most day-to-day decisions and supervision of the administrative and technical staff.

The director receives input from the faculty through the elected Executive Committee, which serves as the director's sounding board. Many ISR functions are overseen by elected committees that make recommendations to the director. Key committees include: Executive, Educational Program, Facilities and Services, and Salary.

Staff units within ISR include finance and administration, led by Jason Strahan; external relations, led by Jeff Coriale; public relations and information management, led by Rebecca Copeland; computing, led by Jeff McKinney; and the MSSE program, led by John MacCarthy.

ISR staff work behind the scenes in administrative, financial, educational, technical, outreach and public relations support to enable the Institute to fulfill and advance its mission and vision, and make its faculty's research possible. They have done so through financial lean times as well as in seasons of relative plenty.

Administrative history

When it was an NSF ERC, ISR's structure called for a full complement of administrative and technical staff that helped the institute support its faculty and accomplish its mandate. After the NSF funding ceased, the institute (a permanent part of the university since 1991), like the rest of the uni-

versity, was subject to the fluctuations of the state economy in periods of turbulence. The state's economic uncertainties often lead to problems with the state budget, and higher education support is a frequent target for cutbacks. Staffing lines throughout the university are frequently lost as a result.

By 2009, ISR was operating with a staff roster less than one-half the size of that established during the NSF years. Most of those lost were technical and mid- and lower-salaried support staff, who had served in positions that kept things running behind the scenes, enabling other staff to address more specialized and visible tasks. Their loss opened holes in ISR's infrastructure that were filled in part by assigning additional tasks to remaining staff. Perhaps the most significant long-term effect has been that staff now spend the majority of their time on foundational and immediate tasks that keep ISR operating on a daily basis. Far less time is available for tasks that are more strategic or require extended planning. ISR's most time-sensitive and critical tasks do get completed. But staff are aware of other beneficial projects they are unable to accomplish.

Examples:

- During the NSF-funded years, five core constituent labs (the Neural Systems Lab, Intelligent Systems Lab, Systems Engineering and Integration Lab, Computer Integrated Manufacturing Lab and Communications and Signal Processing Lab) in ISR each had an ISR/NSF-funded lab manager. These positions continued to be fully funded by ISR after the end of NSF funding through at least 1998, but gradually were defunded in ensuing years. By 2005, four of these labs still received partial support for lab managers; however at this time the funding was used to help support graduate student managers rather than staff. All ISR funding for lab managers ceased in 2006 due to budgetary concerns, and ISR had no technical staff for the next eight years. This changed in 2014 when a general facilities manager was hired using soft money.

- Two staff were lost who had responsibilities for keeping current ISR's database of students, alumni, academic, government and industrial contacts. In the years since, it has been difficult to maintain and add to the database.

To be sure, ISR's circumstances are not all that different from that of staff in many other units at the University of Maryland and in other public higher-education institutions across the country. The long-term situation of having fewer state budget-line staff to accomplish more tasks, coupled with the increased use of student workers, soft money positions and specialized outside contractors appears to be the new normal.

Soft money solutions

Several additions to ISR staff have been funded via soft money starting in the early 2000s. In the time since the recent recession, the Institute has been grateful for the university's recognition of the importance of its research initiatives and strategy for the future. The current ISR Director received start-up funds from the Clark School of Engineering as well as soft money on several occasions for new initiatives and systems engineering education. ISR also has been the recipient of soft money funds from the university's Division of Research, the Office of the Provost and other academic units on campus. Some of this funding has been used to restore staff functionality lost over the years. One example is the position of a staff educational program director. Other funding was used for a staff facilities manager to manage ISR labs and offices, a part-time staff administrator for the growing Maryland Robotics Center, and an administrative staff person for the NEXTOR II project.

A.6 Facilities

ISR occupies space in the A.V. Williams Building and the adjacent Engineering Annex Building. ISR joint-appointment faculty have offices in several different building across campus.

Below is a full list of ISR faculty centers and labs:

Centers

Federal Aviation Administration Center of Excellence in Aviation Operations Research (NEXTOR II)

Maryland Robotics Center

Laboratories

Advanced Manufacturing Lab

Autonomy Robotics Cognition Lab

Collective Dynamics and Control Lab

Computational Sensorimotor Systems Lab

Control of Miniaturized Systems for Mechatronic, Biological, and Clinical Applications Laboratory

CPS & Cooperative Autonomy Lab

Simulation-Based System Design Laboratory (formerly the Computer Integrated Manufacturing Laboratory)

Integrated Biomorphic Information Systems Laboratory

Intelligent Servosystems Lab

Laboratory for Advanced Materials Processing

Laboratory for Microtechnologies

Maryland Embedded Systems and Hardware Security (MeshSec) Lab

MEMS Sensors and Actuators Lab

Micro Robotics Lab

Neural Systems Lab

Power Electronics, Energy Harvesting and Renewable Energies Laboratory

Robotics Realization Lab

Speech Communication Lab

Systems Engineering and Integration Lab

Wireless Sensor Laboratory

A.7 Recommendations

Recommendations can be found at the end of the major sections of this report (cf. Sections B.5, C.4, E.5). In this section, we highlight three of these recommendations in research and education.

1. **(cf. Section B.5) ISR should develop ongoing programs for seeding early-stage interdisciplinary projects.**

   ISR has supported several ad-hoc mechanisms in the past for initiating new interdisciplinary research efforts. These should be regularized and continued as a means of ensuring ISR's continued commitment to this key part of its, the Clark School's, and the university's mission.

2. **(cf. Section C.5) ISR should study and decide the future of the Master of Science in Systems Engineering program.**

   ISR should study and decide the future of the Master of Science in Systems Engineering program. A review should broadly involve ISR faculty and should address the structural issues, which have been identified over the years and are discussed in Section C.5. If the MSSE program is to be sustainable, it must have strong faculty support and secure financial support for the position of director of the program.

3. **ISR should develop mechanisms for the ongoing review and discussion of strategic planning.**

   In Fall 2015, through the extensive efforts of its Strategic Planning Committee, ISR developed a Five Year Strategic Research Plan. This is an important living document that charts strategic research directions for ISR for the next five years. We encourage ISR to establish a mechanism for periodic review and modification of strategic research and education objectives.

B. Research

As its name indicates, the Institute for Systems Research focuses on scholarly research in the area of systems. This section provides more detail about the research program of the institute and how it is carried out. It also reviews some of the noteworthy achievements of ISR-based researchers.

B.1 Research mission and philosophy

A key mission of ISR is to promote and facilitate research in systems science and engineering. While the specific definitions of the terms "system science" and "system engineering" are open to debate, within ISR the former is taken to refer to a collection of mathematically-inspired frameworks and methods for analyzing models of system behavior. Topics such as optimization, simulation, feedback control, and operations research fall naturally within this umbrella.

The term "systems engineering" covers issues related to the principled design and development of systems intended to carry out a specific purpose; traditional engineering concerns such as resource allocation, cost/benefit tradeoffs, system interfaces and operating constraints are related to this subject.

Since its founding, ISR has focused in particular on the scientific and engineering challenges associated with designing and analyzing systems in which communications, computation and control feature prominently. *Figure 2* summarizes the relationship among the major research themes in systems science, and also the relationship between the scientific and engineering themes within ISR.

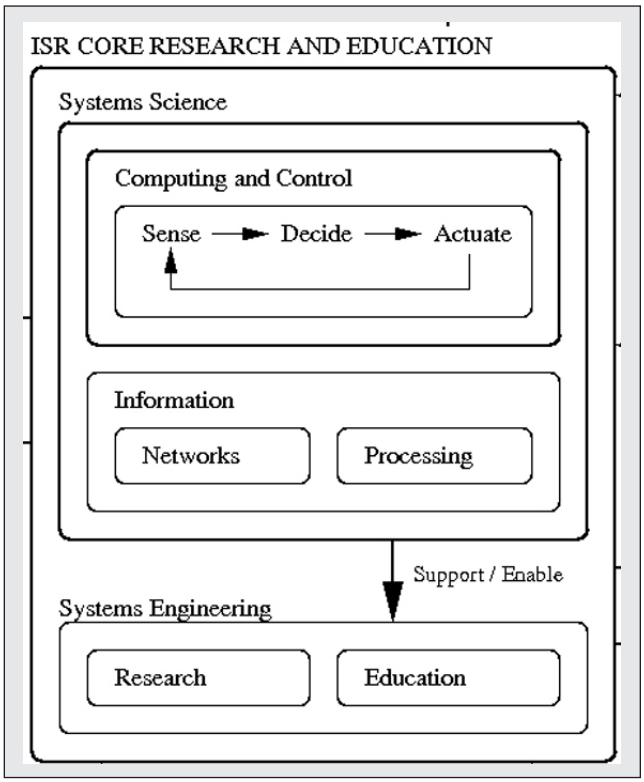


Figure 2. ISR Research Framework (from 25th Anniversary Report)

In comparison to more established disciplines such as mathematics or electrical engineering, systems engineering and systems science are relatively immature. ISR has had, and should continue to have, an important role to play in laying the foundations for these subjects. In this regard, the Institute's focus on technical, as opposed to, for example, managerial, systems helps differentiate it from other systems-engineering institutes and departments.

ISR also is charged with promoting interdisciplinary research. This focus is essential for a systems research organization, since modern systems include a heterogeneous array of components and systems, which may be mechanical, electrical/electronic, biological, software, etc., and which may be co-located or spread over significant distances from one another. ISR is intended to be a cross-cutting organization, with members from different departments given explicit appointments, and with separate, department-style infrastructure for research-proposal processing, grant management, and colloquia series. It also has research centers, such as the Maryland Robotics Center, that it helped found and for which it provides administrative and technical support.

B.2. Research teaming model

ISR's research model is intended to advance its mission as an interdisciplinary institute focused on promoting and facilitating systems science and engineering. Since its inception, and particularly after its graduation from the NSF Engineering Research Center program, ISR has used diverse means for supporting and catalyzing research efforts.

Although not explicitly stated, ISR's research model revolves around group collaborations devoted to specific research topics. At the earliest stages, small groups of two to three ISR faculty undertake such collaborations, typically by submitting joint grant proposals to external research-funding agencies such as the National Science Foundation or the Air Force Office of Scientific Research. To stimulate such early-state collaborations, ISR has in the past made small seed-funding grants available via an internal competition.

As these collaborations mature and expand around a particular topic, larger groups of five to 10 faculty, sometimes with collaborators at other institutions, may submit larger, longer-term project proposals to external funding agencies such as DARPA, or to special programs at the National Science Foundation such as the Engineering Research Centers program or Expeditions in Computing.

ISR supports these activities by providing monetary support to develop initiatives in targeted areas, such as green communications, that can be the basis for such proposals; by acting as a clearinghouse on campus for researchers interested in identifying collaborators with whom to work on these larger-scale projects; and by serving as an informational resource for other sources of on-campus support (such as the Vice President for Research's office) for the pursuit of larger funding opportunities.

For topics attracting significant interest, and with the potential for generating longer-term revenue streams, ISR also serves as an incubator for research centers; the founding of the Maryland Robotics Center is a recent example of this phenomenon. Specific assistance provided by the Institute for the founding of centers includes administrative and business office support; advice on possible on-campus collaborators, office space and other resources; guidance on potential funding and partnering opportunities; and help with publicity and public relations.

Some centers, such as the Maryland NanoCenter, maintain strong ongoing connections with ISR; others, such as the Center for Advanced Life-Cycle Engineering, "graduate" and become free-standing. *Table 3* lists the centers currently affiliated with ISR and the year they were founded.

Centers Affiliated with ISR, 2015

Center	Year Founded
Federal Aviation Administration Center of Excellence in Aviation Operations Research (NEXTOR and NEXTOR II)	1996, 2011
Maryland Robotics Center	2010

Table 3: Centers Affiliated with ISR, 2015

Another aspect of ISR's research model involves providing opportunities for researchers to meet and interact, so that relationships that might lead to future research collaborations can be developed and nurtured.

Such efforts include social events such as the regular "System Breaks" and the annual welcome-back receptions. Other initiatives include eight themed speaker series for which ISR provides funding and support:

- Advanced Networks Colloquia
- Brain-Based System Seminar Series
- ISR Distinguished Lecturer Series
- Intelligent Automation, Inc. Colloquia Series★ (showcase of ISR faculty research)
- Lockheed Martin Maryland Robotics Center Seminar Series★
- Microsystems Seminar Series
- Model-Based Systems Engineering Colloquia
- UTRC Control and Dynamical Systems Invited Lecture Series★

★*These series currently are underwritten by ISR's partner companies; ISR actively seeks sponsorship for all its series.*

A listing of seminar series and speakers from 2002 through Spring 2015 is included in *Appendix 23*.

Faculty-wide meetings, including twice-yearly faculty assemblies and periodic retreats, serve twin purposes of information sharing and facilitating ad-hoc faculty interactions during breaks and meals.

Finally, as noted elsewhere in this document, ISR includes mechanisms for shared governance in the form of various faculty committees. These also provide opportunities for faculty to meet and interact, with research collaborations potentially emerging as a result.

ISR recently drafted a five-year strategic research plan. The process was led by a Strategic Planning Committee, with significant input from the faculty.

B.3 Research by the numbers

Tables 4 and *5* give a quantitative view of ISR research activity in the recent past. Table 4 shows the cumulative external research funding of ISR joint-appointment faculty in the years 2010-14. This figure may be seen as roughly stable in this time frame; the uptick in 2011 and downtick in 2014 may be attributed to changes in the composition of the faculty.

Table 5 is intended to give a sense of the interdisciplinary research output of ISR joint-appointment faculty since 2000. The numbers reflect, for each year, publications involving ISR faculty from more than one department. The steady growth in this figure may be seen as an indication of the emphasis ISR places on the interdisciplinary component of its mission.

External Research Funding, FY2010–2014

FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
$12,939,272	$15,280,753	$16,642,711	$16,865,967	$14,499,677

Table 4: External Research Funding FY2010–2014, ISR Joint Appointment Faculty

Publications by ISR Joint Faculty with a Faculty Member from Another Department, 2000–2015

2000	2001	2002	2003	2004	2005
3	6	3	8	7	16
2006	**2007**	**2008**	**2009**	**2010**	**2011**
7	14	13	15	17	17
2012	**2013**	**2014**	**2015**		
24	24	22	13 (partial year)		

Table 5: Publications by ISR Joint Faculty with a Faculty Member from Another Department, 2000–2015

B.4 A sampling of collaborative research efforts involving ISR joint appointment faculty

This section gives the titles, ISR joint appointment faculty involved and funding agencies of externally funded collaborative research efforts currently underway within ISR. The research awards are from 2009–2015 and involve faculty from two or more University of Maryland departments and/or within the University System of Maryland.

This same information, including abstracts of the research projects, is found in *Appendix 14*.

Note that this list does not include a number of projects where the collaborator is from a different field but outside the University System of Maryland. It also does not include numerous projects undertaken with ISR alumni who are now working in other academic settings.

2015

Air Force Center of Excellence on Nature-Inspired Flight Technologies and Ideas (NIFTI)

Faculty: Pamela Abshire (ECE/ISR); Cynthia Moss (JHU); Sarah Bergbreiter (ME/ISR); Timothy Horiuchi (ECE/ISR); Nuno Martins (ECE/ISR); Susanne Sterbing-D'Angelo (ISR); Miao Yu (ME)

Funding Agency: Air Force Office of Scientific Research

Development of an Implantable Device to Determine Cancer Cell Response to Chemotherapy in Real Time

Faculty: Elisabeth Smela (ME/ISR); Pamela Abshire (ECE/ISR); John Basil (UM Dental School)

Funding Agency: UMD-UMB 2015 Research and Innovation Seed Grant

Simulation-Based and Risk-Sensitive Methodologies for Stochastic Optimization and Control

Faculty: Steve Marcus (ECE/ISR), Michael Fu (BMGT/ISR)

Funding Agency: Air Force Office of Scientific Research

2014

Temporal Auditory Coding in Schizophrenia and Treatment-Resistant Auditory Hallucination

Faculty: Jonathan Simon (ECE/BIOLOGY/ISR), L. Elliot Hong (Psychiatry, UM School of Medicine)

Funding Agency: UMD Division of Research, Research and Innovation Seed Grant

Magnetic Delivery of Therapeutic Nanoparticles to the Dental Pulp

Faculty: Didier Depireux (ISR); Radi Masri (UM School of Dentistry)

Funding Agency: NIH National Institute of Dental and Craniofacial Research

Designing semi-autonomous networks of miniature robots for inspection of bridges and other large infrastructures

Faculty: Nuno Martins (ECE/ISR); Sarah Bergbreiter (ME/ISR); Richard La (ECE/ISR)

Funding Agency: National Science Foundation

Compositional Modeling of Cyber-Physical Systems

Faculty: Rance Cleaveland (CS/ISR); Steve Marcus (ECE/ISR)

Funding Agency: National Science Foundation

Wireless Measurement of Neuronal Currents Using Spin-Torque Nano-Oscillators

Faculty: Benjamin Shapiro (BioE/ISR), Edo Waks (ECE/IREAP)

Funding Agency: National Science Foundation

A New Approach to Nonconvex Risk-Sensitive Stochastic Optimization

Faculty: Steve Marcus (ECE/ISR), Michael Fu (BMGT/ISR)

Funding Agency: National Science Foundation

NEES EFRC renewed for four years

Faculty: Gary Rubloff (MSE/ISR), Gary Sang Bok Lee (Chem/Biochem)

Funding Agency: Department of Energy

2013

Information Engines: Nanoscale Control, Computing and Communication out of Equilibrium

Faculty: P. S. Krishnaprasad (ECE/ISR); Christopher Jarzynski (Chem-Biochem/IPST)

Funding Agency: Army Research Office

Advanced Silicon Carbide based Novel Hybrid Energy Storage System for Plug-In Electric Vehicles

Faculty: Alireza Khaligh (ECE/ISR), André Tits (ECE/ISR), Patrick McCluskey (ME/CALCE); Steven Rogers (Genovation)

Funding Agency: National Science Foundation

2012

Computational Foundations for Learning, Verifying, and Applying Model Simplification Rules

Faculty: S. K. Gupta (ME/ISR); Dana Nau (CS/ISR)

Funding Agency: National Science Foundation

Speech Processing Algorithms for Elderly Listeners with Hearing Loss

Faculty: Carol Espy-Wilson (ECE/ISR), Sandra Gordon-Salant (Hearing and Speech Sciences, BSOS)

Funding Agency: ADVANCE Program for Inclusive Excellence: Interdisciplinary and Engaged Research Seed Grant

Magnetic drug delivery to the inner ear

Faculty: Benjamin Shapiro (BioE/ISR), Didier Depireux (ISR)

Funding Agency: University of Maryland Vice President of Research Seed Grant, Maryland Industrial Partnerships program (MIPS), I Rutel (OuHSC), SZI-Clark Seed Funding Grant

Insect and Robot Locomotion with Heavy Loads

Faculty: Sarah Bergbreiter (ME/ISR); Barbara Thorne, Jeffrey Shultz (both from Entomology, CMNS)

Funding Agency: ADVANCE Program for Inclusive Excellence: Interdisciplinary and Engaged Research Seed Grant

2011

NEXTOR II

Faculty: Michael Ball (BMGT/ISR); David Lovell (CEE/ISR)

Funding Agency: Federal Aviation Administration

Cyber-Physical Systems

Faculty: John Baras (ECE/ISR); Mark Austin (CEE/ISR)

Funding Agency: National Institute of Standards and Technology

2010

Cooperative Research and Development Agreement with RDECOM

Faculty: John Baras (ECE/ISR) and other UMD researchers

Funding Agency: U.S. Army Research, Development and Engineering Command

Adaptive perceptual-motor feedback for the analysis of complex scenes

Faculty: Cynthia Moss (JHU), Timothy Horiuchi (ECE/ISR)

Funding Agency: National Science Foundation: Collaborative Research in Computational Neuroscience

2009

Ant-Like Microrobots—Fast, Small, and Under Control

Faculty: Nuno Martins (ECE/ISR), Pamela Abshire (ECE/ISR), Elisabeth Smela (ME/ISR), Sarah Bergbreiter (ME/ISR)

Funding Agency: National Science Foundation

Interior-Point Algorithms for Optimization Problems with Many Constraints

Faculty: André Tits (ECE/ISR) Dianne O'Leary (CS/UMIACS)

Funding Agency: Department of Energy

Image Guided Autonomous Optical Manipulation of Cell Groups

Faculty: S. K. Gupta (ME/ISR) Wolfgang Losert (Physics/IPST/IREAP)

Funding Agency: National Science Foundation

Next-Generation Model Checking and Abstract Interpretation with a Focus on Embedded Control and Systems Biology

Faculty: Rance Cleaveland (CS/ISR); Steve Marcus (ECE/ISR)

Funding Agency: National Science Foundation: Collaborative Research

Adaptive Environment for Supercompiling with Optimized Parallelism (AESOP)

Faculty: Rajeev Barua (ECE); Rance Cleaveland (CS/ISR)

Funding Agency: Defense Advanced Research Projects Agency (DARPA)

Nanofabrication using Viral Biotemplates for MEMS Applications

Faculty: Reza Ghodssi (ECE/ISR); James Culver (Plant Science/Landscape Architecture, AGNR)

Funding Agency: National Science Foundation

Particle Filtering for Stochastic Control and Global Optimization

Faculty: Michael Fu (BMGT/ISR); Steve Marcus (ECE/ISR)

Funding Agency: National Science Foundation

Quantum Computing: Improving Josephson Junction Qubits

Faculty: Gary Rubloff (MSE/ISR) (Joint Quantum Institute, Physics Dept. CMNS, NIST, LPS)

Funding Agency: Army Research Office: Intelligence Advanced Research Projects Activity (IARPA)

Combining Gradient and Adaptive Search in Simulation Optimization

Faculty: Michael Fu (BMGT/ISR); Steve Marcus (ECE/ISR)

Funding Agency: National Science Foundation: Collaborative Research

A Micro-Direct Methanol Fuel Cell with Nanostructured Platinum Catalysts Using the Tobacco Mosaic Virus

Faculty: Reza Ghodssi (ECE/ISR); James Culver (Plant Science/Landscape Architecture, AGNR), Chunsheng Wang (ChBE/MSE) Gary Rubloff (MSE/ISR)

Funding Agency: Maryland Nanobiotechnology Research and Industry Competition Grant

Science of Precision Multifunctional Nanostructures for Electrical Energy Storage (EFRC)

Faculty: Gary Rubloff (MSE/ISR); Sang Bok Lee (ChBE). Other UMD researchers include John Cumings (MSE), Bryan Eichhorn (Chem/Biochem), Chunsheng Wang (ChBE), Liangbing Hu (MSE), YuHuang Wang (Chem/Biochem), Reza Ghodssi (ECE/ISR), Janice Reutt-Robey (Chem/Biochem)

Funding Agency: Department of Energy: Energy Frontier Research Center

B.5 Recommendations

Overall, ISR has a robust research program. The following recommendations are intended to preserve and enhance this robustness. Each is presented with a short rationale.

1. **Develop ongoing programs for seeding early-stage interdisciplinary projects.**

   ISR has supported several ad-hoc mechanisms in the past (seed grants, initiatives, etc.) for initiating new interdisciplinary research efforts. These should be regularized and continued as a means of ensuring ISR's continued commitment to this key part of its, the Clark School's, and the university's mission.

2. **Convey to the faculty and staff on a regular basis, such as during the annual "State of ISR" presentation by the ISR Director, quantitative data reflecting how ISR is addressing its mission and vision.**

   Currently, a "State of the Institute" address is given; this recommendation would be to use the opportunity to review the mission and vision and to give quantitative as well as anecdotal data on how well ISR is doing in achieving its mission and vision.

3. **Clarify criteria for center relationships, including creation, sustainment, "graduation" and decommissioning.**

   The incubation of centers represents an important aspect of ISR's activities, and yet a review of the centers currently affiliated with the Institute indicates widely varying levels of activity and engagement. Developing guidelines for determining how centers are formed, sustained, and eventually made independent or decommissioned, would help ensure some consistency in these matters.

4. **Ensure intra-Institute communication mechanisms are up-to-date, including mailing lists, web resources and calendars, and develop an "on-boarding" document for new faculty and**

staff describing ISR infrastructure, facilities and resources.

One good way to stimulate collaborations is to make Institute members aware of when their colleagues have competed successfully for grant funding. Announcing these awards via e-mail, and also on ISR website and other social media, achieves this goal.

5. **ISR should develop mechanisms for the ongoing review and discussion of strategic planning.**

   In Fall 2015, through the extensive efforts of its Strategic Planning Committee, ISR developed a Five Year Strategic Research Plan. This is an important living document that charts strategic research directions for ISR for the next five years. We encourage ISR to establish a mechanism for periodic review and modification of strategic objectives.

C. EDUCATION

C.1 Educational impact of ISR's research programs

ISR was born as an NSF Engineering Research Center with a primary mission to pursue a systems science research agenda, and to integrate research, education, and technological innovation. Research continues to be its principal focus. Its primary educational impact is through the integration of students at all levels into its research enterprise. ISR research projects nearly always include (and usually require) substantial input from students. Through this deep involvement in research, ISR students receive the most valuable educational experience a world-class research university has to offer.

A distinctive aspect of the research projects funded under the original NSF ERC structure was that projects were required to be interdisciplinary. That is, to receive funding, projects had to involve faculty and (by association) students from multiple departments. While this is not a requirement of current ISR projects, it continues to be very common. The need to integrate disciplinary knowledge serves to further enhance the educational experience for ISR students.

While students from ISR's MSSE program often participate in research projects, by far the majority of students involved in ISR research projects are Ph.D. and M.S. students whose advisors are ISR faculty members, and who are earning their degrees through departmental programs. However, many ISR projects also involve post-docs and visiting scientists or engineers. It is also the case that many faculty carve out a strong role for undergraduate students. Earlier in its history, ISR hosted the NSF Young Scholars program, which brought high school students to campus during the summer to work on ISR projects.

Research team members from all of these groups have received valuable educations that in many cases have led to outstanding job placements and rewarding careers.

ISR Student Organization

While ISR students have their disciplinary "home" outside the Institute, ISR has its own somewhat special community. The ISR Student Organization (ISO) serves an important role in building this community. What makes this organization unique amongst other student organizations is that like ISR itself, membership is not limited to students from a single department. Thus it serves as a forum that facilitates inter-departmental student interactions which might not occur otherwise.

The ISO existed before its sister organization the ECE Graduate Student Association (GSA) and served as the model for its development. The current ISR leadership has contributed significantly in establishing the ISO as a prominent part of ISR student experience; this has come in the form of newly allocated resources which allowed the creation of an ISR student lounge, as well as staff support for organizing ISO events. These include social events and employment and mentoring events with invited industry partners and ISR alumni. The ISO also has held meet-and-greet events to raise awareness about the ISO, as well as poster sessions in which students have the opportunity to present their own research to faculty members and external guests. The activities and events sponsored by the ISO contribute to student growth not only by fostering student interaction, but also by preparing students for long-term success in their careers after graduate school.

ISR alumni profiles

The following paragraphs are examples of the academic, business and government career paths ISR alumni and postdoctoral researchers have chosen over the years. These examples also are indicative of the quality of our alumni and the many opportunities available to those with systems science training.

Levent Gun (EE Ph.D. 1989) was advised by Professor Armand Makowski (ECE/ISR). Currently the CEO of Ampt, LLC, he has built a career as an experienced technology executive and venture capitalist whose companies focus on solar photovoltaic systems, smart grid, wireless, broadband, cable data, networking systems architecture and semiconductors.

Eytan Modiano (EE Ph.D. 1992) was advised by Distinguished University Professor Anthony Ephremides (ECE/ISR). He is a professor in the Aeronautics and Astronautics Department at the Massachusetts Institute of Technology, where he is also active in its Laboratory for Information and Decision Systems, and Operations Research Center. Modiano designs network architectures.

William Byrne (EE Ph.D. 1993) was advised by Professor Shihab Shamma (ECE/ISR). He is a professor at the University of Cambridge, where he is head of the Information Engineering Division in the Department of Engineering, and a member of the Speech Research Group. He is a Fellow of Clare College, Cambridge and is a director of studies

in engineering there. His research is focused on the statistical modeling of speech and language.

Shravan Goli (CS M.S. 1994) was advised by Professor Nicholas Roussopoulos (CSISR). He is currently the president of dice.com, which provides specialized websites for professional communities, including technology and engineering, financial services, energy, healthcare and security clearance. He has built an entrepreneurial career in consumer Internet, social media, digital media, connected home, and video.

Naomi Leonard (EE Ph.D. 1994) was advised by Professor P. S. Krishnaprasad (ECE/ISR). Leonard is the Edwin S. Wilsey Professor of Mechanical & Aerospace Engineering at Princeton University, and the director of the Council on Science and Technology there. She is a MacArthur Fellow and a Fellow of IEEE, SIAM, ASME and IFAC. Leonard specializes in control and dynamical systems—designing and analyzing feedback and behavior of complex, dynamical systems.

William Regli (CS Ph.D. 1995) was advised by Professor Dana Nau (CS/ISR). Regli is a professor of Computer and Information Science in the Drexel University College of Computing & Informatics, with appointments in Mechanical Engineering and Mechanics; Electrical and Computer Engineering; and in the College of Biomedical Engineering, Science and Health Systems. He currently serves as senior scientific adviser to the Defense Programs Office of the National Nuclear Security Administration of the U.S. Department of Energy.

Hamid Jafarkhani (EE Ph.D. 1997) was advised by Professor Nariman Farvardin (ECE/ISR)—former ECE department chair, Clark School dean, and University of Maryland provost. Jafarkhani is Chancellor's Professor in the Department of Electrical Engineering and Computer Science at the University of California, San Diego. He is well known as one of the inventors of space-time block coding, which is widely used to improve wireless transmission quality.

Sanjeev Khudanpur (EE Ph.D. 1997) was advised by Professor Prakash Narayan (ECE/ISR). He is an associate professor in the Electrical and Computer Engineering Department at Johns Hopkins University. He is part of the Center for Language and Speech processing, where he conducts research in the application of information theoretic methods to human language technologies such as automatic speech recognition, machine translation and natural language processing.

Ali Hirsa (Applied Math Ph.D. 1998) was advised by Associate Professor Mark Austin (CEE/ISR). He is a managing partner at Sauma Capital, LLC. Previously he was a partner and head of analytical trading strategy at Caspian Capital Management, and also held quantitative positions at Morgan Stanley, Bank of America Securities, and Prudential Securities. He currently serves as a Trustee of the University of Maryland College Park Foundation.

Radha Poovendran (EE Ph.D. 1999) was advised by Professor John Baras (ECE/ISR). He is professor and chair of the Electrical Engineering Department at the University of Washington, and founding director of its Network Security Lab. Poovendran is a founding member and the associate director of research of the UW Center for Excellence in Information Assurance Research and Education.

Zhengying Zhao was a postdoctoral researcher within ISR (2003), advised by Professor Michael Ball (BMGT/ISR), who worked on NSF- and Toshiba-funded projects. This experience led directly to a position at Intel where he manages the Global Operations Research Engineer Team for the Supply Planning Operations and Customer Planning and Logistic functions. He was recently named an Intel Principal Engineer.

Enlu Zhou (EE Ph.D. 2009) was co-advised by Professor Steve Marcus (ECE/ISR) and Professor Michael Fu (BMGT/ISR). She is an assistant professor in the Stewart School of Industrial & Systems Engineering at Georgia Tech. Her research interests include simulation optimization, stochastic control, and Monte Carlo methods, with applications in financial engineering and revenue management.

Examples of Undergraduate Research Experiences

- From its earliest days, ISR has been successful in obtaining grants for NSF's summer Research Experience for Undergraduates (REU) programs. These summer programs, typically funded for three-year runs, integrate both University of Maryland students and students from other universities into ISR research projects. Themes vary based on the ISR faculty PI's interests; ISR's most recent REU grant (2012–2014) was on microrobotics and was headed by Sarah Bergbreiter.
- In its early years, ISR obtained state funding for the Undergraduate Research Participation Award (URPA) Program. This program provided a stipend to University of Maryland students to work on ISR projects either during the summer or the academic year.
- Professor Gary Rubloff's Laboratory for Advanced Materials Processing typically has between two and five undergraduates intimately involved in laboratory projects. Alumni of this lab have entered Ph.D. programs at the University of Maryland, UC Berkeley and MIT.
- Professor S. K. Gupta, director of the Maryland Robotics Center, similarly directs between two and five undergraduate students each semester on robotics projects. These are particularly attractive to undergraduates because of the opportunity for broad, innovative thinking and the appeal of the final product.
- Professor P. S. Krishnaprasad has placed a strong emphasis on the integration of undergraduates into the work of his Intelligent Servosystems Laboratory over the past three decades. The student experiences have varied from summer projects, sometimes supported by NSF REU programs, to multiple academic year involvement in collaborative research and independent projects.

One of the students who conducted research in the Intelligent Servosystem Lab was **Ermin Wei** (2008 triple B.S. in Computer Engineering, Mathematics and Finance with a minor in German; 2014 Ph.D. from EECS at MIT). She is now an assistant professor in Electrical Engineering and Computer Science at Northwestern University.

C.2 Masters degree programs in systems engineering

Master of Science in Systems Engineering (MSSE)

The Master of Science in Systems Engineering (MSSE) was launched in 1987. It differs from traditional engineering degrees in that it is not focused on knowledge in a single core domain—e.g. materials, aeronautics, mechanical design—but rather teaches principles and methods applicable across domains. Its students study integration and design problems that by their nature involve multiple engineering disciplines.

The MSSE program also differs from traditional systems engineering degrees in that it incorporates the "system science" knowledge and points-of-view of ISR faculty. Students are taught design, analysis and optimization methods not found in other programs.

Throughout its history, the program has received strong input from ISR industry partners. In the 1996–98 period and again in 2006–2007, formal reviews and curriculum redesigns were proposed and implemented by teams consisting of both ISR faculty and industry partners. In the period 2000–2002, ISR faculty obtained an NSF grant to design curriculum innovations for MSSE courses.

Professional Master of Systems Engineering (PMSE)

The MSSE program graduated its first student in 1990. A related program, the Professional Masters of Systems Engineering (PMSE), was started in 1994. From the beginning these two programs have been closely linked. A set of basic/required systems engineering courses are shared between the PMSE and MSSE programs so that each class contains students from both programs (see *Appendices 24 and 25* for curricula of the two programs).

The MSSE program requires a thesis or scholarly paper, whereas the PMSE program only requires coursework. MSSE students typically choose disciplinary classes from other departments. These classes would not include PMSE students but might include students from other disciplines, such as electrical engineering.

ISR receives funds from the university (a portion of the tuition) to support the PMSE program but does not receive additional funds to support the MSSE program. This program architecture allows the PMSE funds to subsidize instructor costs for the MSSE program.

Table 6 provides statistics on the graduates from the two programs over their histories. The low number of graduates in the periods of 2009–2010 reflects the fact that the MSSE program had stopped accepting students in the years leading up to 2007. Around 2007, some resources were invested into the program and students were once again brought in.

The more recent progress of both programs is reflected in *Figures 3, 4* and *5*. The current number of enrollees should probably be described as modest. Efforts to bring up enrollment have had some success, but more work and investment probably is required to make the programs a success.

Teaching MSSE courses

As discussed earlier, because ISR is a research institute, its faculty have a reduced teaching load and no formal teaching duties within ISR. As such, the MSSE curriculum is taught through special "deals" made with certain faculty and/or their departments, overload teaching and the use of adjuncts.

Recently ISR faculty have developed and offered two innovative special MSSE electives: *Sensor Systems* (Abshire & Lovell) and *Cybersecurity for the Smart Grid* (Qu). The faculty involved volunteered to teach these courses over and above their normal teaching loads.

Recent task force recommendations (2012)

A recent ISR Systems Engineering Task Force sought to address the challenges around the lack of ISR faculty involvement in the MSSE program. The committee's report, delivered in Spring 2012, provided multiple recommendations. These sought both to improve faculty attention to systems engineering (as opposed to systems science) and also to establish faculty teaching commitments.

MSSE and PMSE Degrees Awarded, FY1993–2014

FY	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14
MSSE	7	7	8	10	5	6	7	8	8	10	11	11	4	7	5	3	0	0	0	3	6	10
PMSE	—	—	⋆	⋆	⋆	⋆	⋆	⋆	6	7	6	8	10	7	15	12	15	14	13	9	17	6

TOTALS: MSSE 136 PMSE 174

⋆*PMSE totals from 1995-2000 aggregate only = 29*

Table 6: MSSE and PMSE Degrees Awarded, FY1993–2014

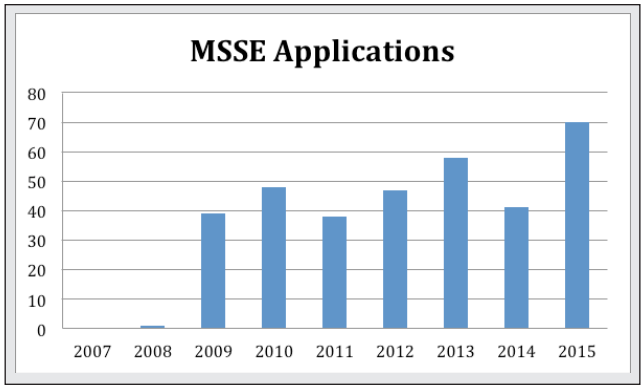


Figure 3: MSSE Applications, 2007–2015

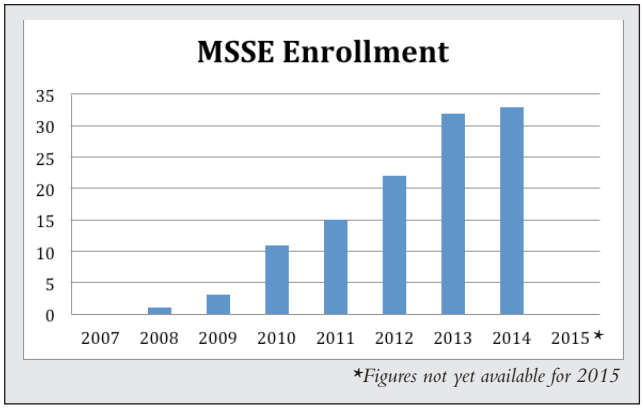


Figure 5: MSSE Enrollment, 2007–2014

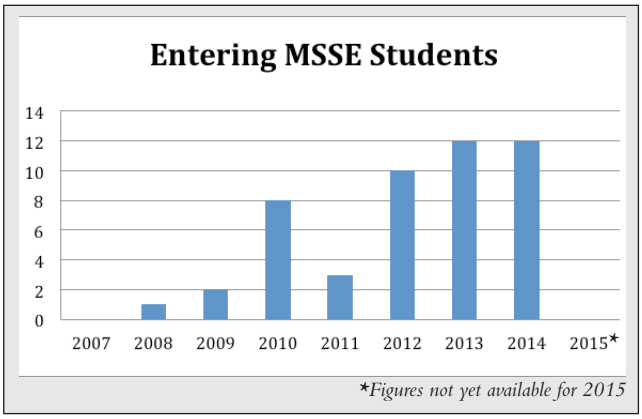


Figure 4: Entering MSSE Students, 2007–2014

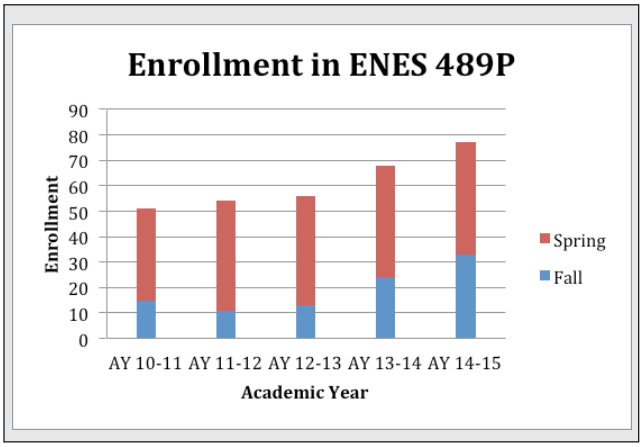


Figure 6: Enrollment in ENES 489P, AY2010-11 to 2014-15

Specifically, the report recommended the establishment of an ISR faculty teaching "obligation." At the time of ISR faculty contract renewals, each faculty member would be required to choose and commit to a teaching "obligation." The nature of this obligation should be flexible, e.g. it does not necessarily involve the delivery of a full course. While course development or delivery might constitute a possible way of fulfilling the obligation, student advising, delivery of a guest lecture or other activities could also satisfy the requirement.

These recommendations never were formally accepted by ISR faculty, although the ISR director is seeking to implement some aspects of them. In addition, at recent ISR faculty meetings there have been productive discussions on how to address these issues, including discussion of how involvement in the MSSE program can enhance faculty members' research programs.

C.3 ISR leadership in systems and cross-disciplinary programs

In the past six years, ISR has developed and offered an undergraduate projects course for senior-level engineering students that teaches the principles of systems science and systems engineering. The course, **ENSE 489P: Special Topics in Engineering: Hands-on Systems Engineering Projects,** draws students from all areas of engineering. Students are introduced to the technical aspects of systems engineering practice through team-based project development and a systematic step-by-step procedure for product development that includes working with a real-world customer. Since its initial offering in Fall 2010, annual enrollment in the course has grown from 11 to 78 in AY2014-2015 (see *Figure 6*).

In 1996, ISR was chosen to administer the brand-new **Gemstone** program. The innovative, interdisciplinary undergraduate honors program was conceived by former Clark School Dean William Destler (now president of the Rochester Institute of Technology). As the Clark School's first interdisciplinary unit, ISR was the natural incubator for this unique undergraduate education program. Freshmen in Gemstone form teams and spend the next three years analyzing and investigating important societal problems from various disciplinary perspectives. Two ISR faculty members, Thomas Fuja (now at the University of Notre Dame) and Christopher Davis (Electrical and Computer Engineering), have served as the director of the Gemstone program and many others have served as Gemstone team mentors.

Currently, four ISR faculty are mentoring Gemstone research teams. Oversight of the Gemstone Program remained in the Clark School until it became one of the five living-learning programs within the University's Honors College in July 2010.

ISR faculty have taken leadership roles in other Clark School and cross-campus programs, reflecting the faculty's broad, cross-disciplinary nature. For example, Jeffrey Herrmann is the associate director for the university's **QUEST (Quality Enhancement Systems and Teams)** honors fellows program, and David Lovell is the faculty advisor of the Clark School's chapter of **Engineers Without Borders.**

A new example of this is Professor Ray Adomaitis' (CHBE/ISR) leadership in the university's Solar Decathalon efforts. The Solar Decathlon is a U.S. Department of Energy-sponsored biennial competition where student teams design, construct, and operate energy efficient and cost-effective solar powered homes.

In winter 2015, Adomaitis, together with two co-PIs from the School of Architecture, were informed that their proposal was selected as one of 20 teams scheduled to compete in 2017.

A distinguishing feature of Team Maryland's proposal is the prominent role systems engineering methods will play in the design, optimization, construction, and operation of the solar home. Under the guidance of ISR faculty, undergraduate and graduate students (including MSSE students) will employ Model-Based Systems Engineering (MBSE) approaches to define system functional requirements from the competition rules, and will decompose the project design elements in a hierarchical manner while simultaneously identifying validation criteria to be tested in the project construction phase.

The systems science elements that will be developed as part of this project include physically based models of house mechanical systems performance; as well as thermal dynamics, dynamic optimization of energy and water use, real-time control of the house environment; and distributed sensing, communication, and actuation of house mechanical systems. The proposed use of Model Predictive Control (MPC) for house environmental control, and stochastic dynamic optimization for the integration of photovoltaic, thermal solar, and energy storage systems will provide substantive research problems for MSSE and other engineering graduate students.

C.4 New educational initiatives

New combined CHBE BS/MSSE program

A five-year combined Chemical and Biomolecular Engineering Bachelor of Science/Master of Science in Systems Engineering degree will be offered by ISR and the Clark School's Department of Chemical and Biomolecular Engineering beginning in Fall 2015. The program offers interested CHBE undergraduate students a strong foundation in process systems engineering concepts. It also will open new employment opportunities for CHBE students in the Washington, D.C. area.

Students will take two core ENSE graduate courses in their senior year (ENSE 621 and ENSE 622) and one elective that counts toward both the BS and MSSE degree. The ENSE courses also count as CHBE electives. In the following year, students will take the remaining courses required to complete the MSSE degree, as well as complete research and a thesis.

Possible undergraduate minor in systems engineering

The ISR Education Program Committee was charged in 2014–2015 to create a roadmap for the development of an undergraduate systems engineering (SE) minor. The motivation came from the feeling that there is a growing interest and need for incorporating systems engineering and systems thinking into the undergraduate curriculum. Moreover, in the last three years the enrollment in the capstone SE project course ENES 489P has grown to the point where there is a waiting list for both semesters. The committee has proposed the following tentative structure:

1) Systems Engineering Concepts Course
2) Probability/Statistics Course
3) System Modeling/Analysis Course
4) SE/Project Management Course
5) SE Project Course ENES 489P

All except the first requirement would come from existing courses. The first requirement may be a one-credit overview course rather than a three-credit course like the other requirements.

C.5 Analysis and recommendations

Analysis

By far ISR's most significant educational impact has been through student involvement in its research programs. ISR has many distinguished alumni who can trace their success back to the rich and unique research experience provided by ISR. This is to be expected, since ISR was created to be a research institute and research remains its principal mission.

Over the years, the MSSE program has gone through good and bad periods. After a relatively short period (2007–2008) when no new students were admitted, the MSSE program has been revived and once again is admitting and graduating students. However, it must still be viewed as a somewhat marginal program. Many issues contribute to the challenges ISR has had with maintaining a high-quality program:

1. The MSSE program is a systems engineering program. As discussed earlier, there is a difference between systems engineering and systems science. Many ISR faculty are strong systems scientists but have little interest in, or affinity for, systems engineering.
2. ISR faculty have no formal teaching requirement within ISR. As such the MSSE program is run through special "deals" with certain faculty and/or their departments, overload teaching and the use of adjuncts. This comment

should be taken as a fact, not as a criticism or necessarily a suggestion for change. In fact, the state originally funded ISR as a research institute so that its faculty support was designated for research and not instruction. Other research institutes on the University of Maryland campus have similar arrangements. A substantial, "wholesale" change in ISR teaching requirements would certainly change the fundamental nature of the Institute.

3. Generally, faculty have a strong preference for providing research support to Ph.D. students rather than (terminal) masters students. As a result, ISR is only able to provide a relatively small number of MSSE students with research assistantships.
4. Because MSSE students share the majority of their classes with PMSE students, it is not possible to add depth to the classes that would provide MSSE students with a stronger, more research-focused program than typical professional masters programs.
5. Largely because of the issues described above, the university, the Clark School and ISR itself have not made a long-term financial or organizational commitment to the MSSE program.

ISR's impact on undergraduate education through involvement of undergraduates in research projects and its delivery of a capstone course is laudable and certainly has had a significant impact.

Opportunities

The demand in various competitive systems engineering programs clearly indicates the possibility for growing the MSSE program. At the same time, ISR must effectively compete with these programs. ISR's clear strategic advantage is the intellectual strength and research reputation of its faculty. Yet, it must address the deficiencies described above to create a world-class program that takes advantage of the strength of its faculty.

Alternatively, ISR and the Clark School could save financial and organizational resources by closing the program. However, in addition to diminishing the impact of ISR in the educational domain, this would close off a lane for ISR to disseminate some aspects of its research into practice. Any drastic changes along these lines should be considered in the context of the PMSE program; the two programs might be merged, or one closed and the other left open.

The first two challenges discussed above represent major structural challenges. These have been known to ISR and Clark School faculty and administrators for many years. Yet attempts to improve the viability of the program over those years have led to, at best, modest results. For example, the conclusion of a review committee that included ISR faculty and industry and government representatives stated that ISR should set an enrollment goal of 100 students to consider its program successful. This goal certainly has not been met. The program history leads one to conclude that either something drastic must be done to improve the program or it should be dropped.

Given the demand for systems engineering education among practicing engineers, there appears to be an opportunity for the delivery of non-degree programs aimed at working professionals.

D. Faculty

There are three types of ISR faculty appointments: joint, affiliate, and research.

- **Joint appointment faculty** are tenure-track faculty who have a portion (usually around 50 percent) of their salary paid by ISR and are expected to spend a significant portion of their time participating in interdisciplinary research projects and ISR activities. The State of Maryland funded ISR to enable faculty to have the time to do this. Joint appointment faculty have full voting rights in ISR and serve on ISR committees. Most have a reduced teaching load in their departments in alignment with their reduced appointment in the department.
- **Affiliate faculty** are tenure-track faculty who do not receive salary from ISR (a "zero percent appointment") but participate in the research and other activities of the Institute. They do not have voting rights.
- **Research faculty** are supported on research grants, as opposed to state funds. Research faculty have full voting rights in ISR and serve on ISR committees.

ISR joint appointments are three-year rotating appointments. A faculty member applies and is evaluated by an ISR Appointment, Promotion, and Tenure (APT) committee that is partly elected and partly appointed. It evaluates all candidates and makes recommendations to the ISR Director, who makes the final decisions. Obviously, ISR looks for quality and excellence, but the appointment is also based on interdisciplinary work and compatibility with ISR's strategic needs. This in-depth review every three years is more thorough than many post-tenure review processes, and provides significant feedback to ISR faculty. It is particularly important for associate professors; the ISR Director has used this process as an opportunity for their mentoring and career development as they move toward full Professor.

ISR joint appointment faculty have tenure track appointments in departments across the campus, including almost all of the engineering departments, the Smith School of Business, Biology, and Computer Science. In addition to

Refereed Journal Publications by ISR Joint Appointment Faculty, 2010–2015

2010	2011	2012	2013	2014	2015
101	86	118	111	99	50 (partial year)

Table 7: Refereed Journal Publications by ISR Joint Appointment Faculty, 2010–2015

these departments, there are also ISR affiliate faculty from the Mathematics Department.

It is difficult for isolated researchers to fit into ISR, with its emphasis on collegiality and interdisciplinary research. ISR lets prospective joint appointment and affiliate faculty know that they are expected to interact with other faculty; one of the criteria during the review is that the committee sees evidence that this is already occurring.

ISR has official input into both the promotion and salary processes of its jointly appointed faculty.

By the early 1990s, faculty were being drawn to the University of Maryland specifically to work in ISR. In addition, current faculty within the university seek joint appointments or affiliations with the institute on a regular basis. Of ISR's five directors, two were already University of Maryland faculty, but three came to the university specifically to work with ISR. Steve Marcus originally was recruited from the University of Texas to be ISR Director in 1991, while Gary Rubloff came from North Carolina State University to become Director in 1996. Reza Ghodssi, ISR's current Director, came to the university as an ISR joint appointment from a postdoctoral position at MIT; being able to be a part of ISR weighed heavily in his decision to accept Maryland's offer. Beyond these directors, many other faculty have chosen the University of Maryland based on the ability to be associated with ISR.

Quality of the faculty

Using any measurement, ISR is at least very competitive in the fields of research it has entered. In certain areas such as communication, control, neuroscience, MEMS and operations research, ISR is among the leaders. *Table 7* shows the number of refereed journal publications by ISR joint appointment faculty from 2010–2015.

ISR faculty have given 27 plenary addresses at international conferences in the past five years (see *Appendix 5*). ISR faculty include 62 Fellows of academic societies (see *Appendix 4*) and 45 NSF CAREER and other Young Investigator awards (see *Appendix 8*).

ISR faculty also have won prestigious national and international awards in their fields. For example, P. S. Krishnaprasad won the IEEE Bode Prize in 2007 "for fundamental contributions to the theory of control of natural and synthetic physical systems." The prize, given by the IEEE Control Systems Society, recognizes distinguished contributions to control systems science or engineering.

ISR affiliated faculty member Ben Shneiderman (Computer Science) was inducted into the National Academy of Engineering in 2010.

S.K. Gupta, Elisabeth Smela, Sarah Bergbreiter and Derek Paley have won the Presidential Early Career Award for Scientists and Engineers (PECASE). The PECASE is the highest honor bestowed by the U.S. government on outstanding scientists and engineers beginning their independent careers. The awards are conferred annually at the White House.

Other awards won by ISR faculty can be found in *Appendices 6, 7* and *9*. A list of ISR faculty patents is available in *Appendix 11*.

E. Industry outreach, external relations and technology transfer

E.1 ISR collaboration mechanisms and modes of interaction

From its beginning, industry interaction has been one of ISR's central goals. ISR has always maintained full-time external relations staff dedicated to this function, and has developed a variety of mechanisms by which companies can have a formal relationship with ISR.

ISR maintains a strategic partners program with four partner levels: Sustaining Partner, Senior Partner, Partner and Associate Partner. Each level has its own minimum contribution and benefits. The top three levels include the benefit of one or more faculty-led research projects.

ISR always has been very flexible in its industry interactions. It has both customized the formal partner programs and created special mechanisms to meet specific company needs. In addition, ISR centers and large projects—for example CSHCN/HyNet—sometimes have had their own programs and mechanisms for interacting with industry. In all of these cases, the external relations staff has adapted and provided support as appropriate.

This staff also has helped develop various international cooperation programs. These have involved formal cooperation mechanisms with either foreign universities or research institutes.

In addition, ISR has kept step with the rest of the university in increasing contact with and emphasis on alumni for collaborative and development purposes in recent years. The external relations staff has been tasked with this challenge. This is a long-term, value-added activity; it is well acknowledged that "philanthropy follows engagement."

Table 8 provides a picture of the level of industry collaboration for the 2015 fiscal year. The first section shows the amount of up-front cash payments made by industry to support ISR research. This comes in three forms: membership dues for the partnership programs, cash gifts to support faculty and their activities and income from intellectual property license agreements. The second section shows in-kind, no-cost software licenses and in-kind visiting scholar salary values. It also shows funding students receive from companies as interns. The third section gives the value of sponsored research contracts and grants such as industry research contracts and Maryland Industrial Partnership

Industry collaboration, FY2015 compared to FY2011

	FY 2011	FY 2015
Membership dues	$45,500	$110,000
Gifts	$232,600	$180,000
License income	$34,800	$25,400
HW and SW in-kind (2015 note: No Magic - SW for courses; $3,768 each x 65 users)	$24,300	$245,000
Visiting Scholar in-kind	$19,000	$34,400
Student internships/fellowships	$108,000	$71,900
Sponsored Research/Teaming	$4,495,500	$450,388
TOTAL	$4,959,700	$1,117,088

In FY 2015, ISR worked with these companies in some form:

Avoneaux Medical Institute, LLC	Micro Logic Corporation
Capita Foundation	Mitsubishi Electric
Cerona Networks Corp.	No Magic
ESCgov	Northrop Grumman
Facebook	Phase One Consulting
Google	Tauros Engineering, LLC
Hearing Health Foundation	Toshiba
Hive Group/Visual Action Software	TTG, Inc.
Hyperion Technologies, LLC	Unconventional Concepts, Inc.
Hughes Network Systems	UTRC
IAI	Weinberg Medical Physics
Lockheed Martin	

Table 8: Industry collaboration, FY2015 compared to FY2011

(MIPS) projects. The bottom section is a list of all industry partners ISR worked with in some form in FY 2015.

This table provides some indication of the breadth of the methods of interaction and also the scope of interactions in terms of numbers and types of organizations.

Over the years, ISR has only had two or three companies classified in one of the top three levels of its Strategic Partners program. The newer Associate Partners program (with lower dues) currently has 11 partners: Intelligent Automation, Inc.; Hughes Network Systems; Lockheed Martin; ESCgov; Northrop Grumman; Qualcomm; NoMagic; Loccioni USA; United Technologies Research Center; and ST Microelectronics. The National Institute of Standards and Technology also is an Associate Partner.

It is safe to say that ISR does not have an extensive set of formal partners. At the same, by using a flexible approach, ISR has been able to very broadly engage industry in a cross-section of its research efforts. In the following section we discuss some the key industry relationships.

E.2 Key industry collaborations

Hughes Network Systems

Hughes Network Systems (HNS), headquartered in Maryland, was an early collaborator with ISR. This collaboration played a strong role in the development of the Center for Satellite and Hybrid Communications Networks (CSHCN), which later became the Maryland Hybrid Networks Center (HyNet). CSHCN/HyNet was a center housed within ISR that brought together satellite communications companies. HNS was probably the most active member and ISR research led by John Baras led to highly successful HNS commercial products.

This research produced multiple inventions productized by HNS, including DirecPC, Turbo Internet, DirecWay, and SpaceWay. The inventions received many awards, including the University of Maryland 1994 Outstanding Invention of the Year; the Outstanding MIPS Project Award (large company); Distinguished Engineer of the Year (Doug Dillon, HNS) from the Maryland Academy of Sciences; the ComNet 1996 New Product Achievement Award (wireless); the 1996 "Hot Product" for network services from *Data Communications* magazine; and the Technical Excellence Award (networking hardware category), from *PC Magazine*.

HNS continues to provide summer internships to University of Maryland students. More than 60 students affiliated with CSHCN/HyNet, and many more from University of Maryland at large, have been employed by HNS.

Toshiba

In 2000, at the invitation of then-University of Maryland President Dan Mote, Toshiba scientists visited several laboratories across campus. Toshiba became a strategic partner of ISR based on these visits. Each year Toshiba funded multiple projects (usually between one and two). Depending on the project, the funding supported a combination of faculty, students and post-docs. In all cases, Toshiba scientists or engineers came to College Park for periods of four months to a year to assist with the research. Over the course of the 2001–present collaboration, 18 Toshiba scientists and engineers have visited in this way. Research topics covered a broad cross section, including supply chain management, manufacturing process monitoring and quality control, and MEMS product and process design. Toshiba executives visited ISR on multiple occasions and ISR faculty and staff visited the Toshiba Corporate Manufacturing Research Center in Yokohama, Japan, as well.

Toshiba put the results of several ISR projects into use. For example, the "Advanced Available to Promise" project directed by Michael Ball produced an optimization model used by Toshiba to drive its available-to-promise business function for point-of-sale terminal production and delivery. This project received the "Outstanding Contribution to Business Performance Award" from the Director of Toshiba Corporate Manufacturing Engineering Center (CMC), June, 2003.

Honda

ISR's long-term partnership with Honda (1999–2009) brought 12 high-quality and high-promise engineers to campus to complete a 14-month set of objectives. Honda engineers were paired with ISR faculty on projects suited to their specialties. As part of Honda's globalization effort, the engineers experienced U.S. university research culture and also learned English. Engineers worked on control theory research, 3-D image reconstruction for video images, hybrid electric vehicle transmissions, and motorcycle noise-damping systems. In addition to the Honda visiting scientists, ISR faculty were awarded two separate Honda Initiation Grant program awards, which added new mechanisms for collaborations.

Research with Bill Levine developed an engine idle speed and emission controller that favorably compared to existing controllers. Modeling was extensively used. The engine model included airflow dynamics, combustion, fuel injection and catalytic converter components. A model was developed by linearizing at nominal points. The model's accuracy was evaluated by comparing both measured and simulated data. The models were used to compare idle controllers, air-fuel ratio controllers, and emission controllers.

Northrop Grumman Electronic Systems

Northrop Grumman was an ISR industrial affiliate program member for 20 years, usually at the sustaining partner level. There were typically three or four projects per year. Project topic areas were mutually agreed upon based on the expertise of ISR faculty and Northrop Grumman's needs at the time. Other collaborations and benefits included: teaming to win agency program awards, participation on the ISR Strategic Advisory Council, Maryland MIPS (state matching) awards, student hiring, in-kind donations, and cash gift support. Extensive and frequent discussions and meetings were held to maintain a close relationship and work towards identifying additional collaborations.

A recent Northrop Grumman collaboration success involved an ISR research team led by Gary Rubloff and Ray Adomaitis. ISR research has helped move Northrop Grumman to a position of competitive leadership in GaN-based materials and process technology for microelectronics systems, in material quality, process uniformity, film thickness control, and manufacturability. NG has used ISR contributions to fabricate high-power, high-frequency GaN devices. This significant new capability enabled NG Electronic Systems to move from an original Phase I to a considerably larger Phase II Defense Advanced Research Projects Agency (DARPA) program.

Lockheed Martin

Lockheed Martin and its CEO Norman Augustine were key industrial supporters at the creation of ISR. The company endowed the Lockheed Martin Chair in Systems Engineering in 1987 for $1.5 million; John Baras holds this chair. For years Lockheed Martin was a dues-paying member of CSHCN/HyNet, and worked extensively with this center on hybrid networks research. They were also the lead industry partner for ATIRP and the Federal Labs Consortium, of which ISR was a part.

Over the years, ISR teamed with Lockheed Martin to win MIPS awards and CRAD government agency awards; the company also has sponsored direct research. Lockheed Martin has sponsored student fellowships and supplied judges for the 489P end-of-semester student presentation competition.

Currently Lockheed Martin is an ISR Associate Partner, a member of ISR's Strategic Advisory Council, and the sponsor of the Lockheed Martin Robotics Seminar Series.

Intelligent Automation, Inc. (IAI)

It is safe to say that Intelligent Automation, Inc., (IAI) is more closely connected to ISR research than any other company. Its president, Vikram Manikonda (EE Ph.D. 1997) is an alumnus. While a graduate student working with P. S. Krishnaprasad, he helped develop MDLe, a motion control language for robotics. IAI further developed the ideas underlying MDLe into the commercial multi-agent computation platform, CybelePro, a distributed control framework for higher level motion programming.

Manikonda is the chair of the ISR Strategic Advisory Council. Two current IAI research scientists have part-time visiting appointments with ISR, interacting with Tony Ephremides and Michael Fu and their students. IAI has hired eight ISR alumni as permanent staff members, and periodically hires students as interns. IAI provides funding for ISR's internal colloquium series.

Work with startup companies and entrepreneurs

ISR relies on the expertise of MTECH and its programs when working with start-up companies and entrepreneurs. Depending upon the needs of the startup (or startup idea), MTECH has programs to assist entrepreneurs working towards success. In particular, ISR faculty and students have collaborated on projects with small, entrepreneurial companies through the Maryland Industrial Partnerships (MIPS) program. ISR periodically engages MTECH professionals to present informative programs to ISR faculty and students.

In 2013, ISR held an alumni symposium focused on entrepreneurship, where successful alumni spoke to current ISR students about their experiences and lessons learned. In addition, in recent years, ISR alumni entrepreneurs have returned to campus on a regular basis to talk specifically with current students in an informal, small group setting.

In addition, ISR faculty work with smaller companies through the federal government STTR/SBIR programs. For example, Sennur Ulukus and IAI, Inc., as well as Ben Shapiro and Weinberg Medical Associates, recently worked together through these programs.

Other significant collaborations

As discussed earlier, ISR has had various levels of interaction with a wide range of industry partners during its history. The various constituent centers within ISR have been a particularly significant mechanism for interaction.

For example, CSHCN/HyNet had its own industry partner program. Those partners contributed financial support to the center and ISR and sponsored a variety of research projects. Prominent partners (in additional to HNS) included Loral, Lockheed Martin, COMSAT, TRW and Bell Atlantic.

NEXTOR and NEXTOR-II have also had their own industry partner programs. Organizations that have worked closely with ISR faculty have included Federal Express Corp., the Maryland Aviation Administration and Metron Aviation. Throughout the almost 20-year life of NEXTOR and NEXTOR-II, Metron Aviation has had close ties to ISR. Metron and Maryland have had a nearly-continuous stream of joint projects sponsored either by the FAA or NASA. Metron has hired five NEXTOR graduates, including Robert Hoffman (Math Ph.D. 1997), now Metron Director of Advanced Research. Hoffman has a long-running ISR visiting appointment: He regularly spends time at ISR working with faculty and students. Through this relationship several NEXTOR research results have been integrated into every-day use, especially via FSM, the Metron-developed decision support tool used daily by the FAA and airlines to plan and control air traffic management initiatives.

E.3 Strategic Advisory Council

The ISR Strategic Advisory Council (SAC) is a scientifically and technically diverse group of seasoned professionals external to ISR. Over the years, its membership has been a balanced mix of industry, academics and international representatives. *Figure* 7 lists the SAC members as of July 2015, with their titles and affiliations. Currently, the SAC draws principally from industry.

In theory, the SAC is a key component of ISR. The SAC charter states its purpose is to provide evaluation and guidance to ISR on research directions, educational programs, and management. This advice ideally delivers strategic benefits to ISR and its external partners. The SAC also is encouraged to contribute substantially by identifying important systems engineering challenges facing industry, government and society.

Figure 7: ISR Strategic Advisory Council, July 2015

E.4 Partnerships with international universities and research institutes

ISR has developed formal collaboration agreements with universities and research institutes in a number of countries (see *Table 9*). These agreements have enriched ISR's research enterprise across several dimensions and given it a global perspective. The types of interactions supported include:

- Bidirectional exchange of researchers;
- Bidirectional short-term visits;
- Co-authors of technical papers;
- U.S.-international funding for joint research and joint proposals;
- Committee membership on student thesis committees, co-advising, and faculty selection committees;

Table 9: Formal International Research Agreements

Australia	**Iraq**
University of South Australia	Baghdad University
Egypt	**Italy**
Alexandria University	Autonomous Province of Trento
Finland	University of Trento
University of Oulu, the Centre for Wireless Communications	Politecnico di Milano (University of Milan)
France	**Russia**
École Supérieure d'Électricité (Supélec)	Institute of Information Transmission Problems, Russian Academy of Sciences
L'École Normale Supérieure (ENS)	**Sweden**
Verimag Laboratory	The Royal Institute of Technology, Stockholm (KTH)
Georgia	Linkoping University
Free University of Tbilisi	**Switzerland**
Agricultural University of Georgia	School of Computer and Communication Sciences, Ecole Polytechnique Federale de Lausanne (EPFL)
Greece	
The Institute of Computer Science (ICS) of the Foundation of Research and Technology- Hellas (FORTH)	
Demokritos: The National Center for Scientific Research	

Table 9: Formal International Research Agreements

- Short course development and jointly organized workshops; and
- Joint degree program development

In addition to improving ISR's research enterprise, these relationships also have enhanced ISR's international reputation.

E.5 Major technologies and intellectual property produced by ISR

ISR research has produced a significant body of valuable intellectual property. In many cases, this has occurred because of the close interaction between ISR researchers and industry partners. As discussed above, ISR research has been directly converted into valuable products or business functions by HNS (DirecPC and related products), IAI (CybelePro), Toshiba (Available-to-Promise optimization software), Northrup Grumman (GaN-based materials and process technology) and Metron Aviation (new FSM optimization-based features).

There also have been several cases where ISR faculty have more directly made new technology available commercially, such as through startup companies or direct software distribution. Some examples include:

Andre Tits and his research team developed the CONSOL and FSQP, software tools for constrained non-linear optimization. These were directly distributed by Tits and developed a large user base. They have been used in important application by ISR industry partners, Northrup Grumman and General Electric.

Carol Espy-Wilson won the University of Maryland 2010 Invention of the Year Award for "Multi-Pitch Tracking in Adverse Environments," her invention that radically improves sound quality over cell phones and through hearing aids. Espy-Wilson founded the company Omni-Speech LLC, which has commercialized the underlying basis of this technology.

S. Raghavan, along with his students, developed a technique to rapidly find so-called Bidder-Pareto-Optimal Core Solutions in Combinatorial Auctions. The underlying algorithm and pricing method is now being used internationally in spectrum auctions. This work was awarded the INFORMS Computing Society Prize and was a finalist for the European Excellence in Practice Award.

Ben Shneiderman's research group in the Human Computer Interaction Laboratory has produced several important software tools and visualization mechanisms. Spotfire, a multidimensional data visualization tool produced in the lab, was commercialized by the Spotfire company started by Christopher Ahlberg, a visiting student who worked in the lab. This product is used by a broad range of companies in the pharmaceutical, oil and gas and manufacturing control industries. Treemaps is a 2D data-visualization display that represents hierarchical data along with many associated attributes in a compact graphical view. An associated software product is distributed commercially and the tool has been profiled in several prominent news outlets. Displays based on it have appeared broadly.

The extent of intellectual property produced by ISR faculty is indicated by the long list of patents in *Appendix 11.*

E.6 Analysis and recommendations

Analysis

ISR has had a very deep and broad set of industry interactions. These interactions have enhanced ISR research enterprise by increasing the level of innovation both in the problems studied and the techniques used and has benefitted students.

Both through interactions with industry partners and through more direct entrepreneurial activity, ISR faculty and students have developed substantial new technologies and intellectual property. In many cases, these capabilities have been applied in industry or government settings.

ISR has a strong set of international collaborations. In addition to enhancing its research, these have helped produce a very strong national and international reputation especially within the control community.

The SAC is a potential significant resource to ISR to provide outside/independent perspectives and ideas. In practice, the SAC's value to ISR, and ISR's utilization of the SAC over the years, has varied. Neither the SAC's observations about ISR, nor its advice have had much impact on the Institute. In recent years, the SAC has convened about every 18 months, in addition to contacts during the year via e-mail and conference calls to discuss specific topics. ISR could gain better value from weighing and considering the SAC's deliberations on its behalf, and having more regular meetings.

Opportunities

ISR's industry interaction largely has been based on the application of "systems science" in a variety of domains. There would seem to be an opportunity to substantially interact with, and influence, the "systems engineering" business community to a much greater extent.

While ISR industry impact and interaction has been substantial, and, while some of this activity involves direct ISR faculty entrepreneurial activities, there would appear to be an opportunity for even more entrepreneurial activities, given the extent of innovation produced by ISR research.

ISR certainly could take greater advantage of the SAC's willingness to serve. However, ISR does not have a productive partnership with its SAC at this point. ISR should fundamentally evaluate what kind of a relationship it wants and what it hopes to gain from its external advisory board. This evaluation should cover the SAC's purpose, structure, function, and utilization. ISR also should consider whether it still wants to have an external board.

Appendix 1: ISR Faculty, as of July 1, 2015

ISR joint appointment faculty

Pamela Abshire	Associate Professor	ECE/ISR
Raymond Adomaitis	Professor	CHBE/ISR
Mark Austin	Associate Professor	CEE/ISR
Michael Ball	Professor	BMGT/ISR
John Baras	Professor	ECE/ISR
Alexander Barg	Professor	ECE/ISR
Sarah Bergbreiter	Associate Professor	ME/ISR
W. Rance Cleaveland	Professor	CS/ISR
Anthony Ephremides	Distinguished University Professor	ECE/ISR
Carol Espy-Wilson	Professor	ECE/ISR
Michael Fu	Professor	BMGT/ISR
Reza Ghodssi	ISR Director & Professor	ECE/ISR
S. K. Gupta	Professor	ME/ISR
Jeffrey Herrmann	Professor	ME/ISR
Timothy Horiuchi	Associate Professor	ECE/ISR
Alireza Khaligh	Associate Professor	ECE/ISR
P. S. Krishnaprasad	Professor	ECE/ISR
Richard La	Associate Professor	ECE/ISR
David Lovell	Associate Professor	CEE/ISR
Armand Makowski	Professor	ECE/ISR
Steven Marcus	Professor	ECE/ISR
Nuno Martins	Associate Professor	ECE/ISR
Prakash Narayan	Professor	ECE/ISR
Dana Nau	Professor	CS/ISR
Derek Paley	Associate Professor	AE/ISR
Gang Qu	Professor	ECE/ISR
Subramanian Raghavan	Professor	BMGT/ISR
Michael Rotkowitz	Assistant Professor	ECE/ISR
Gary Rubloff	Professor	MSE/ISR
Shihab Shamma	Professor	ECE/ISR
Benjamin Shapiro	Professor	BIOE/ISR
Jonathan Simon	Professor	ECE/BIO/ISR
Elisabeth Smela	Professor	ME/ISR
Ankur Srivastava	Professor	ECE/ISR
André Tits	Professor	ECE/ISR
Sennur Ulukus	Professor	ECE/ISR
Huan (Mumu) Xu	Assistant Professor	AE/ISR

ISR affiliate faculty

Eyad Abed	Professor	ECE
David L. Akin	Associate Professor	AE
Yiannis Aloimonos	Professor Computer Science	CS/UMIACS
Stuart S. Antman	Professor	MATH/IPST
Behtash Babadi	Assistant Professor	ECE
Radu Balan	Professor	MATH/CSCAMM
Rajeev Barua	Professor	ECE/ISR
Roger W. Brockett	An Wang Professor	Harvard
Nikhil Chopra	Associate Professor	ME
Christopher Davis	Professor	ECE
Jaydev Desai	Professor	ME
Alison Flatau	Professor and Associate Dean for Research	AE
Steven Gabriel	Professor	ME
Neil Goldsman	Professor	ECE
Patrick Kanold	Associate Professor	Biology
Benjamin Kedem	Professor	Math
William S. Levine	Research Professor	ECE
Cynthia Moss	Professor	Johns Hopkins University
Piya Pal	Assistant Professor	ECE
Peter Sandborn	Professor	ME
Ben Shneiderman	Professor	CS/UMIACS
Ian White	Associate Professor	BioE
Min Wu	Professor	ECE/UMIACS
Miao Yu	Associate Professor	ME
Guangming Zhang	Associate Professor	ME

ISR research faculty

Avis Cohen	Research Professor Emerita	Biology/ISR
Didier Depireux	Associate Research Scientist	ISR
Jonathan Fritz	Associate Research Scientist	ISR
Susanne Sterbing-D'Angelo	Assistant Research Scientist	ISR
Daniel Winkowski	Assistant Research Scientist	ISR

Photos: ISR joint appointment faculty

Pamela Abshire
Associate Professor
ECE/ISR

Alexander Barg
Professor
ECE/ISR

Michael Fu
Professor
BMGT/ISR

Raymond Adomaitis
Professor
CHBE/ISR

Sarah Bergbreiter
Associate Professor
ME/ISR

Reza Ghodssi
ISR Director &
Professor
ECE/ISR

Mark Austin
Associate Professor
CEE/ISR

W. Rance Cleaveland
Professor
CS/ISR

S. K. Gupta
Professor
ME/ISR

Michael Ball
Professor
BMGT/ISR

Anthony Ephremides
Distinguished Univer-
sity Professor
ECE/ISR

Jeffrey Herrmann
Professor
ME/ISR

John Baras
Professor
ECE/ISR

Carol Espy-Wilson
Professor
ECE/ISR

Timothy Horiuchi
Associate Professor
ECE/ISR

Alireza Khaligh
Associate Professor
ECE/ISR

Nuno Martins
Associate Professor
ECE/ISR

Michael Rotkowitz
Assistant Professor
ECE/ISR

P. S. Krishnaprasad
Professor
ECE/ISR

Prakash Narayan
Professor
ECE/ISR

Gary Rubloff
Professor
MSE/ISR

Richard La
Associate Professor
ECE/ISR

Dana Nau
Professor
CS/ISR

Shihab Shamma
Professor
ECE/ISR

David Lovell
Associate Professor
CEE/ISR

Derek Paley
Associate Professor
AE/ISR

Benjamin Shapiro
Professor
BIOE/ISR

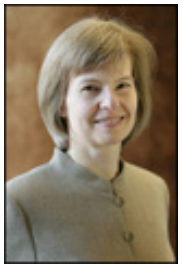
Armand Makowski
Professor
ECE/ISR

Gang Qu
Professor
ECE/ISR

Jonathan Simon
Professor
ECE/BIO/ISR

Steven Marcus
Professor
ECE/ISR

Subramanian Raghavan
Professor
BMGT/ISR



Elisabeth Smela
Professor
ME/ISR

Ankur Srivastava
Professor
ECE/ISR

Yiannis Aloimonos
Professor
Computer Science/CS/
UMIACS

Nikhil Chopra
Associate Professor
ME

André Tits
Professor
ECE/ISR

Stuart S. Antman
Professor
MATH/IPST

Christopher Davis
Professor
ECE

Sennur Ulukus
Professor
ECE/ISR

Behtash Babadi
Assistant Professor
ECE

Jaydev Desai
Professor
ME

Huan (Mumu) Xu
Assistant Professor
AE/ISR

Radu Balan
Professor
MATH/CSCAMM

Alison Flatau
Professor and Associate
Dean for Research
AE

ISR affiliate faculty

Eyad Abed
Professor
ECE

Rajeev Barua
Professor
ECE/ISR

Steven Gabriel
Professor
ME

David L. Akin
Associate Professor
AE

Roger W. Brockett
An Wang Professor
Harvard

Neil Goldsman
Professor
ECE

Patrick Kanold
Associate Professor
Biology

Benjamin Kedem
Professor
Math

William S. Levine
Research Professor
ECE

Cynthia Moss
Professor
Johns Hopkins University

Piya Pal
Assistant Professor
ECE

Peter Sandborn
Professor
ME

Ben Shneiderman
Professor
CS/UMIACS

Ian White
Associate Professor
BioE

Min Wu
Professor
ECE/UMIACS

Miao Yu
Associate Professor
ME

Guangming Zhang
Associate Professor
ME

ISR research faculty

Avis Cohen
Research Professor
Emerita
Biology/ISR

Didier Depireux
Associate Research
Scientist
ISR

Jonathan Fritz
Associate Research
Scientist
ISR

Susanne Sterbing-D'Angelo
Assistant Research
Scientist
ISR

Daniel Winkowski
Assistant Research
Scientist
ISR

Appendix 2: Former ISR faculty members, as of July 1, 2015

Pramod Agrawal
G. Anand Anandalingam
Mathieu Aubailly
Elias Balaras
Carlos Berenstein
Vijay Bharadwaj
Gilmer Blankenship
Sandor Boyson
Kaye Brubaker
Roberto Celi
Kyu-Yong Choi
David E. Corman
Michel Cukier
Jurgen Daniel
W. P. Dayawansa
Judith Dayhoff
Don DeVoe
Robert Dooling
Allison Druin
Ralph Etienne-Cummings
Christos Faloutsos
Nariman Farvardin
Thomas Fuja
Jerome Gansman
Evaggelos Geraniotis
Michael Gruninger
Michael Hadjitheodosiou
George Harhalakis
James Hendler
Dimitrios Hristu-Varsakelis
Sean Humbert
Bruce Jacob
Joseph JáJá
John Kidder
Miroslav Krstic
Carl Landwehr
Laurent Lecordier
Chi H. Lee
K. J. Ray Liu
Nelson Liu
Thomas McAvoy
Raj Madhavan (now visiting)
Stuart Milner
Linda Milor
Ioannis E. Minis
Edward Ott
Haralabos Papadopoulos
Adrian Papamarcou
Michael Pecht
R. Ramesh
Nicholas Roussopoulos
Yalin Sagduyu
Marvin Sambur
Linda Schmidt
Paul Schonfeld
Sanjit Sengupta
Mark Shayman
Nikos Sidiropoulos
Carol Smidts
David Stewart
V. S. Subrahmanian
Petr Svec
Leandros Tassiulas
Mikhail Vorontsov
Gregory Walsh
Thomas Weyrauch
Evanghelos Zafiriou

Appendix 3: ISR Administrative Staff, as of July 1, 2015

Vicci Barrett ..... Coordinator to ISR Director
Rebecca Copeland ..... Director of Public Relations and Information Management
Jeffrey Coriale ..... Director of External Relations
Kimberly Edwards ..... Coordinator to John Baras
Umar Farooq ..... NEXTOR II Research Coodinator
Shawn Fickes ..... Facilities Manager
Alexis Jenkins ..... Coordinator/Payroll Lead
Regina King ..... Coordinator
John MacCarthy ..... Director, Systems Engineering Education Program
Jeffrey McKinney ..... Director, Computing Facilities
Ania Picard ..... Assistant Director of Administrative Affairs, Maryland Robotics Center
Carla Scarbor ..... Finance Coordinator
Toye Stokes ..... Accounting Associate
Jason Strahan ..... Director of Administrative Services
Dawn Wheeler ..... Assistant Director of Administrative Services

Appendix 4: Fellows

Acoustical Society of America

Robert Dooling
Carol Espy-Wilson (2005)
Cynthia Moss (2001)
Shihab Shamma (2004)

Alfred P. Sloan Foundation Research Fellow

Patrick Kanold (2010)

American Association for Artificial Intelligence

James Hendler (2000)
Dana Nau (1996)

American Association for the Advancement of Science

John Baras (2015)
Avis Cohen (2008)
Cynthia Moss (2013)
Ben Shneiderman (2001)
V. S. Subrahmanian (2008)

American Institute of Aeronautics and Astronautics

Alison Flatau (2015)

American Institute of Chemical Engineers

Raymond Adomaitis (2011)
Thomas McAvoy (1989)

American Physical Society

Gary Rubloff (1986)

American Psychological Association

Robert Dooling

American Society of Civil Engineers

Paul Schonfeld (1994)

American Society of Mechanical Engineers

S. K. Gupta (2007)
Peter Sandborn (2013)
Jaydev Desai (2015)
Alison Flatau (2015)
Reza Ghodssi (2015)

American Statistical Association

Ben Kedem (1999)

American Vacuum Society

Gary Rubloff (1993)
Reza Ghodssi (2015)

Association for Computing Machinery

Joseph JáJá (2001)
Dana Nau (2013)
Nicholas Roussopoulos (2001)
Ben Shneiderman (1997)

Institute for Operations Research and the Management Sciences (INFORMS)

Michael Ball (2004)
Michael Fu (2007)

Institute of Electrical and Electronics Engineers

Eyad Abed (2001)
Alexander Barg (2007)
Anthony Ephremides (1984)
Michael Fu (2007)
Joseph JáJá (1996)
Carl Landwehr (2013)
William Levine (1986)
Armand Makowski (2006)
Prakash Narayan (2001)
Ben Shneiderman (2011)
Sennur Ulukus (2015)
John Baras (1984)
Roger W. Brockett (1974)
Nariman Farvardin (1998)
Reza Ghodssi (2015)
P. S. Krishnaprasad (1990)
Chi Lee (1991)
K. J. Ray Liu (2002)
Steven Marcus (1986)
Mark Shayman (2009)
André Tits (1998)
Min Wu (2010)

Institute of Transportation Engineers

Paul Schonfeld (1998)

Korean Academy of Science and Technology

Kyu-Yong Choi (2001)

National Academy of Engineering

Roger W. Brockett (1991)
Ben Shneiderman (2010)

National Academy of Engineering of Korea

Kyu-Yong Choi (2000)

National Academy of Inventors

John Baras (2015)
Ben Shneiderman (2015)

Optical Society of America

Chi Lee

Royal Swedish Academy of Engineering Science

John Baras (2006)

Society for Industrial and Applied Mathematics

Stuart Antman (2009)
John Baras (2014)
Steven Marcus (2009)

Appendix 5: Plenary and Semi-Plenary Lectures by ISR Joint Faculty Members, 2010–2015

Raymond Adomaitis

"Current Modeling and Simulation Challenges in Thin-Film Deposition Processes" Area 10d Plenary Talk, AIChE Annual Meeting, San Francisco, November 2013.

Michael Ball

"Collaborative Decision Making in Air Traffic Management," Triennial Symposium on Transportation Analysis (TRISTAN 8), San Pedro de Atadama, Chile, June, 2013.

"Model Decomposition and Integration: Case Studies from Urban Transit and Airline Planning Problems." 2015 INFORMS Workshop on Transportation Science and Logistics, Berlin, July, 7 2015.

John Baras

"Dynamic Magic Graphs in Cooperative Networked Systems," invited plenary address, 19th International Symposium on Mathematical Theory of Networks and Systems (MTNS 2010), Budapest, Hungary, July 5-9, 2010.

"Component-based Architectures for the Synthesis of Intelligent Networked Systems," invited plenary lecture, First IEEE International Conference on Cyber Technology in Automation, Control and Intelligent Systems (IEEE-CYBER 2011), pp.10-14, Kunming, China, March 21, 2011.

"Component-Based Networking and Design of Wireless Network Protocols," invited distinguished lecture, Department of Electronic Engineering of Tsinghua University, Beijing, China, March 23, 2011.

"Network Science Principles and Cooperative Networked Systems," invited distinguished lecture, the Institute of Systems Science (ISS) of the Chinese Academy of Mathematics and Systems Science (AMSS), Beijing, China, March 23, 2011.

"Physical Layer Security and Trust Mechanisms: Critical and Indispensable," invited keynote address, 2nd Army Research Office Special Workshop on Hardware Assurance, Washington, D.C., April 11, 2011.

"Challenges and Opportunities for Future Broadband Networks: From Physical to Services to Social," invited keynote address, Kick-off meeting of the new center of excellence Labex Comin Labs, June 8, 2011.

"Cooperative Networked Systems: Multiple Graphs, Coalitional Games, New Probabilistic Models," invited plenary lecture, 19th Mediterranean Conference on Control and Automation, (MED2011), Kunming, Corfu, Greece, June 22, 2011

"Wireless Information Infrastructures and the Future Internet: Protocol Components, System Architectures, Security and Privacy," invited tutorial, 14th International Symposium on Wireless Personal Multimedia Communications (WPMC'11), Brest, Bretagne, France, October 3, 2011.

Sarah Bergbreiter

S. Bergbreiter, "Tiny Leaps for Robot-Kind: Combining Microfabrication and Robotics," Living Machines – International Conference on Biomimetic and Biohybrid Systems, Milan, Aug. 1, 2014.

Tony Ephremides

"The Audacity of Throughput," Invited Plenary Lecture at the IEEE International Symposium on Information Theory, in Austin, Texas, June, 2010.

"Being Cooperative," Invited Plenary Lecture at the Conference on Information Sciences and Systems, Princeton, March 2010.

"To Schedule or Not to Schedule," Invited Plenary Lecture at the IEEE Globecom, Miami, FL, December 2010.

"A Broader View of Cooperation in Wireless Networks." International Workshop on Machine to Machine Technology (M2M 2011), October 31, 2011.

Carol Espy-Wilson

"A Change Must Come: African Americans and STEM." College Board's 2015 Diversity Conferences: A Dream Deferred: The Future of African American Education. New Orleans, March 11, 2015.

Raj Madhavan

"Smart, Flexible, and Safe Industrial Mobile Robots: Evaluation & Benchmarking of Navigation Performance in Unstructured and Dynamic Environments." 5th Robotics and Mechatronics Conference, Pretoria, South Africa, November 26-27, 2012.

Prakash Narayan

Plenary Lecture, 2012 IEEE International Symposium on Information Theory, Cambridge, Mass., July 2012.

Plenary Lecture, International Conference on Signal Processing and Communications, Indian Institute of Science, Bangalore, India, July 2012.

Plenary Lecture, National Conference on Communications (NCC 2014), I.I.T. Kanpur, India, March 2014.

Gang Qu

"Building Trusted Infrastructure for IoT", CAST-FEST, IEEE Circuits and Systems Society Forum on Emerging and Selected Topics, IEEE International Symposium on Circuits and Systems (ISCAS'13), Beijing, China, May 19, 2013.

"When Fault Tolerant (Circuit) Design Meets the Internet of Things", 16th Conference on Fault-Tolerance Computing (CFTC), Shanghai, China, July 18, 2015.

"Hardware in Cybersecurity: from the Weakest Link to Great Promises", 11th International Symposium on Advanced Parallel Processing Technology (APPT), Jinan, China, August 20, 2015.

Piya Pal

"Sparse and Coprime Sampling: Benefits, Challenges and Future Directions," plenary talk, 2015 IEEE Underwater Acoustic Signal Processing Workshop, West Greenwich, Rhode Island, Oct. 14, 2015.

Michael Rotkowitz

"Information structures, stability, and optimality," 20th International Symposium on Mathematical Theory of Networks and Systems, Semi-Plenary Lecture, Melbourne, Australia, July 2012.

S. Raghavan

"Multi-Period Traffic Routing in Satellite Networks." (2010 MSSIP award winning plenary talk at EURO conference). 24th European Conference on Operational Research (EURO), Lisbon, July 11-14, 2010. co-author: Ioannis Gamvros.

Ben Shapiro

"Magnetic Control of Therapy to Hard-to-Reach Disease Targets," semi-plenary lecture, 2015 American Control Conference, Chicago, July 1–3, 2015.

"Choosing, Placing, and Immobilizing Nanoscopic Objects On-Chip with Nanoscale Precision by Flow Control." Plenary Talk, nanoscale science conference (3M-NANO), Xi'an China, Aug. 29, 2012.

Appendix 6: Faculty Honors and Awards from Academia, Professional Societies and other Sources, 1985–Present

ALCOA Foundation

Engineering Research Achievement Award

Rance Cleaveland (1994)

Alexander von Humboldt Foundation

Senior Scientist Award

Ramamoorthy Ramesh (2000)

American Institute of Aeronautics and Astronautics

"Broken Propeller" Award

David Akin (1999)

American Helicopter Society

Schroers Award for Outstanding Rotorcraft Research

William Levine (1998)

American Society for Quality Control

Reliability Division—Austin Bonis Award for the Advancement of Reliability Education

Michael Pecht (1996)

American Society of Mechanical Engineers

Computers and Information in Engineering Division's Excellence in Research Award

S. K. Gupta (2013)

Lyapunov Award

Stuart Antman (2015)

American Vacuum Society

Gaede-Langmuir Award

Gary Rubloff (2000)

Association for Computing Machinery

ACM/SIGMOBILE Award for Outstanding Contributions to Research on Mobility of Systems, Users, Data, and Computing

Anthony Ephremides (1996)

ACM SIG Governing Board Recognition of Service Award

Gang Qu (2005, 2006)

Special Interest Group on Design of Communication (SIGDOC) Rigo Award

Ben Shneiderman (1996)

Distinguished Speaker

Ankur Srivastava (2012)

Baron Barclay World Bridge Computer Challenge

Winner

Dana Nau (1997)

DARPA

Award for Outstanding Performance

John Baras (1995)

European Association of Operational Research Societies (EURO)

European Excellence in Practice Award finalist

S. Raghavan (2009)

Management Science Strategic Innovation Prize

S. Raghavan (2010)

Engineers Without Borders

EWB-USA Peter J Bosscher Faculty Adviser Award

David Lovell (2012)

European Research Council

Advanced Senior Award

Shihab Shamma (2012)

Hebrew University of Jerusalem

Lady Davis Trust Fellowship (Visiting Professorship)

Armand Makowski (2014)

Institute for Operations Research and the Management Sciences (INFORMS)

INFORMS Simulation Society Outstanding Simulation Publication Award

Michael Fu (1998)

Operations Research Meritorious Service Award

Michael Fu (1999)

Daniel H Wagner Prize for Excellence in Operations Research Practice

S. Raghavan (2005)

INFORMS Computing Society Outstanding Service Award

S. Raghavan (2005)

Institute of Electrical and Electronics Engineers

IEEE Control System Society Hendrik W. Bode Lecture Prize
P. S. Krishnaprasad (2007)

IEEE Control System Society Distinguished Faculty Research Fellow
P. S. Krishnaprasad (1998)

IEEE Information Theory Society Paper Award
Alexander Barg and Izthak Tamo (2015)

IEEE Signal Processing Society Distinguished Lecturer
K. J. Ray Liu (2003)

IEEE Vehicular Technology Society Distinguished Lecturer
Alireza Khaligh (2014)

Leonard G Abraham Prize in Communication Systems
John Baras (2007)

Best Paper Award for Wireless Networks
John Baras (2008)

IEEE Donald Fink Paper Award for Best Tutorial Paper
Anthony Ephremides (1991)

Third Millenium Medal
Anthony Ephremides (1999)
William Levine (1999)

Institute of Industrial Engineers

Operations Research Division Award
Michael Fu (1999)

International Society of Agile Manufacturing

Outstanding Achievement in Service Award
Guangming Zhang (1998)

National Aeronautical and Space Administration

Goddard Exceptional Achievement Award
Ben Kedem (1997)

National Institutes of Health

Independent Scientist Award
Carol Espy-Wilson

Naval Research Laboratory

Alan Berman Research Publication Award
Eyad Abed
John Baras (1978, 1983, 1993)
Anthony Ephremides (1987, 1996, 2000, 2002, 2004, 2006)

Society for Industrial and Applied Mathematics (SIAM)

Theodore von Karman Prize
Stuart Antman (1999)

Control and Systems Theory Prize
Michael Rotkowitz (2011)

Society for Automotive Engineers

Excellence in Oral Presentation Award
Rance Cleaveland (2008)

Ralph R Teetor Educational Award
Alireza Khaligh (2010)

Society for Health Systems

Diplomate
Jeffrey Herrmann (2013)

Society of Manufacturing Engineers

Member of the Year Award, Region 3
Guangming Zhang (1999)

Technology Review

Top 100 young innovators in the world
Min Wu (2004)

Appendix 7: Best Paper Awards, Journals and Conferences, 1985–Present

American Automatic Control Council

O. Hugo Schuck Best Paper Award (best paper at the American Control Conference)

Eyad Abed

Miroslav Kristic (1998)

Nuno Martins (2006)

American Vacuum Society

Best Paper Award

Reza Ghodssi (2004)

American Society of Mechanical Engineers

Best Paper Award

S. K. Gupta (1994, 1999, 2006, 2010, 2012)

Dana Nau (1994)

Prakash Krishnaswami Best Paper Award

S. K. Gupta (2013)

Army Science Conference

Best Paper Award

John Baras (2002, 2008)

Association for the Advancement of Artificial Intelligence

Conference on Artificial Intelligence Planning and Scheduling Distinguished Performance Award

Dana Nau (2002)

Association for Computing Machinery

ACM SIGMOD Best Paper Award

Nicholas Roussopoulos (1999)

ACM Workshop Best Paper Award

John Baras (2004)

Computer Aided Design Journal

Most Cited Paper Award

S. K. Gupta (2012)

Conference on Systems Engineering Research

Best Conference Paper Award

Mark Austin (2013)

MITRE Best Transition in Systems Engineering Research Award

Mark Austin (2015)

Design SuperCon

Outstanding Paper Award

John Baras (1996)

European Association for Signal Processing (EURASIP)

Journal on Applied Signal Processing Best Paper Award

K. J. Ray Liu (2004)

Min Wu (2004)

European Conference on Case-Based Reasoning

Best Research Paper Award

Dana Nau (2002)

Institute of Electrical and Electronics Engineers

IEEE Control Systems Society George S. Axelby Outstanding Paper Award

Nuno Martins (2010)
John Baras (1980)

IEEE/ASEE Frontiers in Education Conference Benjamin J. Dasher Best Paper Award

Steven Marcus (2002)

IEEE International Conference on Application-specific Systems, Architectures and Processors Best Paper Award

Gang Qu (2006)

IEEE International Conference on Robotics and Automation Best Conference Paper Award

Sarah Bergbreiter (2010)

IEEE International Symposium on VLSI Design, Automation and Test Best Paper Award

Ankur Srivastava (2012)

IEEE Guglielmo Marconi Prize Best Paper Award (best paper published in IEEE Transactions on Wireless Communications)

Sennur Ulukus (2003)

IEEE MILCOM Fred Ellersick Award for Best Paper

Anthony Ephremides (2000)

IEEE/RSJ International Conference on Intelligent Robots and Systems New Technology Foundation (NTF) Award for Entertainment Robots and Systems

Sarah Bergbreiter (2011)

IEEE International Symposium on Modeling and Optimization in Mobile, Ad-hoc and Wireless Networks Best Paper Award

Anthony Ephremides (2010)

IEEE Signal Processing Society Best Paper Award
K. J. Ray Liu (2005)
Min Wu (2005)

IEEE Vehicular Technology Society Best Vehicular Electronics Paper Award
Alireza Khaligh (2012, 2013)

IEEE Vehicular Technology Conference Best Paper Award
K. J. Ray Liu (1999)

Institute of Industrial Engineers

Transactions on Operations Engineering Best Paper Award
Michael Fu (1998, 1999)

International Council on Systems Engineering (INCOSE)

B. Mar Outstanding Systems Engineering Paper Award
Mark Austin (2012)

Institute for Operations Research and the Management Sciences (INFORMS)

Junior Faculty paper competition, second place prize
S. Raghavan (2003)

Computing Society Prize
S. Raghavan (2005, 2008)

Glover/Klingman Prize for the best paper published in the journal Networks
S. Raghavan (2006)

International Conference on Automated Planning and Scheduling

Influential Paper Honorable Mention
Dana Nau (2002)

International Conference on Indium Phosphide and Related Materials

Best Paper Award
Reza Ghodssi (2005)

International Conference on Research in Air Transportation

Best Paper Award
David Lovell (2013)

International Symposium on Highway Geometric Design

Best Paper Award
David Lovell (2010)

Literati Club

Highly Commended Award
S. K. Gupta (2002)

National Fire Protection Association

Harry C. Bigglestone Award (Best Paper in Fire Technology)
Thomas McAvoy (1996)

Science Spectrum Magazine

Trailblazer Award
S. K. Gupta (2006)

World MultiConference on Systemics, Cybernetics, and Informatics

Best Paper Award
Mark Austin (2002)

USA/Europe ATM R&D Seminar

Best Paper Award
Michael Ball (2003)

Best Paper in Traffic Flow Optimization
Michael Ball (2005)

Best Paper in Metrics and Performance Management
Michael Ball (2005)

Best Paper in Finance and Policy
Michael Ball (2011)

USA/Europe International Conference on Research in Air Transportation

Best Paper in Advanced Modeling
Michael Ball (2012)

Best Paper in Network Management
Michael Ball (2014)

Winter Simulation Conference

Best Theoretical Paper Award
Michael Fu (2009, 2012)

Appendix 8: Young Faculty Awards to ISR Faculty

Presidential Early Career Award for Scientists and Engineers (PECASE)

Sarah Bergbreiter (2013)
Don DeVoe (1999)
S. K. Gupta (2001)
Derek Paley (2013)
Elisabeth Smela (2004)

NSF CAREER Award

Pamela Abshire (2003)
Elias Balaras (2004)
Rajeev Barua (2001)
Sarah Bergbreiter (2011)
Michel Cukier (2003)
Don DeVoe (1999)
Alison Druin (2000)
Ralph Etienne-Cummings (1996)
Reza Ghodssi (2002)
S. K. Gupta (2001)
Timothy Horiuchi (2004)
Bruce Jacob (2000)
Miroslav Kristic (1996)
Richard La (2003)
Nuno Martins (2007)
Derek Paley (2010)
Harhalabos Papadopolous (2001)
Michael Rotkowitz (2014)
Linda Schmidt (1999)
Benjamin Shapiro (2004)
Elisabeth Smela (2003)
David Stewart (1998)
Sennur Ulukus (2005)
Gregory Walsh (1997)
Ian White (2012)
Min Wu (2001)
Miao Yu (2007)

NSF Presidential Young Investigator Award (1984–1991) and Young Investigator Award (1992–1996)

Eyad Abed (1987)
Rance Cleaveland (1992)
Nariman Farvardin (1987)
K. J. Ray Liu (1994)
Armand Makowski (1984)
Dana Nau (1984)
V.S. Subrahamanian (1993)
André Tits (1985)

Office of Naval Research Young Investigator Award

Rance Cleaveland (1992)
Ralph Etienne-Cummings (2000)
S. K. Gupta (2000)
Leandros Tassiulas (1997)
Min Wu (2005)

Society of Manufacturing Engineers Robert W. Galvin Outstanding Young Manufacturing Engineer Award

S. K. Gupta (2000)

Society of Manufacturing Engineers Jiri Tlusty Outstanding Young Manufacturing Engineer Award

Jeffrey Herrmann (2003)

DARPA Young Faculty Award

Sarah Bergbreiter (2008)

IBM Faculty Development Award

Dana Nau (1984)

Maryland Distinguished Young Scientist Award

V.S. Subrahamanian (1997)

NSF Engineering Education Scholar

Raymond A. Adomaitis (1995)

Appendix 9: University of Maryland Awards Won by ISR Faculty, 1985–Present

University-wide

$75K Business Plan Competition
Carol Espy-Wilson (2010)

Academy of Excellence, Teaching and Learning
Anthony Ephremides (2002)

ADVANCE Leadership Fellow
Nuno Martins (2013)

Distinguished University Professor
Anthony Ephremides (2012)

Distinguished Scholar-Teacher Award
Avis Cohen (2011)
Carol Espy-Wilson (2012)
Michael Fu (2004)
Reza Ghodssi (2014)
K. J. Ray Liu (2007)
Steve Marcus (2000)
Thomas McAvoy (1997)
Min Wu (2013)

George Corcoran Education Award
Min Wu (2003)

Invention of the Year
Pamela Abshire (2004)
John Baras (1984, 1991, 1994, 2009)
Christopher Davis (2000)
Anthony Ephremides (1995)
Carol Espy-Wilson (2010)
Nariman Farvardin (1999)
Neil Goldsman (2009)
S. K. Gupta (2008)
James Hendler (1998)
K. J. Ray Liu (2004)
Gary Rubloff (2010; 2015)
Benjamin Shapiro (2004)
Ben Shneiderman (2000)
Elisabeth Smela (2004)
V. S. Subrahmanian (2000)
Min Wu (2012; 2015)

Kirwan Faculty Research and Scholarship Prize
Anthony Ephremides (2001)

Mancur Olson Research Achievement Award
John Baras (1998)

Maryland Industrial Partnerships Awards
Principal Investigator with Greatest Impact, John Baras (2012)
Largest Selling Product, John Baras (2012)

Regents' Faculty Award for Research, Scholarship and Creative Activities
Cynthia Moss (2010)

Clark School of Engineering

E. Robert Kent Outstanding Teaching Award for Junior Faculty
Pamela Abshire (2011)
Kaye Brubaker (2003)
Elisabeth Smela (2004)
Ian White (2013)
Min Wu (2009)
Guangming Zhang (1993)
George Harhalakis (1987)

ENGAGED Faculty Award
David Lovell (2011)

ENPM Outstanding Teaching Award
Guangming Zhang (2006)

Faculty Outstanding Research Award
Anthony Ephremides (1990)
Ramamoorthy Ramesh (2001)

Faculty Service Award
André Tits (2011)

Keystone Professor
Guangming Zhang (2006)

Poole and Kent Teaching Award for Senior Faculty
K. J. Ray Liu (2005)
Steve Marcus (2013)
Peter Sandborn (2009)
Guangming Zhang (2004)

Smith School of Business

Allen J. Krowe Award for Teaching Excellence
Michael Fu (1995)

Appendix 10: Faculty Books, 1985–Present

2016

The New ABCs of Research: Achieving Breakthrough Collaborations; Ben Shneiderman (ISR); Oxford University Press, 2016.

2015

Engineering Decision Making and Risk Management; Jeffrey Herrmann (ISR); Wiley, 2015

Handbook of Simulation Optimization; Michael C. Fu (ISR), Ed.; Springer; 2015

The Auditory System at the Cocktail Party, Jonathan Simon (ISR) co-editor, forthcoming 2015

2014

Encyclopedia of Thermal Packaging, Set 2: Thermal Packaging Tools, Volume 4: Thermally-Informed Design of Microelectronic Components; Ankur Srivastava (ISR), Sachin Sapatnekar, Bing Shi, Yufu Zhang; World Scientific, 2014

Handbook of Modern Techniques in Auditory Cortex; Depireux (ISR), Elhilali (alumna; Johns Hopkins University); Nova Science Pub.; 2014

Discrete Geometry and Algebraic Combinatorics, Alexander Barg (ISR) and Oleg R. Musin, University of Texas at Brownsville, Editors; American Mathematical Society; 2014

Small-Scale Robotics from Nano-to-Millimeter-Sized Robotic Systems and Applications, Sarah Bergbreiter (ISR) and Igor Paprotny, Eds.; Springer, 2014

2013

Handbook of Operations Research for Homeland Security, Jeffrey Herrmann, Ed., Springer, 2013

Encyclopedia of Operations Research and Management Science; Fu (ISR) and Gass; Springer, 2013

Simulation-Based Algorithms for Markov Decision Processes, Second Edition; Hyeong Soo Chang, Michael C. Fu (ISR), Jiaqiao Hu, Steve Marcus (ISR); Springer; 2013

2012

Complementarity Modeling in Energy Markets; Gabriel (ISR), Conejo, Fuller, Hobbs, Ruiz; Springer; 2012

Strategies to the Prediction, Mitigation, and Management of Product Obsolescence; Bjoern Bartels, Ulrich Ermel, Peter Sandborn (ISR), Michael G. Pecht; Wiley; 2012

Feedback Control of MEMS to Atoms; Ben Shapiro (ISR), Jason Gorman, eds.; Springer; 2012

2011

Simulation Driven Innovation and Discovery in Energetics Applications; D.K. Anand, S.K. Gupta (ISR), R. Kavetsky; CALCE EPRC Press, University of Maryland; 2011

Engineering Dynamics: A Comprehensive Introduction; N. Jeremy Kasdin (Princeton University), Derek Paley (AE/ISR); Princeton University Press; 2011

Scheduling in Wireless Networks; Anna Pantelidou (ISR alumnae), Anthony Ephremides (ISR); Now Publishers, Inc.; 2011

MEMS Materials and Processes Handbook; Reza Ghodssi (ISR), Piyen Lin eds.; Springer; 2011

Decision and Game Theory for Security; John Baras (ISR), Tansu Alpcan, Levente Buttyán; Springer; 2011

2010

The Control Handbook, 2nd Ed.; William Levine, ed. (ISR); CRC Press; 2010

Path Problems in Networks (Synthesis Lectures on Communication Networks); John Baras and George Theodorakopoulos (ISR); Morgan & Claypool Publishers; 2010

2009

Building Scientific Apparatus, 4th Ed.; Christopher Davis (ISR), John H. Moore, Michael A. Coplan and Sandra C. Greer; Cambridge University Press; 2009

Bilinear Control Systems: Matrices in Action; David Elliott (ISR); Springer; 2009

Energy Harvesting: Solar, Wind, and Ocean Energy Conversion Systems, Alireza Khaligh (ISR), Omer C. Onar; CRC Press, 2009

Integrated Power Electronic Converters and Digital Control, Ali Emadi, Alireza Khaligh (ISR), Zhong Nie, Young Joo Lee; CRC Press, 2009

2008

Engineering Design and Pro/ENGINEER Wildfire v.4.0, 4th ed.; Guangming Zhang (ISR); College House Enterprises, LLC; 2008

Introduction to Engineering Design, Book 9, Third Edition, Engineering Skills and Hovercraft Missions; Vincent Branningan, Kevin Calabro, James Dally, William Fourney, Bruce Jacob, Wesley Lawson, Gary Pertmer and Guangming Zhang (ISR); College House Enterprises, LLC; 2008

The Vehicle Routing Problem: Latest Advances and New Challenges; S. (Raghu) Raghavan (ISR), Bruce Golden and Edward Wasil; Springer; 2008

Telecommunications Modeling, Policy, and Technology Series: Operations Research/Computer Science Interfaces Series, Vol. 44; S. (Raghu) Raghavan (ISR), Bruce Golden and Edward Wasil; Springer; 2008

Training in Virtual Environments: A Safe, Cost-Effective, and Engaging Approach to Training; S.K. Gupta (ISR), D.K. Anand, J. Brough, M. Schwartz, and R. Kavetsky; CALCE EPSC; 2008

2007

Ultra-Wideband Communications Systems: Multiband OFDM Approach; K.J. Ray Liu (ISR), W. Pam Siriwongpairat (alumnae and former postdoc); Wiley; 2007

Network-Aware Security for Group Communications; K.J. Ray Liu (ISR) Yan Sun, Wade Trappe (alumni); Springer; 2007

Simulation-Based Algorithms for Markov Decision Processes; Hyeong Soo Chang, Michael C. Fu (ISR), Jiaqiao Hu, Steve Marcus (ISR); Springer; 2007

2006

Perspectives in Operations Research; Frank Alt, Michael C. Fu (ISR) and Bruce Golden, eds.; Springer; 2006

Telecommunications Planning: Innovations in Pricing, Network Design and Management; G. Anandalingam (ISR) and S. (Raghu) Raghavan (ISR), eds.; Springer; 2006

Contemporary Mathematics 405: Integral Geometry and Tomography; Carlos Berenstein, John Baras, Franklin Gavilánez (all ISR), article; American Mathematical Society; 2006

Proceedings of the Royal Society of London, Series A; Eric Justh and P.S. Krishnaprasad (both ISR), article; The Royal Society; 2006

Handbook of Production Scheduling; Jeffrey Herrmann (ISR), ed.; Springer; 2006

2005

Handbook of Networked and Embedded Control Systems; William Levine and Dimitrios Hristu-Varsakelis (both ISR), eds.; Birkhäuser; 2005

Multimedia Fingerprinting Forensics for Traitor Tracing; Min Wu, K.J. Ray Liu, Z. Jane Wang, Wade Trappe and Hong Zhao (all ISR); Hindawi Publishing Corp.; 2005

The Next Wave in Computing, Optimization, and Decision Technologies; S. (Raghu) Raghavan (ISR), Bruce L. Golden and Edward Wasil, eds.; Springer; 2005

Advances in Control, Communication Networks, and Transportation Systems: In Honor of Pravin Varaiya; Eyad Abed (ISR), ed.; Birkhäuser; 2005

2004

Harmonic Analysis, Signal Processing and Complexity; Carlos Berenstein, P.S. Krishnaprasad, David Walnut, Radha Poovendran (all ISR), contributors; Birkhäuser; 2004

Designing the User Interface: Strategies for Effective Human-Computer Interaction, 4th ed.; Ben Shneiderman (ISR) and Catherine Plaisant; Addison-Wesley; 2004

Automated Planning; Dana Nau (ISR) Malik Ghallab and Paolo Traverso; Morgan Kaufmann Publishers; 2004

Introduction to Engineering Programming in C, Matlab and Java; Mark Austin and David Chancogne (both ISR); Wiley; 2004

Advances in the Study of Echolocation in Bats and Dolphins; Jeanette Thomas, Cynthia Moss (ISR) and Marianne Vater, eds.; University of Chicago Press; 2004

2003

The Craft of Information Visualization: Readings and Reflections; Ben Shneiderman (ISR) and Ben Bederson (HCIL); Elsevier Morgan Kaufmann; 2003

Intellectual Property Protection in VLSI Designs: Theory and Practice; Gang Qu (ISR), Miodrag Potkonjak; Springer, 2003

Spinning the Semantic Web; Dieter Fensel, James Hendler (ISR), Henry Lieberman and Wolfgang Wahlster, eds.; MIT Press; 2003

2002

Introduction to Cryptography with Coding Theory; Wade Trappe (ISR) and Lawrence Washington (Math); Prentice Hall; 2002; 2nd Ed. 2006

Leonardo's Laptop; Ben Shneiderman (ISR); MIT Press; 2002

Building Scientific Apparatus, 3rd Ed.; John Moore (Chemistry), Christopher Davis (ISR), Michael Coplan (IPST) and Sandra Greer (Chemistry); Westview Press; 2002

2001

Design of Digital Video Coding Systems: A Complete Compressed Domain Approach; Ut-Va Koc, Jie Chen and K.J. Ray Liu (all ISR); Marcel Dekker, Ltd.; 2001

2000

Nonlinear Control and Analytical Mechanics: A Computational Approach; William Levine (ISR), series editor; Birkhäuser; 2000

1999

Control System Applications; William Levine (ISR); CRC Press; 1999

Control System Fundamentals; William Levine (ISR); CRC Press; 1999

Robust Kalman Filtering for Signals and Systems with Large Uncertainties; William Levine (ISR), series editor; Birkhäuser; 1999

Robot Analysis: The Mechanics of Serial and Parallel Manipulators; Lung-Wen Tsai (ISR); Wiley; 1999

Readings in Information Visualization: Using Vision to Think; Ben Shneiderman (ISR), Stu Card and Jock Mackinlay; Elsevier; 1999

1998

Quality Management in Systems; Guangming Zhang (ISR); The Commercial Press; 1998

High Performance VLSI Signal Processing: Vol. 1—Algorithms and Architectures; K.J. Ray Liu (ISR) and Kung Yao, eds.; Wiley; 1998

High Performance VLSI Signal Processing: Vol. 2—Systems Design and Applications; K.J. Ray Liu (ISR) and Kung Yao, eds.; Wiley; 1998

1997

Neural Systems for Control; David Elliott (ISR) and Omid Omidvar, eds. Shihab Shamma (ISR), chapter; Elsevier; 1997

Conditional Monte Carlo: Gradient Estimation and Optimization Applications; Winner, 1998 INFORMS College on Simulation Outstanding Simulation Publication Award; Michael Fu (ISR) and Jian-Qiang Hu; Springer; 1997

Robust Process Control; Manfred Morari, Evanghelos Zafiriou (ISR); Prentice Hall; 1997

Motion; Motion, Control, and Geometry: Proceedings of a Symposium; Roger Brockett and P.S. Krishnaprasad (both ISR), sections; National Academies Press; 1997

1996

Searching Multimedia Databases by Content; Christos Faloutsos (ISR); Kluwer Academic Publishers; 1996

The Control Handbook; William S. Levine (ISR); CRC Press; 1996

Mechanics Day; P.S. Krishnaprasad, R. Yang, and W. Dayawansa (all ISR), chapter; P.S. Krishnaprasad, Tudor Ratiu and William F. Shadwik, eds.; American Mathematical Society; 1996

Neuroethological Studies of Cognitive and Perceptual Processes; Cynthia Moss (ISR) and Sara Shettleworth, eds.; Westview Press; 1996

1995

Using MATLAB to Analyze and Design Control Systems; Naomi Leonard and William Levine (both ISR); Addison Wesley; 1995

Nonlinear and Adaptive Control Design; Miroslav Krstic (ISR), Ioannis Kanellakopoulos, Petar Kokotovic; Wiley; 1995

1994

Massively Parallel Artificial Intelligence; Hiroaki Kitano and James Hendler (ISR), eds.; MIT Press; 1994

1993

Sparks of Innovation in Human-Computer Interaction; Ben Shneiderman (ISR), ed.; Ablex Publishing; 1993

Appendix 11: Patents to ISR Faculty, 1985–Present

Communication systems and networks

Wireless communication method and system for transmission authentication at the physical layer
John S. Baras, Paul L.Yu, Brian Sadler
10/13/2015 9,161,214

Method and apparatus for authenticating biometric scanners
Vladimir Ivanov, John S. Baras
02/10/2015 8,953,848

Method and apparatus for authenticating swipe biometric scanners
Vladimir Ivanov, John S. Baras
01/27/2015 8,942,438

Method and apparatus for authenticating area biometric scanners
Vladimir Ivanov, John S. Baras
01/27/2015 8,942,430

Method and implementation for information exchange using Markov models
John Baras, Paul Yu, Brian Sadler
09/30/2014 8,848,904

Systems, Methods, Devices, and Computer Program Products for Control and Performance Prediction in Wireless Networks
Christopher Davis, Stuart Milner, Jaime Llorca
09/09/2014 8,831,524

Method of performance-aware security of unicast communication in hybrid satellite networks
John Baras, Ayan Roy-Chowdhury
03/11/2014 8,671,273

Systems and methods for multiple pitch tracking using a multidimensional function and strength values
Carol Espy-Wilson, Srikanth Vishnubhotla
03/04/2014 8,666,734

Method and apparatus for authenticating biometric scanners
John Baras,Vladimir Ivanov
11/05/2013 8,577,091

Method and System for Cooperative Transmission in Wireless Multi-Hop Networks
Anthony Ephremides, Beiyu Rong
09/24/2013 8,542,579

Detection of distributed denial of service attacks in autonomous system domain
Chris Kommareddy, Samrat Bhattacharjee; Mark Shayman, Richard La
03/12/2013 8,397,284

Method and System for Source Authentication in Group Communications
John S. Baras, Ayan Roy-Chowdhury
03/12/2013 8,397,062

Topology Selection and Broadcast Method for Rule-Based Link State Routing
John S. Baras, Kiran Somasundaram, Kaustubh Jain,Vahid Tabatabaee
12/04/2012 8,325,746

Data Hiding in Compiled Program Binaries for Supplementing Computer Functionality
Min Wu, Ashwin Swaminathan,Yinian Mao
11/23/2010 7,840,789

An Improved Communications Protocol
John S. Baras, Xiaoming Zhou
11/02/2010 7,827,459

System and method for automatic speech recognition from phonetic features and acoustic landmarks
Carol Espy-Wilson, Amit Juneja
02/16/2010 7,664,642

Denoising Mechanism for Speech Signals using Embedded Thresholds and an Analysis Dictionary
Carlos Berenstein, David Walnut, Domenico Napoletani, Timothy Sauer, Daniele Struppa
09/09/2008 7,424,463

Method for Quantifying Reponsiveness of Flow Aggregates to Packet Drops in a Communication Network
Mark Shayman, Mehdi Khandani
06/24/2008 7,391,740

Far-Field Optical Microscope with a Nanometer-Scale Resolution Based on the In-Plane Image Magnification by Surface Plasmon Polaritions
Christopher Davis, Igor Smolyaninov
04/22/2008 7,362,440

Far-Field Optical Microscope with a Nanometer-Scale Resolution Based on the In-Plane Image Magnification by Surface Plasmon Polaritions
Christopher Davis, Igor Smolyaninov
04/22/2008 7,362,442

Lossy/Lossless Region-of-Interest Coding
Nariman Farvardin, Eiji Atsumi
08/14/2007 7,257,266

Group TDMA Frame Allocation Method and Apparatus
Anthony Ephremides, Gam Nguyen, Jeffrey Wieselthier
06/19/2007 7,233,584

Method and Apparatus for Compressing and Decompressing Images
Nariman Farvardin, Eiji Atsumi
05/22/2007 7,221,804

System and Method for Optical Wireless Communication
Christopher Davis
09/12/2006 7,106,971

Method of Controlling Routing of Packets to a Mobile Node in a Telecommunications Network
M. Scott Corson, Alan O'Neill
08/01/2006 7,085,241

Security Methods for Use in a Wireless Communications System
M. Scott Corson, Rajiv Laroia, Vincent Park, Sathyadev Venkata Uppla, Michaela Vanderveen
06/27/2006 7,069,000

Methods and Apparatus for Updating Mobile Node Location Information
M. Scott Corson, Rajiv Laroia, Vincent Park, Sathyadev Venkata Uppala, Michaela Vanderveen
03/21/2006 7,016,690

3D Wavelet-Based Video Codec with Human Perceptual Model
John S. Baras, Junfeng Gu, Yimin Jiang
02/28/2006 7,006,568

Optical Wireless Networks with Adjustable Topologies
Christopher Davis, Stuart Milner, Igor Smolyaninov
01/24/2006 6,990,350

Power Control-Based Admission Methods for Maximum Throughput in DS-CDMA Networks with Multimedia Traffic
Anthony Ephremides, Deepak Ayyagari
09/20/2005 6,947,407

Dynamic Network Resource Allocation Using Multimedia Content Features and Traffic Features
Min Wu, Robert Joyce, Anthony Vetro, Hau-San Wong, Ling Guan, Sun-Yuan Kung
09/20/2005 6,947,378

System and Method for Optical Processing Based on Light-Controlled Photon Tunneling
Christopher Davis, Igor Smolyaninov, Abatoly Zayats
05/24/2005 6,897,436

Integrated Method for Performing Scheduling, Routing and Access Control in a Computer Network
Anthony Ephremides, Deepak Ayyagari
05/17/2005 6,894,991

Lossy/Lossless Region-if-Interest Image Coding
Nariman Farvardin, Eiji Atsumi
05/10/2005 6,891,973

Power Control for Active Link Quality Protection in CDMA Networks
Anthony Ephremides, Deepak Ayyagari
04/12/2005 6,879,572

Method and Apparatus for Compressing and Decompressing Images
Nariman Farvardin, Eiji Atsumi
10/05/2004 6,801,665

Adaptive Routing Method for a Dynamic Network
M. Scott Corson, Vincent Park
12/23/2003 6,667,957

Focused Ion-Beam Fabrication of Fiber Probes for Use in Near Field Scanning Optical Microscopy
Christopher Davis, Igor Smolyaninov, Klaus Edinger, Walid Atia, Saeed Pilevar
10/14/2003 6,633,711

A Method for Eliminating the Requirement for Synchronized Clocks in Distributed Routing Approaches that are Dependent on the Temporal Ordering of Events
M. Scott Corson, Vincent Park
09/30/2003 6,628,643

Human Visual Model for Data Hiding
Min Wu, Hong Heather Yu
08/26/2003 6,611,608

Optical Fiber Evanescent Field Excited Fluorosensor
Christopher Davis, Saeed Pilevar, Alexander Fielding, Frank Portugal
05/06/2003 6,558,958

Methods and Apparatus for Multi-Layer Data Hiding
Min Wu, Hong Heather Yu, Xin Li, Alexander Gelman
09/24/2002 6,456,726

Combined Power Control and Space-Time Diversity in Mobile Cellular Communications
K. J. Ray Liu, Leandros Tassiulas, Farrokh Rashid-Farrokhi
04/23/2002 6,377,812

Watermarking Scheme for Image Authentication
Min Wu, Bede Liu
09/04/2001 6,285,775

Rotation, Scale, and Translation Resilient Public Watermarking for Images Using a Log-Polar Fourier Transform
Min Wu, Matthew Miller, Jeffrey Bloom, Ingemar Cox, Yiu Man Lui, Ching-Yung Lin
08/28/2001 6,282,300

Capacity Enhancement for Multi-Code CDMA with Integrated Services through Quality of Services and Admission Control
Anthony Ephremides, Deepak Ayyagari, Samuel Resheff
08/21/2001 6,278,701

Method and System to Optimize Capacity of a CDMA Cellular Communication System
S. Raghavan, Jennifer Sanchez, S. Vasudevan, Steve Chiu, Victoria Okeson
10/03/2000 6,128,500

Computer-Aided Determination of Window-and-Level Settings for Filmless Radiology
John S. Baras, Nikolaos Sidiropoulos
10/03/2000 6,127,669

Optical Fiber Evanescent Field Excited Fluorosensor and Method of Manufacture
Christopher Davis, Saeed Pilevar, Alexander Fielding, Frank Portugal
08/15/2000 6,103,535

Method and Apparatus for Analyzing Co-Evolving Time Sequences
Alexandros Biliris, Christos Faloutsos, Hosagrahar Jagadish, Theodore Johnson, Nikolaos Sidiropoulos, Byoung-Kee Yi
04/25/2000 6,055,491

Near Field Optical Probe for Simultaneous Phase and Enhanced Amplitude Contrast in Reflection Mode using Path Matched Differential Interferometry and Method of Making It
Christopher Davis, Walaid Atia, Saeed Pilevar
11/23/1999 5,990,474

Method and Device for Placement of Transmitters in Wireless Networks
Anthony Ephremides, Dimitrios Stamatelos
11/16/1999 5,987,328

External Cavity Fiber Fabry-Perot Magnetometer
Christopher Davis, Richard Wagreich
11/09/1999 5,982,174

Method and Apparatus for Processing Data from a Tomographic Imaging System
David Walnut, Carlos Berenstein, K.J. Ray Liu, Farrokh Rashid-Farrokhi
09/14/1999 5,953,388

Frame Relay Network Planning Tool
S. Raghavan, Steve Chiu, Ronald Hansen, Jiyang Xu
08/17/1999 5,940,373

DCT-Based Motion Estimation
K. J. Ray Liu, Ut-Va Koc
08/04/1998 5,790,686

Method and apparatus for aggregating terminals into clusters to assist in the construction of a distributed data communication network
Paul Nemirovsky, Michael Ball and Roy Dahl
7/29/1997 5,652,841

Method and computer system for selecting and evaluating data routes and arranging a distributed data communication network
Paul Nemirovsky and Michael Ball
6/20/1995 5,426,674

System for identifying candidate link, determining underutilized link, evaluating addition of candidate link and removing of underutilized link to reduce network cost
Paul Nemirovsky, Michael Ball and Michael Post
4/4/1995 5,404,451

Precoding Scheme for Transmitting Data Using Optimally-Shaped Constellations Over Intersymbol-Interference Channels
Steven Tretter, Rajiv Laroia, Nariman Farvardin
02/07/1995 5,388,124

Low Complexity CELP Speech Coder
John S. Baras, Yuhung Kao
12/06/1994 5,371,853

Optimal Unified Architectures for the Real-Time Computation of Time Recursive Discrete Sinusoidal Transforms
K. J. Ray Liu, Chin-Te Chiu
08/16/1994 5,339,265

Method for routing data in a near-optimal manner in a distributed data communications network
Paul Nemirovsky, Michael Ball and Michael Post
10/12/1993 5,253,161

Method for efficient distributed data communications network backbone node location
Paul Nemirovsky, Michael Ball and Roy Dahl
6/1/1993 5,216,591

Method for efficient distributed data communications network access network configuration
Paul Nemirovsky, Michael Ball and Roy Dahl
1/7/1992 5,079,760

Computing, artificial intelligence, data mining

Automatic parallelization using binary rewriting
Rajeev Barua, Aparna Kotha
04/30/2014 8,645,935

Binary rewriting without relocation information
Rajeev Barua, Matthew Smithson
08/13/2013 8,510,723

Method and System for Optimal Data Diagnosis
V.S. Subrahmanian, Jason Ernst
01/06/2009 7,474,987

Compiler-Driven, Dynamic Memory Allocation Methodology for Scratch Pad-Based Embedded Systems
Sumesh Udayakumaran
04/29/2008 7,367,024

Dwarf Cube Architecture for Reducing Storage Sizes of Multidimensional Data
Nicholas Roussopoulos, John Sismanis, Antonios Deligiannakis
11/07/2006 7,133,876

Methods for the Electronic Annotation, Retrieval and Use of Electronic Images
Ben Shneiderman
03/07/2006 7,010,751

Control systems and methodologies

Methods and systems for magnetic focusing of therapeutic, diagnostic or prophylactic agents to deep targets
Benjamin Shapiro, Andreas Luebbe, Declan Diver, Hugh Potts, Roland Probst
11/18/2014 8,888,674

Multiple-Input DC Converter
Alireza Khaligh
10/07/2014 8,853,888

Methods and systems for using therapeutic, diagnostic or prophylactic magnetic agents
Benjamin Shapiro, Michael Emmert-Buck
11/12/2013 8,579,787

Devices, systems and methods for magnetic-assisted therapeutic agent delivery
Benjamin Shapiro, Isaac Rutel
11/27/2012 8,316,862

Techniques for Compensating Movement of a Treatment Target in a Patient
Warren D'Souza, X. Cedric Yu, Mohan Suntharalingam, William Regine, Thomas McAvoy
10/25/2011 8,042,209

Method for controlling uniformity of thin films fabricated in processing systems
Raymond Adomaitis
12/15/2009 7,632,542

Wavefront Phase Sensors using Optically or Electrically Controlled Phase Spatial Light Modulators
Mikhail Vorontsov, P. S. Krishnaprasad, Eric Justh, Leonid Beresnev, Jennifer Ricklin
06/28/2005 6,911,637

Spatially Programmable Microelectronics Process Equipment using Segmented Gas Injection Showerhead with Exhaust Gas Recirculation
Gary Rubloff, Raymond A. Adomaitis, John Kidder
11/23/2004 6,821,910

Method for Operating a Sensor to Differentiate between Analytes in a Sample
Tekin Kunt, Richard Cavicchi, Stephen Semancik, Thomas McAvoy
08/01/2000 6,095,681
Continuous-Time Adaptive Learning Circuit
Eric Justh, Francis Kub
07/14/1998 5,781,063

Design, operations and supply chain management

Apparatus and Method for Multi-Purpose Setup Planning for Sheet Metal Bending Operations
S.K. Gupta, David Bourne
05/15/2001 6,233,538

A Method of Fabricating Oxide Ceramic Articles
Guangming Zhang, Said Jahanmir
04/16/1996 5,507,962

Micro and nano devices and systems; robotics

Ball Bearing Supported Electromagnetic Microgenerator
C. Michael Waits, Mustafa Beyaz, Reza Ghodssi
07/14/15 9,083,208

Superhydrophobic surfaces
James N Culver, Ryan Enright, Konstantinos Gerasopoulos, Reza Ghodssi, Matthew McCarthy and Evelyn N Wang
03/24/15 8,986,814

Phosphorylated and Branched Dihydroxy-Pentane-Dione (DPD) Analogs as Quorum Sensing Inhibitors in Bacteria
Reza Ghodssi, William Bentley, Herman Sintim, Varnika Roy, Jacqueline Smith, Mariana Tsacoumis Meyer
02/10/2015 8,952,192

Nanodevice arrays for electrical energy storage, capture and management and method for their formation
Gary Rubloff, Sang Bok Lee, Israel Perez, Laurent Lecordier, Parag Banerjee
12/16/2014 8,912,522

Structures and methods for increasing the speed of electroactive polymers
Elisabeth Smela, Xuezheng Wang
02/26/2013 8,383,226

Lateral two-terminal nanotube devices and method for their formation
Gary Rubloff, Sang Bok Lee, Israel Perez, Erin Robertson
02/19/2013 8,378,333

Cell-based sensing: biological transduction of chemical stimuli to electrical signals (nose-on-a-chip)
Elisabeth Smela, Pamela Abshire
04/10/2012 8,152,992

Controlled Electrochemical Deposition of Polysaccharide Films and Hydrogels, and Materials Formed Therefrom
Reza Ghodssi, Gary Rubloff, Gregory Payne, William Bentley, Hyunmin Yi, Rohan Fernandes, Tianhong Chen, David Small, Li-Qun Wu
02/08/2011 7,883,615

Biolithographical Deposition and Materials and Devices Formed Therefrom
Gary Rubloff, Reza Ghodssi, Gregory Payne, Hyunmin Yi, Rohan Fernandez, Li-Qun Wu, William Bentley
10/26/2010 7,820,227

Spatially Selective Deposition of Polysaccharide Layer onto Patterned Template
Reza Ghodssi, Gary Rubloff, William Bentley, Gregory Payne, Li-Qun Wu, Hyunmin Yi, Wolfgang Losert, Douglas English
09/07/2010 7,790,010

Electrically Driven Microfluidic Pumping for Actuation
Benjamin Shapiro, Elisabeth Smela
04/28/2009 7,523,608

Electrically conductive metal impregnated elastomer materials and methods of forming electrically conductive metal impregnated elastomer materials
Elisabeth Smela, Remi Delille, Mario Urdaneta, Samuel Moseley
04/13/2012 7,695,647

Micro-Optical Sensor System for Pressure, Acceleration, and Pressure Gradient Measurements
Miao Yu, Balakumar Balachandran
09/23/2008 7,428,054

Fabrication and Integration of Polymeric BioMEMS
Reza Ghodssi, Gary Rubloff, Jung Jin Park, Mark Kastantin, Sheng Li, Li-Qun Wu, Hyunmin Yi, Theresa Valentine
05/20/2008 7,375,404

Fiber Tip Based Sensor System for Measurements of Pressure Gradient, Air Particle Velocity and Acoustic Intensity
Miao Yu, Balakumar Balachandran, Moustafa Al-Bassyiouni
05/29/2007 7,224,465

Fiber Tip Based Sensor System for Acoustic Measurements
Miao Yu, Balakumar Balachandran, Moustafa Al-Bassyiouni
05/31/2005 6,901,176

A Process for Fabrication of 3-Dimensional Micromechanisms
Donald DeVoe, Lung-Wen Tsai
12/16/2003 6,664,126

Acoustic Consumption Monitor
Gary Rubloff, Carl A. Gogol, Jr., Abdul Wajid
11/19/2002 6,482,649

Simplified and Symmetric Five-Bar Linkage Drivers
Lung-Wen Tsai, Farhad Tahmasebi
04/12/1994 5,301,566

Six-Degree-of-Freedom Parallel Minimanipulator with Three Inextensible Limbs
Lung-Wen Tsai, Farhad Tahmasebi
01/18/1994 5,279,176

Anti-Backlash Drive Systems for Multi-Degree Freedom Devices
Lung-Wen Tsai, Sun-Lai Chang
09/14/1993 5,245,263

Modular Dexterous Hand
Fabrice de Comarmond, Josip Loncaric
10/01/1991 5,052,736

Vibratory Linear Motor Systems
Roger Brockett, Gerald Kliman, Donald Jones, Russell Tompkins
02/19/1991 4,994,698

Neuroscience and biology-based technology
Discrimination of Components of Audio Signals based on Multiscale Spectro-Temporal Modulations
Shihab Shamma, Nima Mesgarani
03/17/2009 7,505,902

Cochlear Filter Bank with Switched Capacitor Circuits
Shihab Shamma, Jyhfong Lin, Thomas Edwards
07/19/1994 5,331,222

Systems engineering methodologies

Tree-To-Graph Folding Procedure for Systems Engineering Requirements
Mark Austin, Natalya Shmunis, Virnal Mayank, David Everett
01/25/2011 7,877,737

Appendix 12: Professional Service Rendered by ISR Joint Appointment Faculty, 2010–2015

Faculty member	Position/responsibility and tenure
Ray Adomaitis	Organized a set of three reaction-engineering sessions for WCCE9 (9th World Congress of Chemical Engineering), Seoul Korea 2013
	US Representative to the EuroCVD Board 2013-Present
Michael Ball	Co-Organizer, Congestion Management of Transportation Systems on the Ground and in the Air, Inaugural INFORMS Transportation Science and Logistics Society Workshop 2011
	Associate Editor: Transportation Science 2003-Present
	Area Editor: Operations Research-Transportation 2006-2011
	Member, IEOGG & CAEP - Part of the International Civil Aviation Organization - United Nations March 2011-November 2012
John Baras	Associate Editor for the IMA Journal of Mathematical Control and Information 1983-Present
	Lecturer to high schools and PTAs on Engineering: Challenges and Opportunities 1988-Present
	Member of the Editorial Board of SARA ---
	Member of the Editorial Board of IMA Journal of Mathematical Control and Information, Oxford University Press ---
	Member of the Editorial Board of Systems & Control: Foundations & Applications No Date Given
	Member of the Editorial Board of Progress in Systems and Control Theory ---
	Member of the Editorial Board of Mathematics of Systems and Control, Springer-Verlag ---
Alexander Barg	Chair, Technical Program Committee, Information Theory Workshop, Dublin, Ireland 2010
	Chair, Technical Program Committee, Information Theory Workshop, Jerusalem, Israel 2015
	Editorial Board Member, Problems of Information Transmission 1994-Present
	Associate Editor, SIAM Journal on Discrete mathematics 2004-Present
	Associate Editor, Serdica, Journal of Computing 2006-2014
	Associate Editor, Advances in Mathematics of Communications 2006-Present
	Member, Board of Governors, IEEE Information Theory Society 2008-2010
	Editorial Board Member, International J. Information and Coding Theory 2014-Present
Sarah Bergbreiter	Associate Editor at Large, IEEE Conference on Robotics and Automation 2011
	Co-Organizer, IEEE ICRA 2013 Workshop, "The Different Sizes of Small-Scale Robotics: from Nano-, to Millimeter-Sized Robotic Systems and Applications," 2013
	Board Member, Mid-Atlantic Micro-Nano Alliance, 2010-Present
	Associate Editor, IEEE/RSJ International Conference on Intelligent Robots and Systems, 2011–12
	Associate Editor, Journal of Micro-Bio Robotics, 2012-Present
	Associate Editor, ASME Journal of Mechanisms and Robotics, 2015–present
Rance Cleveland	Editorial Board: International Journal on Software Tools for Technology Transfer 1997-Present
	Editorial Board: Formal Methods in System Design Journal 1997-Present
	Editorial Board: Electronic Notes in Theoretical Computer Science 2000-Present
	Editorial Board: IEEE Transactions on Software Engineering 2006-2010
	Editorial Board: Journal of Computing Science and Engineering 2007-Present
	Editorial Board: Journal of Algebraic and Logical Methods in Programing 2013-Present
Anthony Ephremides	General Chair IEEE ISIT, St. Petersburg, Russia 2011
	Historian, IEEE Society on Information Theory 1991-Present
	Editor, Foundations and Trends in Networking as of 1/1/2006

Carol Espy-Wilson	Chair, Speech Technical Committee, ASA 2007-2010
	Advisory Board, NIH NICHD Medical Rehabilitation Board 2010-2013
	Associate Editor, Journal of the Acoustical Society of America 2010-Present
	Advisory Council, NIH National Institute on Biomedical Imaging and Bioengineering 2015-2018
Michael Fu	Program Chair, Winter Simulation Conference, Phoenix, AZ 2011
Reza Ghodssi	Associate Editor, Journal of Biomedical Microdevices (BMMD), May 2008 – Present; Journal of Microelectromechanical Systems (JMEMS), July 2008 – Present
	Co-Editor with Dr. Pinyen Lin at Touch Micro-System Technology (Total of 35 Contributing Authors): "Handbook of MEMS Materials and Processes," MEMS Reference Shelf, Series Editor: Professor Stephan Senturia, Springer, Published March 2011.
	Guest Editor, A. Khaligh, P. L. Chapman, and R. Ghodssi, "Special Section on Energy Harvesting," IEEE Transactions on Industrial Electronics, Vol. 57, No. 3, pp. 810-812, March 2010; R. Ghodssi, C. Livermore, and D. Arnold, "Selected papers from the 9th International Workshop on Micro and Nanotechnology for Power Generation and Energy Conversion Applications (PowerMEMS 2009)," Journal of Micromechanics and Microengineering (JMM), Vol. 20, No. 10, October 2010.
	Chair, Denice Denton Emerging Leader Award, Anita Borg Institute for Women and Technology, 2007-Present
	Chair, NSF Workshop on Micro, Nano, and Biosystems, Arlington, VA March 30-31, 2012
	Chair, The 9th International Workshop on Micro and Nanotechnology for Power Generation and Energy Conversion Applications – Power MEMS 2009, Washington, DC, December 1-4, 2009
	Americas Technical Committee Program Chair, IEEE Sensors 2010, 2011 and 2012 Conferences: Waikoloa, HI, November 1-4, 2010, Limerick, Ireland, October 28-31, and Taipei, Taiwan, October 28-31, 2012
	Chair, MEMS and NEMS Technical Group, American Vacuum Society, 2002–2004
S. K. Gupta	Air Force Office of Scientific Research Proposal Reviewer 2010
	King Abdulaziz City for Science and Technology Proposal Reviewer 2011
	Editor, Manufacturing Automation Track, IEEE International Conference on Automation Science and Engineering 2012
	Session Chair, IEEE CASE 2012
	Proposal Reviewer Department of Energy 2013
	Associate Editor: IEEE ICARA 2015
	Guest Co-Editor, Special issue on Advances in Computer Aided Manufacturing, ASME Journal of Computing and Information Science in Engineering 2007
	University Grant Commission Proposal Reviewer, Hong Kong Between 1997 and 2012
	Associate Editor, ASME Journal of Computing and Information Science in Engineering January 2006-December 2011
	Associate Editor, ASME Journal of Mechanisms and Robotics July 2014-Present
Jeffrey Herrmann	Department Editor (Homeland Security), IIE Transactions, Focused Issue on Operations Engineering and Analysis 2009-2012
	Track Chair, Tutorials, Industrial and Systems Engineering Research Conference, San Juan, Puerto Rico May 19-21, 2013
	Conference Co-Chair, Industrial and Systems Engineering Research Conference, Orlando, FL May 19-23, 2012
	Track Chair, Homeland Security, Industrial Engineering Research Conference, Reno, Navada May 21-25, 2011
Alireza Khaligh	Technical Track Chair, Vehicular Electronics, IEE Applied Power Electronics Conference and Exposition (APEC), Fort Worth, TX 2014
	Assistant Program Chair, IEEE Applied Power Electronics Conference and Exposition (APEC), Fort Worth, TX 2014
	Program Chair, IEEE Applied Power Electronics Conference and Exposition (APEC), Charlotte, NC 2015

	Editor, IEEE Transactions on Vehicular Technology 2007-Present
	Guest Associate Editor, Special Section of IEEE Journal of Emerging and Selected Topics in Power Electronics on Transportation Electrification 2013-Present
	Associate Editor, IEEE Transactions on Transportation Electrification 2014-Present
	Publicity Chair (AdCom Member), Power Electronics Society (PELS) February 2013 - Present
	Vice Chair, IEEE-PELS Technical Committee on Vehicle and Transportation Systems June 2013 - Present
Richard La	Track Co-Chair, Mobile and Wireless Networks, IEEE Personal, Indoor, and Mobile Radio Communications (PIMRC) 2014
	Editor, Journal of Communications and Networks 2008-2010
	Editor, IEEE Communications Surveys and Tutorials 2009-Present
	Associate Editor, IEEE Transactions on Mobile Computing 2011-Present
David Lovell	National Academies, Transportation Research Board 1993-Present
	Intelligent Transportation Society of America 2000-Present
	Chair, Faculty Leadership Council Engineers Without Borders, USA 2012-2013
	Co-Chair, Southeast Regional Techinical Advisory Committee, EWB-USA 2013-Present
	Guest Editor, IEEE Transactions on Vehicular Technology ---
	Guest Editor, Transportation Research Part C ---
Nuno Martins	Guest Editor for a special issue of Information Processing and Decision Making in Distributed Control Systems, International J. Systems, Control and Communications 2010
	Approached "FIRST Robotics" and motivated them to move the Chesapeake regional competition from Baltimore to the COMCAST at College Park. With the support of Dean Pines, the COMCAST management and FIRST reached an agreement. The competition was held in our campus on April 4-5, 2014. On suggestion by Martins, the Clark School and FIRST agreed on a suitable arrangement to further leverage the event to promote our programs and capabilities. 2014
	From the fall of 2013 until Spring of 2014 organized a series of meetings to foster the interaction between the center (and ISR) and NAVAIR. This effort culminated with the U. Maryland College Park and NAWCAD Autonomy Research Workshop held on Feb 21st 2014. The participants held conference calls and meetings to finalize a collection of white papers that may lead to new funding programs and opportunities for the community at large. 2014
	Associate Editor for Systems and Control Letters, Elseview 2006-2014
	Associate Editor and Member of the IEEE Control Systems Society Conference Editoral Board 2008-2013
	Associate Editor for Automatica, Elsevier 2011-2014
	Director of the Maryland Robotics Center from September 1st 2012 until August 31st 2014. During this period, the Director is responsible for leading and participating in the organization of all outreach events, including the Maryland Robotics day, visits to and by national and foreign organizations and definition of strategies 2012-2014
	Program Vice-Chair for the IEEE Conference on Decision and Control 2013-2014
Prakash Narayan	Chair, External Nominations Committee, IEEE Information Theory Society February 2012 - January 2013
	Co-Organizer, DIMACS Workshop on Information Theoretic Security, Rutgers 2012
	Member, Board of Governors, IEEE Information Theory Society January 2007-December 2009 & January 2010-December 2012
Dana Nau	Editorial Board, ACM Transactions on Intelligent Systems (TIST) 2009-Present
Derek Paley	Session Co-Chair: American Control Conference (Multi-vehicle systems) 2010
	Session Co-Chair: Northeast Control Conference (Optimization) 2010
	Session Co-Chair: AIAA Guidance, Navigation, and Confrol Conference (Flapping Wing MAV Dynamics and Control) 2010

	Technical area Co-Chair, AIAA Guidance, Navigation, and Control Conference (Multi-Vehicle Control) 2011
	Mini-Symposium Organizer SIAM Conference on Applications of Dynamical Systems (Reconstruction and Analysis of Individual Dynamics in Biogroups) 2011
	Session Chair: AIAA Guidance, Navigation, and Control Conference (Multi-Vehicle Control I and II) 2011
	Session Co-Chair: IEEE Conference on Decision and Control (Cooperative Control) 2011
	Session Chair International Conference on Unmanned Aircraft Systems (UAV Applications II) 2012
	Vice Chair, IEEE-PELS Technical Committee on Vehicle and Transportation Systems 2012
	Session Chair: AIAA Guidance, Navigation, and Control Conference (Multi-Vehicle Control II and III) 2012
	Session Chair: International Symposim on Distributed Autonomous Robotic Systems (Modular Robots II) 2012
	Session Co-Chair: IEEE Conference on Decision and Control (Autonomous Systems) 2012
	Associate Editor: American Control Conference 2013
	Mini-Symposium Organizer, SIAM Conference in Applications of Dynamical Systems (Data-driven adaptive sampling of dynamic spatial processes) 2013
	Session Chair: AIAA Guidance, Navigation, and Control Conference (Control of Multiple Autonomous Aircraft I and II) 2013
	Session Chair: IEEE Conference Decision and Control (Autonomous Robots) 2013
	Session Co-Chair: IEEE Conference Decision and Control (Coordinated Control: Models and Mechanisms from Collective Animal Behavior) 2013
	Associate Editor: American Control Conference 2014
	Session Chair of Faculty Presentations Symposium on Autonomy, Center for Energetic Concepts Development, Department of Mechanical Engineering UMDCP 2014
	Organizer UD Workshop on Distributed Sensing, Actuation, and Control for Bio-inspired Soft Robotics 2014
	Associate Editor: J Guidance, Control, and Dynamics 2013-Present
Gang Qu	TPC co-chair, IEEE/ACM Great Lakes Symposium on VLSI, 2005
	Guest Editor, *EURASIP Journal on Embedded Systems* special issue on "Embedded DSP Systems," 2005
	Co-Chair GLSVLSI'06 16th IEEE / ACM Great Lakes Symposium on VLSI 2006
	ACM SIGDA Low Power Technical Committee, May 2007
	IEEE CEDA Publications Committee, January 2010
	Co-Chair Hardward Assurance'11: 2nd ARO Special Workshop on Hardware Assurance 2011
	IEEE CEDA Publicity Committee, March 2012
	Chair: CyberVehicles'12 ARO Workshop on Cyber-Security and Dependability for Next Generation Vehicular Systems 2012
	IEEE CANDE Committee, Fall 2013
	Chair, Workshop on Emerging Cyber War-Fighting Technologies, 2015
	Chair, Workshop on Cryptography and Hardware Security for the Internet of Things, 2015
	Associate Editor: IEEE Embedded Systems Letters January 2011 - present
	Associate Editor: Integration, the VLSI Journal January 2011 - present
	Associate Editor: IEEE Transactions on Computers July 2011 - present
Subramanian Raghavan	Editorial Advisory Board, Algorithmic Operations Research 2006-2012
	Associate Editor, Networks August 1999-Present
	Area Editor for Telecommu nications and E-Commerce. INFORMS Journal on Computing January 2007-Present

	Associate Editor, Operations Research June 2008-December 2011
	Area Editor for Telecommunications, Networks and Spatial Economics March 2006-Present
Michael Rotkowitz	Session Organizer: "The Witsenhausen Counterexample: 40 Years Later" 47th IEEE Conference on Decision and Control 2008
Gary Rubloff	Co-Chair, ALD 2011
	Co-Chair, AVS-ALD Atomic Layer Deposition 2011
	International Advisory Board, ALD 2012
	Advisory Board, Symp. E, Next Generation Micro/Nano Systems 2012
Shihab Shamma	Blaise Pascal International Research Chair, l'Universite Paris Descartes 2010
	Co-organizer/director Mathematical Models of Sound Processing 2012
	Co-Organizer and director of numerous workshops and symposia including most recently the Annual Telluride Workshop on Neuromorphic Cognition 1997-Present
	Academic Editor for PLoS ---
	Action Editor for the Journal of Compputational Neuroscience ---
	Academic Board Member Trends in Cognitive Sciences ---
André Tits	Appointed Member of the Board of Governors of the IEEE Control Systems Society 1998
	Associate Editor, Optimization and Engineering 2002-present
	Associate Editor, Computational Optimization and Applications 2002-present
	Editor, Rapid Publications for Automatica 2005-Present
Sennur Ulukus	TPC Co-Chair IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, Washington, DC 2005
	TPC Co-chair, Wireless Comm. Symp., IEEE ICC 2010
	Guest Editor, IEEE Transactions on Information Theory, special issue on Interference networks 2011
	TPC Co-Chair, Communication Theory Workshop 2011
	TPC Co-chair, Physical Layer Security Workshop, IEEE Globecom 2011
	TPC Co-chair, Physical Layer Security Workshop, IEEE ICC 2011
	Guest Editor, Journal of Communications and Networks, Special Issue on Energy Harvesting in Wireless Networks 2012
	TPC Co-chair, Energy Harvesting & Green Wireless Comm., IEEE GlobalSIP 2013
	TPC Co-chair, Comm. Theory Symp., IEEE ICC 2013
	TPC Co-chair, Comm. Theory Symp., IEEE Globecom 2014
	Lead Guest Editor, IEEE Journal on Selected Areas in Communications, Special Issue on Wireless Communications Powered by Energy Harvesting and Wireless Energy Transfer 2015
	Associate Editor, IEEE Transaction on Information theory 2007-2010

Appendix 13: ISR Joint Appointment Faculty Industry Collaborations, 2010–2015

Ray Adomaitis

Current work with AccuStrata developing models of thin film optical properties for the development of model-based thin-film deposition monitoring and control systems Recent with with Cambridge NanoTech in developing physically based models for atomic layer deposition systems to understand the physical and chemical mechanisms at work in these systems and to optimize the performance of high-throughout reactor designs.

Michael Ball

"Advanced Available-to-Promise" project funded by, and jointly carried out with, Toshiba Corporation produced an optimization model Toshiba used to drive its available-to-promise business function for point-of-sale terminal production and delivery. This project received "the Outstanding Contribution to Business Performance Award" from the Director of Toshiba Corporate Manufacturing Engineering Center (CMC), June, 2003.

Certain concepts and models developed in my FAA-funded research project on "Collaborative Decision Making" have been integrated into decision support tools and procedures used by the FAA and the airlines. For example, the "distance-based Ground Delay Program" mechanism we developed is now part of the FMS decision support tool used by FAA and airlines in ground delay program planning.

Alexander Barg

My most important contribution to industry is related to the problem of data encoding in distributed storage systems for the purpose of data protection against disk failures. I constructed an optimal solution to the encoding problem which improves on the state of the art technology widely used in industry. I am currently exploring possibilities for commercialization of the new coding design.

Sarah Bergbreiter

Collaboration with Renensys on NSF CPS grant for bridge monitoring (just starting). In addition, a Google solve for a talk.

Fabricated tactile sensors sent to companies iWalk and BionicSkins.

Anthony Ephremides

In the '90's along with John Baras and a team from the CCDS we worked with Hughes Network Systems to help them develop their product DirectPC. This was a major success for the company and they acknowledged it. We received a campus award for that, and we still receive royalties.

Recently (during 2014) Lucent-Alcatel Bell Labs ran a competition for the Bell Prize. They advertised it extensively, asking for "ideas" contributions that would be "movers and shakers." I submitted one on Implementable Random Access. They received over 400 inputs and they selected about forty (mine was amongst them). I went to Murray Hill to defend it as a finalist. In the end the award was given to a Princeton Professor (Abbe).

Carol Espy-Wilson

Consulting for UltraVoice in Philadelphia, PA; Scientific Atlanta in Atlanta, GA; Belfort Instruments, Baltimore, MD; Speech Technology and Applied Research, Lexington, MA

Michael Fu

Toshiba semiconductor manufacturing project (with Steve Marcus), 2013-2014.

Preventive maintenance scheduling in semiconductor manufacturing fabs (Semiconductor Research Corporation; specific collaboration with Intel and AMD), 2001-2003.

Reza Ghodssi

The MEMS-based Gray-scale Technology developed in our group and funded by Army Research Lab (ARL), was also used by Toshiba to develop a miniature/compact relay device in silicon. They sent two of their engineers to ISR to work with us in my MSAL lab for almost one year to develop and implement the initial concept.

The micro-ball bearing technology in MEMS has been recognized as one of the highlights in our group here at ISR. In the last few years, both SAMSUNG and SONYO have used this technique for some for their next generation minature energy harvesting devices.

Maryland Robotics Center

We have started dialogues with these four companies:

- Lockheed Martin Advanced Technology Lab (ATL) to develop a strategic robotics partnership. Pete Staritz from ATL visited us last semester. ATL has renewed its robotics seminar series sponsorship.
- Northrop Grumman Undersea Systems. Jeff Coriale and I visited them last semester and they have joined ISR's Associate Partners Program (APP). They would like to find ways to support autonomy research at Maryland.
- ABB, to arrange a donation of their new dual arm robot, and sign them up as an ISR APP member as a result. This will add a new capability to the Robot Realization Lab.

- Intelligent Automation Inc., for potential collaboration on new DARPA programs.

S. K. Gupta

My research group has developed planning algorithms for realizing autonomous unmanned surface vehicles (USVs), funded by ONR. We developed a model-predictive trajectory planning algorithm for USVs operating in civilian traffic. It reasons about the availability of contingency maneuvers needed if any of the civilian vessels breaches the International Regulations for Preventing Collisions at Sea.

We also developed a local trajectory planning algorithm that generalizes the velocity obstacle concept to systems with non-linear dynamics and performed physical experiments to evaluate the planner in a real-world surveillance task. We have filed an invention disclosure on this software, recently received funding from MIPS, and partnered with Hyperion Technologies to transition to a commercial product.

Jeffrey Herrmann

Throughout my career here I have worked with Maryland manufacturing firms to help them improve operations through better scheduling, facility layout, and improved processes, often using the ideas of lean manufacturing. I have created a professional development short course on facility design for lean manufacturing (which is also used to further my research on engineering design decision making).

As a leader of the QUEST Honors Program, I have recruited corporate partners, scoped consulting projects, and advised teams of seniors who work with manufacturers and other firms to invent, evaluate, and recommend solutions to real-world problems. These student projects have made an impact on numerous firms over the years and have provided our students with outstanding learning opportunities.

Alireza Khaligh

Advancement of highly efficient and integrated power electronic interfaces for plugin electric vehicles, and introduction of miniature power electronic interfaces for microrobotics and energy harvesting.

P. S. Krishnaprasad

I have worked with IAI through student interns (Alldredge, Mischiati, Twu and Dey, with summer support), development and use (by Kulis and Sodre at IAI) of industrial implementation of MDLe (spun-off from ISL), and mentoring of engineers. I have worked with Northrop Grumman on semiconductor manufacturing, focusing on modeling and control of epitaxial CVD processes (A. Newman was partly supported under this).

Richard La

From 2008 to 2011, I collaborated with Intelligent Automation Inc., (IAI), a local company located in Rockville, Md., on a successful SBIR contract funded by the Army Research Lab: "A swarm intelligence based approach to secure, scalable and robust design for tactical networks". Together with the PI from IAI, we investigated the fundamental limits of the communication overhead that is necessary for exchanging location information in multi-hop wireless networks. In addition, we designed a new family of robust and scalable message forwarding schemes based on swarm intelligence, which can be viewed a backward reinforcement learning method.

Since the summer of 2014, my student and I have been collaborating with researchers at Bell Labs, a research lab for Alcatel-Lucent, on designing and evaluating the performance of real-time transport protocol (RTTP) for delivering both streaming services and online gaming. In particular, our collaboration focused on implementing the RTTP protocol proposed by Google Inc., and carrying out its performance analysis in real networks. We are also developing a mathematical model for capturing the dynamics of the RTTP protocol as a feedback control system with delays to understand the fundamental behavior of such RTTP protocols interacting with the Internet that exhibit complex dynamics at multiple timescales.

Armand Makowski

I am in preliminary discussions to develop internship support, and possible techical support to improve existing products for AirPatrol Corp., a startup located near Columbia, Md., which develops mobile cybersecurity platforms for enterprises and government agencies.

Steve Marcus

A project on statistical process control (SPC), funded by and joint with Toshiba Corp., in 2005. This project was the basis for further work (leading to a Ph.D.) by the Toshiba engineer, and led to testing of the resulting SPC methodologies in Toshiba factories.

With Michael Fu, a project on preventive maintenance (PM) scheduling in semiconductor manufacturing fabs, joint with Intel, AMD, and the University of Cincinnati, in 2001–2003. The project involved joint work and summer internships at AMD and Intel for Ph.D. students. This project resulted in new methodologies and software for PM scheduling in semiconductor fabs, as well as joint journal papers with engineers from Intel and AMD.

Nuno Martins

Established a relationship between UTRC and ISR that lead to the creation of the UTRC Invited Lectures on Control and Dynamical Systems. UTRC also became a member of ISR Associate Partners program and Sonja Glavaski (former UTRC) became a member of ISR SAC.

Led a $1M NSF CPS proposal that was funded in collaboration with Resensys, LLC. Alumni Mehdi Khnadani, who is the CEO and funder of Resensys, is a co-PI. I also estab-

lished an NDA with the National Geographic Society, and we partnered to get a $1.8M grant from NSF to develop an animal-borne wireless network (still ongoing).

Prakash Narayan

InterDigital, King of Prussia, Pa., initiated collaboration on the algorithmic aspects of our work on network security, and sponsored a two-year joint project on secret key propagation in a wireless network. My former Ph.D. student Nitin Sirinawarat and Professor A. Barg (ECE/ISR), and Drs. Alex Reznik and Chunxuan Ye (both of InterDigital) collaborated with me on this project from 2007-2009.

Our ongoing work on secure function computation over a network was initiated jointly with Dr. Piyush Gupta of Bell Labs Alcatel-Lucent. My former Ph.D. student, Himanshu Tyagi conducted an internship at Bell Labs with Dr. Gupta in 2010, and our collaboration continued for two years thereafter.

Collaboration with Dr. Piyush Gupta of Bell Labs-Lucent on the problem of network function computation. This led to the publication: H. Tyagi, P. Narayan, P. Gupta, "When is a Function Securely Computable?," *IEEE Transactions on Information Theory,* vol. 57, no. 10, pp. 6337–6350, October 2011.

Derek Paley

Consulting for Primordial, Inc., 2013–2014. This project was a Phase I SBIR with MDA that was awarded Phase II. Unfortunately, Primordial was purchased by a larger company (Polaris) and is no longer eligible for the small business award.

I have a longstanding relationship with Bluefin Robotics, for whom I worked 2000–2002 as a software engineer. Bluefin manufacturers autonomous underwater vehicles for commercial and defense applications. A Bluefin program manager visited UMD in Fall 2014 to describe Bluefin's involvment in the search for the missing airliner MH370.

Gang Qu

I developed a six-week MOOC on hardware security through a university partnership with Coursera. The first offering attracted more than 35,000 students, out of which more than 1,400 completed all the quizzes and final exam.

In Spring 2014, I co-developed and co-taught ENSE 698C, Cybersecurity for Smart Grid, with four colleagues from outside of the university. One from NSA/NCCoE, two from NIST, and one from a local company.

In Summer 2015, I participated in a panel discussion in the INCOSE 25th Anniversary International Symposium. The panel is entitled "Have We Systems Engineered Our Infrastructure Well Enough to Withstand a Cyberterrorism Attack? A Debate on the Issues." I am the only panelist from academia, the other five are all from industry.

I have continued to push for research collaboration with industry in these ways:

- I have 3 SBIR/STTR with industry: one (with John Baras) from DARPA with ACS, one from AFOSR with MiMoCloud, and one (awarded) from NRL with MiMoCloud.
- I have worked with Cisco, which has agreed on a contract of $180K ($60 for the initial one and $120 for the second phase). However, due to the lengthy contract negotiation between the University and Cisco, the funding period expired.
- I have worked with several researchers in NIST on cybersecurity related topics. Currently we are preparing to submit a collaboration proposal.

Ankur Srivastava

Collaboration with CoolCAD LLC on their design tool flow. Graduation of students who have found employment in various companies.

Subramanian Raghavan

I have developed a technique to rapidly find so-called Bidder-Pareto-Optimal Core Solutions in Combinatorial Auctions. This work loosely speaking has generalized and developed a type of second price auction in the package/combinatorial auction setting. It has spurred a significant interest in the economics literature (Professor Paul Milgrom from Stanford has coined the term "Core-Selecting Auctions" to describe the type of auction I proposed). Further, several governments across the world are using our specific algorithm and pricing method in their auctions, Specifically, the Office of Communications in the UK, the Austrian, Australian, Canadian, Dutch, Danish, Irish and Swiss governments have used this technique in their spectrum auctions. This work was awarded the INFORMS Computing Society Prize and was a finalist for the European Excellence in Practice Award.

I have worked on problems of interest to the satellite industry. In particular, I worked on a multiperiod traffic routing problem in a satellite network. It is my understanding that the algorithms developed were used as part of an annual business plan exercise at the satellite company (INTELSAT) we collaborated with, to help plan for future capacity expansion needs. This work was awarded the 2010 Management Science Strategic Innovation Prize by the European Operational Research Society.

Gary Rubloff

Collaboration with Northrop Grumman (and Ray Adomaitis) on in-situ sensing/metrology/control of MOCVD processes for fabrication of GaN-based HEMT devices. This lasted three to four years with significant funding, involved biweekly meetings at NG and my student there full time. We achieved real-time in-situ chemical sensing of reaction byproducts and exploited these signals to control

a thin AlGaN layer thickness to something like 0.1nm (can check the number if it matters). Ray did excellent process and equipment modeling which allowed design of optimized precursor delivery spatial distributions. Together I believe we/ISR helped NG move from the starting lines (new hires/new program) to competitive with best of breed. The experimental part of this in my group was developed by other industry collaborations on real-time in-situ mass spectrometric sensing, done first with Inficon and later with MKS Instruments.

Collaboration with Toshiba visitor Tomimo Ino on advanced process control (APC). While this was just a year and small ($36K), it had significant impact. I had been a protagonist for APC adoption in industry/Sematech circles, particularly as part of the International Technology Roadmap for Semiconductors activity. Mr. Ino learned the strategic picture of APC while working with me, building the view in part from our equipment/process level simulations, in part from equipment and factory logistics/throughput considerations that flowed out of our IPDPM project (NSF-SRC, involving Marcus, Fu, Herrmann, Rubloff). Ino was successful in developing an APC "pitch" and strategy to start implementation of APC in Toshiba manufacturing. My understanding is that he has since been successful in leading this in Toshiba.

Jonathan Simon

My most important contribution to industry is as coauthor of the biological signal denoising technique TSPCA (de Cheveigné, A., and J. Z. Simon (2007) Denoising Based on TimeShift PCA, J Neurosci Methods 165(2), 297305.), which has been incorporated into the magnetoencephalography software product "MEG Laboratory." This software is produced jointly by Yokogawa Electric Corp., Eagle Technology Corp., and Kanazawa Institute of Technology.

Andre Tits

Collaboration with Sikorsky Aircraft Corp. from 2008 to 2011 on controller design for a rotorcraft. (Featured an algorithm and software for convex quadratic optimization, produced by my group in earlier research.) This included over $100k of financial support. It produced one conference paper (American Control Conference).

For more than two decades, collaboration with AEM Design, a startup that handled distribution of FSQP, optimization software produced by my group (based on algorithms developed by my group). FSQP has been extensively used (thousands of users) both in academia and in industry.

Sennur Ulukus

RADIUS: Reliable and Adaptive Decision makIng under Uncertainty for Spectrum access This was a phase I Air Force STTR project.

RADAR: A Comprehensive and Dynamic Framework toward Realtime Network Traffic Resiliency This is a phase II DoD SBIR project.

Appendix 14: Research Grants to ISR Joint Appointment Faculty with a Faculty Member from a Different Department, 2009–2015

2015

AFOSR: Air Force Center of Excellence on Nature-Inspired Flight Technologies and Ideas (NIFTI)

Faculty: Pamela Abshire (ECE/ISR); Cynthia Moss (JHU); Sarah Bergbreiter (ME/ISR); Timothy Horiuchi (ECE/ISR); Nuno Martins (ECE/ISR); Susanne Sterbing-D'Angelo (ISR); Miao Yu (ME)

Funding Agency: Air Force Office of Scientific Research

The Air Force Center of Excellence on Nature-Inspired Flight Technologies and Ideas (NIFTI) will conduct research into how animals move, navigate and use their senses, and create solutions for challenging engineering and technological problems related to building small, remotely operated aircraft. It is housed at the University of Washington, and in addition to Maryland researchers, includes faculty from Case Western Reserve University and international partners like Imperial College, University of Bristol, University of Sussex and Oxford University in the U.K. and Lund University in Sweden.

The NIFTI center, one of six AFOSR COEs nationwide, is funded by the U.S. Air Force for up to $9 million over six years. It will focus on three main research areas:

Locating objects. Researchers will look at how animals are able to find prey, a mate or food sources by encoding and processing information through their senses.

Navigating in complex environments. Insects and bats often fly in windy and crowded spaces, skillfully avoiding collisions. Scientists will study how their neurological and physiological systems function to allow them to move in these ways.

Navigating in sensory-deprived environments. Animals often fly in low light or nearly complete darkness, and in places where their ability to smell and hear might be compromised. Researchers will look more broadly at how animals use sensory information and how they make decisions about flight under different contexts.

Learning from the behavior of insects and animals could inspire more advanced micro-air vehicles, or small, flying robots. These could be used in difficult search-and-rescue missions, to help detect explosives or mines when it would be too dangerous for humans to go on foot or in vehicles, and for environmental monitoring.

AFOSR: Simulation-Based and Risk-Sensitive Methodologies for Stochastic Optimization and Control

Faculty: Steve Marcus (ECE/ISR), Michael Fu (BMGT/ISR)

Funding Agency: Air Force Office of Scientific Research

This research will study basic questions aimed at challenges in information superiority, logistics, and planning. The researchers will develop and analyze new algorithms for the simulation optimization approach of sequential response surface methodology by incorporating direct gradient estimates; develop and analyze new global stochastic kriging simulation metamodels using an extrapolation method enabled by direct gradient estimates; utilize risk-sensitive cost functions to achieve express risk preferences and robustness in control problems; study how incorporation of risk-sensitivity affects the behavior of decision makers and controllers; develop and study efficient sampling and simulation-based methods for risk-sensitive control problems; study population-based methods for finding and improving on a good set of policies in risk-sensitive problems; and apply these optimization methodologies to practical problems, such as preventive maintenance, path planning for unmanned aerial vehicles, data mining, supply chain management, and financial engineering. This is a three-year, $554K grant.

2014

UMD Research and Innovation Seed Grant: Temporal Auditory Coding in Schizophrenia and Treatment-Resistant Auditory Hallucination

Faculty: Jonathan Simon (ECE/BIOLOGY/ISR), L. Elliot Hong (Psychiatry, UM School of Medicine)

Funding Agency: UMD Division of Research, Research and Innovation Seed Grant

Simon and Hong will investigate the neural processing of rhythmic sounds (whether speech or simpler sound rhythms) in schizophrenia patients with treatment-resistant auditory hallucinations, compared to neural processing in patients whose auditory hallucinations are treatable, and with healthy listeners. The neural mechanisms underlying these diverse abnormalities, which are measured by electroencephalography and magnetoencephalography techniques, are not known. This research will advance the state of research in schizophrenia.

Hong is Chief of the Neuroimaging Research Program in the Department of Psychiatry and the director of the UM Center for Brain Imaging Research.

NIH NIDCR: Magnetic Delivery of Therapeutic Nanoparticles to the Dental Pulp

Faculty: Didier Depireux (ISR); Radi Masri (UM School of Dentistry)

Funding Agency: NIH National Institute of Dental and Craniofacial Research

Pulpitis, is an inflammation of the dental pulp deep within the tooth, most often experienced as a sharp pain when eating ice cream or having a cold drink. Usually treatment involves the dreaded root canal procedure to remove the

damaged pulp. Depireux and Masri's (UM Dental School) research could give dental practitioners a much less invasive treatment option. The pair are developing a new, patent-pending technique to deliver medication directly into the center of a tooth.

The research uses strong magnetic fields to move medication-coated, magnetic nanoparticles through the tooth's dentin and into the pulp. Dentin, a solid substance that encases the pulp, is surrounded by a harder-than-bone layer of enamel. "When you have a cavity, usually the enamel has been damaged and the dentin is exposed, so when you eat or drink, it will stimulate the fluid within the dentinal tubules and cause pain," Masri explained.

The researchers are using tubules, the microscopic channels that travel through the dentin into the tooth pulp, as the vehicles to deliver the inflammation-reducing or antibiotic medication. They have designed a system of magnetic arrays effective for upper or lower teeth. By manipulating a series of cube-shaped magnets, they can control the magnetic field so the nanoparticles are pulled through the tubules into the tooth pulp. This is a two-year, $450,000 grant.

NSF CPS Collaborative Research: Designing semi-autonomous networks of miniature robots for inspection of bridges and other large infrastructures

Faculty: Nuno Martins (ECE/ISR); Sarah Bergbreiter (ME/ISR); Richard La (ECE/ISR)

Funding Agency: National Science Foundation

This new research will create a self-organizing network of small robots that could aid in visually inspecting bridges and other large civilian infrastructure. As they create the network, the researchers will establish new design and performance analysis principles and technologies.

The networked robots could remotely and routinely inspect complicated structures, like the assemblage of girders supporting a suspension bridge. The robots will use wireless information exchange to autonomously coordinate and cooperate in the inspection, and whenever possible, they will report back images and key measurements to experts for evaluation. The tiny networked robots will be able to access tight spaces, operate under various weather conditions, and autonomously execute tasks for long periods of time.

The researchers are collaborating with Resensys a company that specializes in remote bridge monitoring. Resensys is a portfolio company of the Maryland Technology Enterprise Institute's (Mtech) Technology Advancement Program an Mtech VentureAccelerator graduate and a former UMD $75K Business Plan Competition winner. Resensys' President and CTO Mehdi Kalantari (EE Ph.D. 2005) is an assistant research scientist in the Electrical and Computer Engineering Department.

"Designing semi-autonomous networks of miniature robots for inspection of bridges and other large infrastructures" is a three-year, $850K grant, part of NSF's National Robotics Initiative.

NSF CPS Breakthrough: Compositional Modeling of Cyber-Physical Systems

Faculty: Rance Cleaveland (CS/ISR); Steve Marcus (ECE/ISR)

Funding Agency: National Science Foundation

Compositional Modeling of Cyber-Physical Systems is a three-year, $500K grant to develop new mathematical modeling techniques for cyber-physical systems. Cleaveland and Marcus will devise novel conceptual methods for assembling systems from subsystems, and for reasoning about the behavior of systems in terms of the behavior of their computational or physical subsystems. The research will enable scientists and engineers to develop more realistic models of the systems they are designing, and to obtain greater insights into the eventual behavior of these systems without having to build costly prototypes.

Specifically, the researchers will develop the novel modeling paradigm Generalized Synchronization Trees (GSTs) into a rich framework for both describing cyber-physical systems (CPSs) and studying their behavior under interconnection. GSTs are inspired by Milner's use of Synchronization Trees (STs) to model interconnected computing processes, but GSTs generalize the mathematical structure of their forebears in such a way as to encompass systems with discrete ("Cyber") as well as continuous ("Physical") dynamics.

NSF BRAIN EAGER: Wireless Measurement of Neuronal Currents Using Spin-Torque Nano-Oscillators

Faculty: Benjamin Shapiro (BioE/ISR), Edo Waks (ECE/IREAP)

Funding Agency: National Science Foundation

The brain is a complex network of interconnected circuits that exchange signals in the form of "action potentials." These are key to understanding cognition and complex thought. Currently available non-invasive methods for probing neuronal activity are limited; they cannot achieve sufficient spatial or temporal resolution to observe individual action potentials from single neurons or small clusters.

Waks (ECE, IREAP) and Shapiro will develop a novel approach for non-invasive measurements that can read out individual action potentials across the entire brain. Their project will take advantage of recent advances in spintronic devices to create injectable nano-reporters. These nano-reporters will detect weak electrical signals in the brain and convert them to microwave signals that can be detected wirelessly outside the body using a spin-torque nano-oscillator (STNO). This approach could ultimately lead to the first non-invasive technology capable of measuring activations of individual neurons and small-scale neuronal networks in primates and humans, and could have a major impact on the understanding of the inner workings of the brain and cognition. The approach also could have important clinical applications, particularly in neurological disorders and brain machine interfaces.

This two-year, $300K award is made jointly by two NSF programs: the Instrument Development for Biological Research program (IDBR) and Emerging Frontiers (EF) in the Directorate of Biological Sciences (BIO).

NSF: A New Approach to Nonconvex Risk-Sensitive Stochastic Optimization

Faculty: Steve Marcus (ECE/ISR), Michael Fu (BMGT/ISR)

Funding Agency: National Science Foundation

A New Approach to Nonconvex Risk-Sensitive Stochastic Optimization is a three-year, $340K grant that will fund development of a new framework for incorporating risk into sequential decision making under uncertainty. The two pillars of the approach are cumulative prospect theory and dynamic risk measures. The framework builds on both of these research streams to formulate a single theory that integrates subjective preferences in human behavior with normative decision-making objectives. Existing utility-based dynamic models cannot handle the nonconvexity implied by the behavioral models of prospect theory, whereas the framework allows the probability weighting found in cumulative prospect theory to be combined with the usual outcome weighting of traditional expected utility formulations in a sequential decision-making model that incorporates both types of risk sensitivity. The framework will be used to develop efficient dynamic programming sampling and simulation-based methods for risk-sensitive optimization and control problems, and to investigate how the new modeling of risk-sensitivity affects the behavior of decision makers.

The research will provide an alternative framework for decision making under risk to currently existing approaches. The framework unifies the predominantly descriptive research stream of prospect theory coming primarily from psychology and behavioral economics with the normative approaches generally associated with the microeconomics and operations research communities. From this new approach arise a host of challenges, both theoretical and computational. Algorithms will be developed that can be used to address practical operational and tactical decision-making problems arising in a wide variety of application areas, from manufacturing and supply chain management to service systems, including health care, transportation, and financial engineering.

DOE: NEES EFRC renewed for four years

Faculty: Gary Rubloff (MSE/ISR), Gary Sang Bok Lee (Chem/Biochem)

Funding Agency: Department of Energy

The U.S. Department of Energy's (DOE) Basic Energy Sciences has renewed its support for the University of Maryland's (UMD) Nanostructures for Electrical Energy Storage Energy Frontier Research Center (NEES EFRC) for another four years. The renewal is based both on the NEES EFRC's achievements to date and the quality of its proposals for future research.

Professor Gary Rubloff (MSE/ISR) is the director of NEES, and Professor Sang Bok Lee (Chem&Biochem) is its deputy director.

2013

ARO MURI: Information Engines: Nanoscale Control, Computing and Communication out of Equilibrium

Faculty: P. S. Krishnaprasad (ECE/ISR); Christopher Jarzynski (Chem-Biochem/IPST)

Funding Agency: Army Research Office

Professor P. S. Krishnaprasad (ECE/ISR) and Professor Christopher Jarzynski (Chem-Biochem/IPST) are part of a new Army Research Office Multi-University Research Initiative (MURI) grant, "Information Engines: Nanoscale Control, Computing and Communication out of Equilibrium." The five-year award was recently announced by the Department of Defense.

Drawing on four distinct perspectives--computational mechanics, nonequilibrium thermodynamics, control theory, and nanoscale experiments--this project will investigate fundamental principles and algorithms for the creation of synthetic nanosystems that are able to gather, store, and manipulate information while immersed in a thermally noisy environment. Such capabilities appear to be a basis for achieving directed nanoscale flows of matter and energy. The team's research is also expected to yield insights into bio-molecular complexes with similar functionality.

Advanced Silicon Carbide based Novel Hybrid Energy Storage System for Plug-In Electric Vehicles

Faculty: Alireza Khaligh (ECE/ISR), André Tits (ECE/ISR), Patrick McCluskey (ME/CALCE); Steven Rogers (Genovation)

Funding Agency: National Science Foundation

The three-year, $438K National Science Foundation GOALI (Grant Opportunities for Academic Liaisons with Industry) award will provide funding to develop a novel hybrid energy storage system for electric vehicles. The new system will be composed of a high energy-density battery pack, an ultracapacitor pack and a DC/DC converter. This new lightweight system will weigh less than a conventional high power-density battery pack alone. At the same time it will offer an increased battery lifetime. The new system will be developed, implemented and validated on the powertrain of a new electric car.

2012

NSF Collaborative Research: Computational Foundations for Learning, Verifying, and Applying Model Simplification Rules

Faculty: S. K. Gupta (ME/ISR); Dana Nau (CS/ISR)

Funding Agency: National Science Foundation

The researchers will develop feature-based simplification of computer-aided-design models, specifically to accelerate and automate downstream finite-element-analysis. In particular, the research will create algorithmic foundations for learning conservative feature suppression rules from demonstrations performed by human experts. The effect of simplification on simulation accuracy will be formally characterized and this understanding will be used to create robust algorithms

for feature suppression within computer-aided design models. Research findings will be integrated into graduate and undergraduate curriculum. The research will ultimately lead to a framework to automatically learn, validate, and apply context dependent model simplification rules that can be audited by human experts, and deployed to automate the model simplification task.

The research will significantly speed up model simplification, and enhance the automated use of engineering analysis tools in the design process. Potential applications include design of heat exchangers, aircraft structures, and semi-conductor equipment. Computational Foundations for Learning, Verifying, and Applying Model Simplification Rules is a three-year, $265K award.

UMD ADVANCE: Speech Processing Algorithms for Elderly Listeners with Hearing Loss

Faculty: Carol Espy-Wilson (ECE/ISR), Sandra Gordon-Salant (Hearing and Speech Sciences, BSOS)

Funding Agency: ADVANCE Program for Inclusive Excellence: Interdisciplinary and Engaged Research Seed Grant

The ADVANCE Program for Inclusive Excellence's 2012 Interdisciplinary and Engaged Research Seed Grants awarded Professor Carol Espy-Wilson (ECE/ISR) and Professor Sandra Gordon-Salant (Hearing and Speech Sciences, BSOS) a seed grant for "Speech Processing Algorithms for Elderly Listeners with Hearing Loss."

UMD VPR: Magnetic drug delivery to the inner ear

Faculty: Benjamin Shapiro (BioE/ISR), Didier Depireux (ISR)

Funding Agency: University of Maryland Vice President of Research Seed Grant, Maryland Industrial Partnerships program (MIPS), I Rutel (OuHSC), SZI-Clark Seed Funding Grant

Associate Professor Benjamin Shapiro (BioE/ISR) and ISR Associate Research Scientist Didier Depireux have teamed up on several research grants related to delivering drug therapies to the inner ear. This is a new collaborative area for the two ISR researchers. A $50K, one-year University of Maryland Vice President for Research Seed Grant, "Magnetically Delivering Therapies to Inner Ear Diseases." A $100K, 16-month Maryland Industrial Partnerships Program (MIPS) grant, "Magnetic Therapy Injection to Treat Hearing Loss. A $5K, four-month I Rutel (OUHSC) sub-award, "Magnetic Injector for Targeted Delivery of Therapeutics." An $80K, one-year SZI-Clark Seed Funding grant to establish a collaboration with Dr. Diego Preciado of Children's National Medical Center in Washington, D.C., "Magnetic Delivery of Drugs to the Middle Ear without Ear Drum Puncture."

UMD ADVANCE: Insect and Robot Locomotion with Heavy Loads

Faculty: Sarah Bergbreiter (ME/ISR); Barbara Thorne, Jeffrey Shultz (both from Entomology, CMNS)

Funding Agency: ADVANCE Program for Inclusive Excellence: Interdisciplinary and Engaged Research Seed Grant

The ADVANCE Program for Inclusive Excellence's 2012 Interdisciplinary and Engaged Research Seed Grants awarded Assistant Professor Sarah Bergbreiter (ME/ISR), Professor Barbara Thorne and Associate Professor Jeffrey Shultz (both from Entomology, CMNS) a seed grant, "Insect and Robot Locomotion with Heavy Loads."

2011

FAA: NEXTOR II

Faculty: Michael Ball (BMGT/ISR); David Lovell (CEE/ISR)

Funding Agency: Federal Aviation Administration

The University of Maryland is the lead institution for an eight-university consortium forming NEXTOR II, a research program focused on aviation operations research. The new seven-year contract with the Federal Aviation Administration (FAA) will extend and expand the work of the original National Center of Excellence for Aviation Operations Research (NEXTOR). Research expenditures could total as much as $60M over the length of the contract. ISR professors Michael Ball (ISR/Robert H. Smith School of Business) and David Lovell (ISR/CEE) lead the Maryland NEXTOR II team.

NIST Cooperative Agreement: Cyber-Physical Systems

Faculty: John Baras (ECE/ISR); Mark Austin (CEE/ISR)

Funding Agency: National Institute of Standards and Technology

Professor John Baras (ECE/ISR) is the principal investigator for a $1 million cooperative agreement with the National Institute of Standards and Technology. Associate Professor Mark Austin (CEE/ISR) and ISR postdoctoral researcher Shah-An Yang are co-principal investigators on the agreement. The research team will help NIST develop and deploy standards, test methods, and measurement tools to support consistently reliable performance of new smart systems. These cyber-physical systems (CPS) knit information and physical technologies into interactive, self-optimizing products and infrastructures ranging from smart cars, aircraft and buildings to an intelligent electric power grid. By developing standards, test methods, and measurement tools, the UMD/NIST effort can help U.S. industry accelerate development of innovative cyber-physical system products that create jobs, while also protecting these new types of CPS infrastructure from cyber threats.

2010

DOD: Cooperative Research and Development Agreement: RDECOM

Faculty: John Baras (ECE/ISR) and other UMD researchers

Funding Agency: U.S. Army Research, Development and Engineering Command

The University of Maryland and the U.S. Army Research, Development and Engineering Command (RDECOM) officially joined forces to expand research, development and engineering efforts by signing a Cooperative Research and Development Agreement (CRADA) in September. The CRADA builds upon already existing working relationships with the university while increasing the understanding

of the transforming missions and functions of Aberdeen Proving Ground, where RDECOM is headquartered. The ceremony took place in the rotunda of the Jeong H. Kim Engineering Building.

NSF: Adaptive perceptual-motor feedback for the analysis of complex scenes

Faculty: Cynthia Moss (JHU), Timothy Horiuchi (ECE/ISR)

Funding Agency: National Science Foundation: Collaborative Research in Computational Neuroscience

Professor Cynthia Moss (Psych/ISR) is the principal investigator and Associate Professor Timothy Horiuchi (ECE/ISR) is the co-PI for a new National Science Foundation Collaborative Research in Computational Neuroscience grant, "Adaptive perceptual-motor feedback for the analysis of complex scenes." The five-year, $1.5 million grant will fund research to understand the processes that support perception and action in complex settings. The research will focus on spatial perception and navigation in the echolocating bat, an auditory specialist that produces high frequency sonar calls and listens to echo returns to determine the location of objects in its environment. The echolocating bat modifies its sonar calls in response to echo information from targets (insect prey) and obstacles. Quantitative analyses of this animal's adaptive vocal behavior will be used to infer its perception of a changing environment.

2009

NSF CPS: Ant-Like Microrobots—Fast, Small, and Under Control

Faculty: Nuno Martins (ECE/ISR), Pamela Abshire (ECE/ISR), Elisabeth Smela (ME/ISR), Sarah Bergbreiter (ME/ISR)

Funding Agency: National Science Foundation

A team of Clark School faculty from the Institute for Systems Research, the Electrical and Computer Engineering Department and the Mechanical Engineering Department has won a three-year, $1.5 million National Science Foundation grant for Ant-Like Microrobots—Fast, Small, and Under Control. Assistant Professor Nuno Martins (ECE/ISR) is the principal investigator. Co-PIs are Associate Professor Pamela Abshire (ECE/ISR), Associate Professor Elisabeth Smela (ME), and Assistant Professor Sarah Bergbreiter (ME/ISR). No robots at the sub-cm3 scale exist because their development faces a number of open challenges. This research will identify and determine means for solving these challenges. In addition, it will provide new solutions to outstanding questions about resource-constrained algorithms, architectures, and actuators that can be widely leveraged in other applications. The team will discover new fundamental principles, design methods, and technologies for realizing distributed networks of sub-cm3, ant-sized mobile microrobots that self-organize into cooperative configurations.

DOE: Interior-Point Algorithms for Optimization Problems with Many Constraints

Faculty: André Tits (ECE/ISR) Dianne O'Leary (CS/UMIACS)

Funding Agency: Department of Energy

Professor André Tits (ECE/ISR) is the co-principal investigator for a new Department of Energy (DoE) grant, "Interior-Point Algorithms for Optimization Problems with Many Constraints." The Principal Investigator for this grant is Professor Dianne O'Leary (CS/UMIACS). The three-year, $303,701 grant continues the research of an earlier grant in the same area. The researchers will develop, analyze, and test algorithms for the solution of optimization problems with a very large number of inequality constraints, specifically, many more inequality constraints than variables.

NSF: Image Guided Autonomous Optical Manipulation of Cell Groups

Faculty: S. K. Gupta (ME/ISR) Wolfgang Losert (Physics/IPST/IREAP)

Funding Agency: National Science Foundation

Professor S.K. Gupta (ME/ISR) is the principal investigator for a three-year, $550K National Science Foundation grant, "Image Guided Autonomous Optical Manipulation of Cell Groups." Associate Professor Wolfgang Losert (Physics) is the co-PI. The research team will create a computational foundation, methods, and tools for efficient and autonomous optical micromanipulation using microsphere ensembles as grippers. This system will make use of a holographic optical tweezer, which uses multiple focused optical traps to position microspheres in three-dimensional space.

NSF: Next-Generation Model Checking and Abstract Interpretation with a Focus on Embedded Control and Systems Biology

Faculty: Rance Cleaveland (CS/ISR); Steve Marcus (ECE/ISR)

Funding Agency: National Science Foundation: Collaborative Research

Professor Rance Cleaveland (CS/ISR) is the principal investigator and Professor Steve Marcus (ECE/ISR) is a co-PI for the University of Maryland's portion of a major new National Science Foundation collaborative research grant, "Next-Generation Model Checking and Abstract Interpretation with a Focus on Embedded Control and Systems Biology." The five-year, $10 million project is part of NSF's "Expeditions in Computing" initiative. Maryland's part of the project is worth $1.8 million. Along with Marcus, Tongtong Wu of the University of Maryland's School of Public Health is also a co-PI. The consortium will develop new computational tools to help scientists and engineers analyze and understand the behavior of the complex models they develop for application domains ranging from systems biology to embedded control. Building on the success of model checking and abstract interpretation (MCAI), two well-established methods for automatically verifying properties of digital circuit designs and embedded software, this research project will extend the MCAI paradigm to systems with complex continuous dynamics and probabilistic behaviors. The research will include: understanding the precursors and

course of pancreatic cancer; predicting the onset of atrial fibrillation; and obtaining deep design-time insights into the behavior of automotive and aerospace control systems. Ultimately, the project is expected to provide vital tools that will enable health care researchers to discover better treatments for disease and will allow engineers to build safer aircraft and other complex systems.

DARPA: Adaptive Environment for Supercompiling with Optimized Parallelism (AESOP)

Faculty: Rajeev Barua (ECE); Rance Cleaveland (CS/ISR)

Funding Agency: Defense Advanced Research Projects Agency (DARPA)

Associate Professor Rajeev Barua (ECE/ISR) is the PI and Professor Rance Cleaveland (CS/ISR) is a co-PI for a DARPA research grant, Adaptive Environment for Supercompiling with Optimized Parallelism (AESOP). The University of Maryland will collaborate with BAE Systems Inc and Princeton University on this four-year, $11.5 million program; Maryland's share is $2.53 million. Reflecting the belief that serial programs will continue to represent the vast majority of programs in the world, AESOP will develop a state-of-the-art compiler that can automatically compile serial programs into parallel programs to a wide variety of platforms. Unlike existing efforts which have focused on regular, scientific programs alone, the AESOP project will use an aggressive suite of existing methods and new techniques that the researchers have developed to extract large-amounts of scalable parallelism even from seemingly serial irregular programs. This will enable software to exploit the full potential of the hardware in the modern multi-core era. Further, the compiler will accurately characterize and compile to a wide variety of computer systems without any manual effort.

NSF: Nanofabrication using Viral Biotemplates for MEMS Applications

Faculty: Reza Ghodssi (ECE/ISR); James Culver (Plant Science/Landscape Architecture, AGNR)

Funding Agency: National Science Foundation

Professor Reza Ghodssi (ECE/ISR) is the PI for a three-year, $401,712 NSF grant, "Nanofabrication Using Viral Biotemplates for MicroElectroMechanical Systems (MEMS) Applications." The research will make use of the self-assembly and metal-binding properties of a biological nanostructure, the Tobacco Mosaic Virus (TMV), in the development of novel functional materials and fabrication processes for energy microsystems applications. The TMV is a high aspect ratio cylindrical plant virus that can be genetically engineered to include amino acids with enhanced metal-binding properties. These genetic modifications facilitate electroless plating of the molecules as well as self-assembly onto various substrates. The developed processes will be incorporated in the fabrication of new, nanostructured small-scale energy storage devices.

NSF: Particle Filtering for Stochastic Control and Global Optimization

Faculty: Michael Fu (BMGT/ISR); Steve Marcus (ECE/ISR)

Funding Agency: National Science Foundation

Professor Steve Marcus (ECE/ISR) and Professor Michael Fu (BMGT/ISR) are co-PIs for a three-year, $390K NSF grant, Particle Filtering for Stochastic Control and Global Optimization. The objective of this program is to provide new breakthroughs in the areas of stochastic control and global optimization through insights gained from particle filtering and from additional recent results in nonlinear filtering. Stochastic control and optimization can be applied to many problems of critical concern in US industry, so the resulting algorithms will have broad and transformative applicability. In the project, they will be tested on problems in industries from telecommunications to manufacturing to finance.

ARO IARPA: Quantum Computing: Improving Josephson Junction Qubits

Faculty: Gary Rubloff (MSE/ISR) (Joint Quantum Institute, Physics Dept. CMNS, NIST, LPS)

Funding Agency: Army Research Office: Intelligence Advanced Research Projects Activity (IARPA)

Professor Gary Rubloff (MSE/ISR) is the co-PI on an interdisciplinary research collaboration with the Joint Quantum Institute (JQI) that has been awarded a five-year, $2.8 million grant from the Intelligence Advanced Research Projects Activity (IARPA) through the Army Research Office (ARO) to devise, fabricate, study and test a new kind of key component for quantum computing. The team will work on novel methods of constructing the crucial, ultra-thin insulating barrier that lies between two superconductors to form a "Josephson junction."

NSF: Combining Gradient and Adaptive Search in Simulation Optimization

Faculty: Michael Fu (BMGT/ISR); Steve Marcus (ECE/ISR)

Funding Agency: National Science Foundation: Collaborative Research

Professor Michael Fu (BMGT/ISR/ECE) is the principal investigator and Professor Steve Marcus (ECE/ISR) is the co-PI for a three-year, $350K NSF collaborative research grant, Combining Gradient and Adaptive Search in Simulation Optimization. The researchers will develop new simulation optimization algorithms based on different sequences of the so-called "reference distributions" in a recently developed approach called model reference adaptive search, and new hybrid global-local search algorithms integrating local gradient search and problem structure. They also will conduct rigorous theoretical analysis of the resulting algorithms, both finite-time behavior using an adaptive search framework and asymptotic behavior using a novel connection to stochastic approximation methods. A wide variety of applications from supply chain management to financial engineering will be tested to investigate specific gradient search algorithms and problem structure, and evaluating the effectiveness in terms of empirical behavior. This line of research fills an important part of the "analytics" computa-

tional tool kit that has led to increased competitiveness for US businesses from manufacturers and retailers with global supply chains to financial services managing complex risk factors.

Maryland: A Micro-Direct Methanol Fuel Cell with Nanostructured Platinum Catalysts Using the Tobacco Mosaic Virus

Faculty: Reza Ghodssi (ECE/ISR); James Culver (Plant Science/Landscape Architecture, AGNR), Chunsheng Wang (ChBE/MSE) Gary Rubloff (MSE/ISR)

Funding Agency: Maryland Nanobiotechnology Research and Industry Competition Grant

Professor Reza Ghodssi (ECE/ISR) is the principal investigator for a $250,000 FY2009 Maryland Nanobiotechnology Research and Industry Competition Grant for "A Micro-Direct Methanol Fuel Cell with Nanostructured Platinum Catalysts Using the Tobacco Mosaic Virus." The research will develop fuel cells with surface area nano-structured electrodes using the Tobacco mosaic virus. The TMV is a high aspect ratio plant nanostructure which can be genetically modified to include functional groups that facilitate electroless metal deposition and self-assembly onto gold surfaces. This biotemplating process has been integrated with standard micro-machining for the development of micro-fabricated batteries.

DOE: Science of Precision Multifunctional Nanostructures for Electrical Energy Storage (EFRC)

Faculty: Gary Rubloff (MSE/ISR); Sang Bok Lee (ChBE). Other UMD researchers include John Cumings (MSE), Bryan Eichhorn (Chem/Biochem), Chunsheng Wang (ChBE), Liangbing Hu (MSE), YuHuang Wang (Chem/Biochem), Reza Ghodssi (ECE/ISR), Janice Reutt-Robey (Chem/Biochem)

Funding Agency: Department of Energy: Energy Frontier Research Center

Former ISR Director and Professor Gary Rubloff (MSE/ISR) will lead a new Energy Frontier Research Center (EFRC) as part of a major new U.S. Department of Energy program. Rubloff, who directs the Maryland NanoCenter, will draw faculty groups from three colleges—The A. James Clark School of Enginering; Chemical and Life Sciences; and Computer, Math and Physical Sciences. EFRCs enlist the talents and skills of the very best American scientists and engineers to address current fundamental scientific roadblocks to U.S. energy security. The University of Maryland EFRC will address the "Science of Precision Multifunctional Nanostructures for Electrical Energy Storage." Its objective is to understand how nanostructures formed from multiple materials behave and their potential for a new generation of electrical energy storage technology. By using materials in precisely built nanostructures, energy storage devices will hold more energy, will charge or deliver electricity faster, and remain stable for longer lifetimes, while reducing space and weight.

Appendix 15: Number of PhD Students with ISR Advisors, by Department/Program, 1985-2014

AMSC	3
Biology	5
BioE	10
BMGT	32
CE and CEE	15
ChE and ChBE	47
Chemical Physics	1
CS	73
EE/Applied Math	1
AE	13
EE and ECE	450
ME	77
MAPL	7
MATH	20
MSE and MNE	17
NACS	9
Physics	5
Reliability Engineering	2
Statistics	2
TOTAL	788

Appendix 16: PhD Students Co-Advised by ISR Joint Faculty and Faculty from a Different Department, 2010–2015

Student	ISR faculty/department	Other faculty/department	
Sourav Chowdhury	Reza Ghodssi (ECE/ISR)	Michael Ohadi	ME
Angela Lewandowski	Reza Ghodssi (ECE/ISR)	William Bentley	BioE
Xiaolong Luo	Reza Ghodssi (ECE/ISR)	Gary Rubloff	MSE/ISR
Theresa Valentine	Reza Ghodssi (ECE/ISR)	Gary Rubloff	MSE/ISR
Li-Qun Wu	Reza Ghodssi (ECE/ISR)	Gregory Payne	IBBR
Kim Young-Sik	SK Gupta (ME/ISR)	Nicholas Dagalakis	NIST
Arvind Balijeppali	SK Gupta (ME/ISR)	Thomas LeBrun	NIST
Ahiyang Yao	SK Gupta (ME/ISR)	Dana Nau	CS/ISR
Sehadri Raghavan	Alireza Khaligh (ECE/ISR)	Steven Gabriel	CEE (ISR affiliate)
Yongqiang Wang	Steven Marcus (ECE/ISR)	Michael Fu	BGMT/ISR
Xue Mei	Gang Qu (ECE/ISR)	David Jacobs	CS/UMIACS
Maria Chait	Jonathan Simon (ECE/Biology/ISR)	David Poeppel	Biology
Kim Drnec	Jonathan Simon (ECE/Biology/ISR)	Ray Stricklin	Animal & Avian Sciences
Alessandro Presacco	Jonathan Simon (ECE/Biology/ISR)	Samira Anderson	Hearing & Speech Sciences

Appendix 17: Number of MSSE Students Mentored/ Advised by ISR Joint Appointment Faculty from Inception of MSSE Program to Date

Faculty	# of students
Eyad Abed	1
G. Anandalingam	1
Mark Austin	61 (**1)(^2)
Mike Ball	19 (*2)(**1)
John Baras	30 (#1)(^2)
Sarah Bergbreiter	1
Christos Faloutsos	1
Michael Fu	1
Reza Ghodssi	1
S. K. Gupta	2
Jeffrey Herrmann	8
Alreza Khaligh	1
William Levine	1
David Lovell	5 (*2)
Armand Makowski	1
Steven Marcus	1
Ioannis Minis	3
Nicholas Roussopoulos	1
Ben Shneiderman	7
V.S. Subrahmanian	2
Guangming Zhang	10
Advised by non-ISR faculty	14
TOTAL	**168**

* Jointly advised by Mike Ball and David Lovell
** Jointly advised by Mark Austin and Mike Ball
# Jointly advised by John Baras and André Tits
^ Jointly advised by Mark Austin and John Baras

Appendix 18: Number of Undergraduate Students Mentored by ISR Faculty, 2010–2015

Faculty member	# of students	Notes from faculty CVs
Ray Adomaitis	3	
Sarah Bergbreiter	7	"Independent Study"
Sarah Bergbreiter	22	Includes current students
Carol Espy-Wilson	7	Three are at Harvard, Loyola, & Georgia Tech)
Michael Fu	2	
Reza Ghodssi	7	
Jeffrey Herrmann	10	Inventis mentor to 10 ME undergrads
Alireza Khaligh	23	
Armand Makowski	5	
Nuno Martins	6	
Derek Paley	15-20	This is the number per *year*
Gang Qu	13	
Michael Rotkowitz	2	
Jonathan Simon	13	

Appendix 19: Winners of ISR Student Awards, 1985–Present

George Harhalakis Outstanding Systems Engineering Graduate Student Award

Biswadip Dey....2014
Sagar Chowdhury....2013
Dimitrios Spyropoulos....2012
Yongqiang Wang....2011
Kiran Somasundaram....2010
Ashis Gopal Banerjee....2009
Stephan Koev....2008
Nima Ghalichechian....2007
Rinku Parikh....2006
Nima Mesgarani....2005
Kaushik Ghose....2004
Zoltan Safar....2003
Wade Trappe....2002
Vasilios Lagakos....2001
Thomas Vossen....2000
Haitao Zheng....1999
Philip "Flip" Korn....1998
Farrokh Rashid-Farrokhi....1997
Eric Justh....1996
William Regli....1995
Satyandra Gupta....1994
Naomi Erich Leonard....1993
Rajiv Laroia....1992
Rakesh Nagi....1991
Sun-Lai Chang....1990
Ouassima Akhrif....1989
Digendra Butala....1988
Anthony LaVigna....1987

Outstanding Systems Engineering Undergraduate Student Award

Daniel Mirsky....2014
Mehdi Dadfarnia....2013
David Daily....2012
David Billet, Zachariah Panneton, and Jason Saeedi....2011
- - -....2010
- - -....2009
Ermin Wei....2008
- - -....2007
- - -....2006
- - -....2005
- - -....2004
Patrick Sodré Carlos....2003
- - -....2002
- - -....2001
- - -....2000
Matthew Impett....1999
Keith Holleman....1998
- - -....1997
Narin Suphasindhu....1996
Catherine Piper Lesesne....1995
K. A. Khan....1994
Craig Lawrence....1993
Laura Knox....1992
- - -....1991
Philip Wiser....1990
Gregory Walsh....1989
Nam Phamdo....1988
- - -....1987

Appendix 20: ISR Alumni in Academic Positions

Year	Advisor	Last name	First name	Institution	Department	Position
1985	Narayan	Hughes	Brian	North Carolina State University	ECE	Professor
1986	Geraniotis	Vlachos (MS here)	Theodore	Ionian University	Informatics	Asso Professor
1987	Geraniotis	Balakirsky (BS here)	Stephen	Georgia Tech Research Institute	AE	Sr Res Scientist
1987	Geraniotis	Ketseoglou (MS here)	Thomas	California State University Ponoma	ECE	Professor
1987	Krishnaprasad	Sreenath	Narasingarao	Case Western University	EECS	Professor
1987	Roussopoulos	Kang	Hyunchul	Cung-Ang University	CSE	Professor
1988	Baras	James	Matthew	Australian National University	ECS	Professor
1988	Abed/Tits	Saydy	Lachen	Ecole Polytechnique de Montreal	EE	Professor
1988	Ephremides	Viniotis	Yannis	North Carolina State University	ECE	Professor
1988	Krishnaprasad	Posbergh	Thomas	University of Minnesota	ECE	Adj Asso Prof
1988	Levine	He (retired)	Jiping	Arizona State University	BioE/EE	Professor
1988	Levine	Yang	Jiann-Shiou	University of Minnesota Duluth	EE	Professor/Chair
1988	Narayan	Gubner	John	University of Wisconsin	ECE	Professor
1989	Berenstein	Walnut	David	George Mason University	Mathematics	Professor/Chair
1989	Davis	Chen	Kwang-Cheng	National Taiwan University	EE	Disting Professor
1989	Nau	Yang	Qiang	Hong Kong Univ of Sci & Tech	CSE	New Bright Professor/Chair
1990	Abed	Liaw	Der-Cherng	National Chiao Tung University	ECE	Professor
1990	Geraniotis	Chau	Yaw-Geng	Yuan-Ze Institute of Technology	EE	Asso Professor
1990	JaJa	Chakrabarti	Chaitali	Arizona State University	ECEE	Professor
1990	Krishnaprasad	Wang	Li-Sheng	National Taiwan University	App Mech	Professor
1991	Fuja	Bross	Shraga	Bar Ilan University	EE	Professor
1991	Makowski	Sowers	Richard	Univ of Illinois Urbana-Champaign	Mathematics	Professor
1991	Pecht	Osterman	Michael	University of Maryland	CALCE	Sr Res Scientist
1991	Tsai	Chen	Dar-Zen	National Taiwan University	ME	Professor
1992	Ball	Lin	Feng Lee	National Sun Yat-Sen University	BMGT	Asso Professor
1992	Baras/ Berenstein	Sidiropoulos	Nikos	Technical University of Crete	ECE	Professor
1992	Ephremides	Modiano	Eytan	Mass Institute of Technology	AE	Professor
1992	Ephremides	Tassiulas	Leandros	Yale University	EE	John C. Malone Professor
1992	Fuja	Yang	Guu-Chang	National Chung-Hsing University	ECE	Distinguished Professor
1992	Hendler	Spector	Lee	Hampshire College	CS	Professor
1992	Liu	Chiu	Ching-Te	National Tsing-Hua Univ, Taiwan	Comm.	Professor
1992	McAvoy	Qin	Si Zhao Joe	University of Southern California	ChE/MS	Professor
1992	Narayan	Lambadaris	Ioannis	Carleton University	SCE	Professor
1992	Tits	Lee	Li	National Sun Yat-Sen University	EE	Asso Professor
1992	Tits	Tsing	Nam Kiu	University of Hong Kong	Mathematics	Asso Professor
1993	Abed	Wang	Hua	Boston University	ME	Asso Professor
1993	Pecht	Lall	Pradeep	Auburn University	ME	Thomas Walter Professor

1993	Roussopoulos	Delis	Alexios	University of Athens	Info/Telecom	Professor
1993	Shamma	Byrne	William	University of Cambridge	IE	Professor
1993	Zhang	DeVoe (Earned BS and MS here)	Don	University of Maryland	ME	Professor
1994	Ball	Datta	Anindya	National University of Singapore	Info Systems	Asso Professor
1994	Fuja	Alajaji	Fady	Queens University	Math/Stat	Professor
1994	Krishnaprasad	Leonard	Naomi	Princeton University	ME/AE	Edwin S. Wilsey Professor
1994	Krishnaprasad	Ozkazanc	Yakup	Haceteppe University, Turkey	EE	Asst Professor
1994	Nau	Gupta	SK	University of Maryland	ME/ISR	Professor, MRC Director
1995	Fu	Diaz	Angel	Instituto de Empresa Business School	OR/SCM	Professor
1995	Fu	Xu	Kefeng	University of Texas San Antonio	Mgt Sci/Stat	Asso Professor
1995	Fuja	Al-Semari	Saud	King Fahd Univ of Petro/Minerals	EE	Asso Professor
1995	Krishnaprasad	Tsakiris	Dimitris	Inst of Comp Science – FORTH	Comp Vis/ Robotics	Principal Researcher
1995	Liu	Wu	An-Yeu	National Taiwan University	EE	Professor
1995	Minis	Ioannou	Georgios	Athens Univ of Econ and Business	Mgmt Science	Professor
1995	Nau	Regli	William	Drexel University	CS	Professor; Sr. Asso. Dean; DARPA
1996	JáJá	Bader	David	Georgia Institute of Technology	CSE	Professor/Chair
1996	Tits	Chou	Yung Shan	Tamkang University	EEg	Asso Professor
1997	Farvardin	Jafarkhani	Hamid	University of California-Irvine	EE & CS	Chancellor's Professor
1997	JaJa	Chen	Po-Yueh	Chaoyang University of Technology	EE	Professor
1997	Narayan	Khudanpur	Sanjeev	Johns Hopkins University	ECE/CS	Asso Professor
1997	Tsai	Stamper	Richard	Rose-Hulman Inst of Technology	ME	Dean of Faculty
1998	Baras	Sonmez	Mustafa Kemal	Oregon Health and Science Univ	CS/EE	Asso Professor
1998	Krishnaprasad	Venkataraman	Iyer Ram	Texas Tech University	Math/Stat	Asso Professor
1998	Liu	Chen	Jie	University of Alberta	ECE	Professor
1998	Shneiderman	Zaphiris (MSSE here)	Panayiotis	Cyprus University of Technology	Multimedia/ Graphic Arts	Asso Professor
1999	Berenstein	Marmolejo-Olea	Emilio	Univ Nac Autónoma de México	Mathematics	Investigador
1999	Geraniotis	El Gamal	Hesham	Ohio State University	ECE	Professor
1999	Krishnaprasad	Kantor	George	Carnegie Mellon University	Robotics Inst	Sr Sys Scientist
1999	Liu	Zheng	Haitao	Univ of California-Santa Barbara	CS	Professor
2000	Abed	Sayyad (earned MS here; PhD WVU)	Abdel Salam	Birzeit University	ECS	Asst Professor
2000	Ball	Inniss	Tasha	Spelman College	Mathematics	Asso Professor
2000	Baras/Tits	Liu	Mingyan	University of Michigan	ECE	Professor
2000	Baras	Poovendran	Radha	University of Washington	EE	Professor/Chair
2000	Ephremides	Tamer	Elbatt	Nile University	Comm/IT	Asst Professor
2000	Geraniotis	Khairy	Mohamed	Cairo University	ECE	Professor
2000	Hendler	Luke	Sean	George Mason University	CS	Asso Professor
2000	Herrmann	Vieira	Guilherme	Pontifical Catholic Univ of Parana	ISE	Asso Professor
2000	Tassiulas	Sarkar	Saswati	University of Pennsylvania	EE	Professor
2001	DeVoe	Panchapakesan	Balaji	Worcester Polytechnic Institute	ME	Asso Professor
2001	Lovell	Tantakasem (earned MS here)	Pariya	Mahidol University	CEE	Instructor

2001	Roussopoulos	Rodriguez-Martinez	Manuel	Univ of Puerto Rico Mayaguez	ECE	Asso Professor
2002	Ball	Vossen	Thomas	University of Colorado	Mgmt/Entrep	Asso Professor
2002	Baras	Tan	Xiaobo	Michigan State University	ECE	Professor
2002	Corson	Tunpan	Apinun	Asian Institute of Technology	EE	Sr Researcher
2002	Fu	Jin	Xing	Warwick Business School	Finance	Asso Professor
2002	Krishnaprasad	Andersson	Sean	Boston University	AE/ME	Asso Professor
2002	Lee	Tachatraiphop	Sukanya	Suranaree University of Technology	Laser/Phot	Faculty
2002	Liu	Trappe	Wade	Rutgers University	ECE	Professor
2002	Tassiulas	Ercetin	Ozgur	Sabanci University	EE	Asso Professor
2002	Tassiulas	Kar	Koushik	Rensselaer Polytechnic Institute	ECSE	Asso Professor
2002	Tsai	Schultz	Gregory	University of Maryland	ME/M-CART	Lecturer
2003	Shamma	Chi	Tai-Shih	National Chiao Tung University	EE	Asso Professor
2003	Tits	Bakhtiari (EE MS here)	Sasan	Australian National University	Economics	Sr Economist
2003	Liu	Han	Zhu	University of Houston	ECE	Asso Professor
2004	Liu	Chandrachoodan	Nitin	IIT Madras	EE	Asso Professor
2004	Shamma	Elhilali	Mounya	Johns Hopkins University	ECE	Asso Professor
2004	Farvardin	Kwasinski	Andres	Rochester Institute of Technology	CE	Asso Professor
2004	Liu	Sun	Yan Lindsay	Univ. of Rhode Island	ECBioMedE	Asso Professor
2004	Raghavan	Day	Robert	University of Connecticut	OR/IM	Asso Professor
2004	Krishnaprasad	Zhang	Fumin	Georgia Institute of Technology	ECE	Asso Professor
2004	Liu	Zhao	Hong (Vicky)	University of Alberta	ECE	Asso Professor
2005	Barua	Haga	Steve	National Sun Yat-Sen University	CS/CE	Asst Professor
2005	Cohen	Wheaton	Lewis	Georgia Institute of Technology	App Phys	Asso Professor
2005	Gupta	Cardone	Antonio	University of Maryland	UMIACS	Asst Res Sci
2005	Moss	Bohn	Kirsten	Florida International University	Science/Hum	Res Asst Prof
2005	Nau	Au	Tsz-Chiu	Ulsan Nat Inst of Sci and Tech	ECE	Asst Professor
2005	Roussopoulos	Deligiannakis	Antonios	Technical University of Crete	ECE	Asst Professor
2005	Shayman	Kalantari	Mehdi	University of Maryland	ECE	Asst Res Sci
2005	Ulukus	Kaya	Onur	Isik University, Istanbul	EE	Asso Professor
2006	Adomaitis	Zeitoun (BS here; Ph.D. Michigan)	Ramsey	University of Colorado	Chem/BioE	Res Associate
2006	Baras	Rabi	Maben	Chalmers University of Technology	Auto Control	Asst Professor
2006	Baras	Cárdenas	Alvaro	University of Texas at Dallas	CSe	Asst Professor
2006	Berenstein	Gavilanez	Franklin	Montgomery College	Math	Asso Professor
2006	Fu, Marcus	Hu	Jiaqiao	SUNY-Stony Brook	App Math Stat	Asso Professor
2006	Roussopoulos	Tsoumakos	Dimitrios	Ionian University	Informatics	Asst Professor
2006	Simon	Chait	Maria	University College London	Aud Cog Neu	Reader
2006	Srivastava	Davoodi	Azadeh	University of Wisconsin	ECE	Asso Professor
2007	Abed	Saad	Mohamed	Cairo University	Engineering	Asso Professor
2007	Baras	Theodorakopoulos	Georgios	Cardiff University	CS/Infor	Lecturer
2007	Ephremides	Faridi	Azadeh	Univ Pompeu Fabra, Barcelona	Tecnologia	Visiting Lecturer
2007	Ephremides	Girici	Tolga	Tobb University, Ankara, Turkey	EE	Asso Professor
2007	Fu, Jank	Heath	Jeffrey	Centre College	Math	Asso Professor
2007	Ghodssi	Ghalichechian	Nima	Ohio State University	ECE	Res Scientist
2007	Liu	Qiu	Peng	Georgia Tech/Emory	BioMedEng	Asst Professor
2007	Raghavan	Chen	Si	Murray State University	CS/IS	Asst Professor
2007	Shapiro	Walker	Shawn	Louisiana State University	Mathematics	Asst Professor

2007	Ulukus	Liu	Nan	Southeast University Nanjing	ECE	Professor
2008	Ephremides	Shrader	Brooke	MIT Lincoln Laboratory	Nat Security	Res Scientist
2008	Krishnaprasad	Wei (BS here; Ph.D MIT)	Ermin	Northwestern University	EE/CS	Asst Professor
2008	Rubloff	Luo	Xiaolong	Catholic University of America	ME	Asst Professor
2008	Shamma	Mesgarani	Nima	Columbia University	EE	Asst Professor
2008	Ulukus	Soysal	Alkan	Bahcesehir University, Turkey	EE	Asso Professor
2008	Ulukus	Kang	Wei-Hsuan	Southeast University Nanjing	EE	Asso Professor
2008	Ulukus	Soysal	Alkan	Bahcesehir University	EEE	Asso Professor
2009	Ball	Lan	Yingjie	Peking University	MS/Info Sys	Asst Professor
2009	Cukier	Berthier	Robin	University of Illinois U-C	Coord Sci	Res Scientist
2009	Fu	Reindorp	Matthew	Technische Universiteit Eindhoven	OR/Control	Asst Professor
2009	Gupta	Banerjee	Ashis	University of Washington	ME	Asst Professor
2009	Krishnaprasad	Afsari	Bijan	Johns Hopkins University	Imaging Sci	Asst Res Sci
2009	Krishnaprasad	Kaipa	Krishna Vinod	Indian Inst of Sci Ed/Res Bhopal	Mathematics	Asst Professor
2009	Liu	El Sherif	Amr	Alexandria University, Egypt	Arch Eng	Asst Professor
2009	Marcus, Fu	Zhou	Enlu	Georgia Institute of Technology	IE/SE	Asst Professor
2010	Abshire	McFarlane	Nicole (Nelson)	University of Tennessee	EECS	Asst Professor
2010	Ghodssi	Khbeis	Michael	University of Washington	Nanofab	Director
2010	Shamma	Atiani	Serin	Montreal Neurological Institute	Neuroscience	Postdoc
2010	Ulukus	Tandon	Ravi	University of Arizona	ECE	Asst Professor
2010	Ulukus	Yang	Jing	University of Arkansas	EE	Asst Professor
2010	Yu	Liu	Yuxiang	Worcester Polytechnic Institute	ME	Asst Professor
2011	Barg	Mazumdar	Arya	University of Minnesota	ECE	Asst Professor
2011	Barua	Tzannes	Alexandre	Univ of Illinois Urbana-Champaign	CS	Postdoc
2011	Ghodssi	Beyaz	Mustafa	Antalya International University	EEE	Asst Professor
2011	Gupta	Thakur	Atul	Indian Institute of Technology Patna	ME Robotics	Asst Professor
2011	Krishnaprasad	Galloway	Kevin	U.S. Naval Academy	ECE	Asst Professor
2011	Krishnaprasad	Mischiati	Matteo	Howard Hughes Medical Institute	Leonardo Lab	Associate
2011	Makowski	Yagan	Osman	Carnegie Mellon Silicon Valley	ECE	Asst Res Prof
2011	Martins	Sabau	Serban	Stevens Institute of Technology	ECE	Asst Professor
2011	Raghavan	Bardossy	Maria	University of Baltimore	IS/Decis Sci	Asst Professor
2011	Rubloff	Banerjee	Parag	Washington University	ME/MSE	Asst Professor
2011	Simon	Zhuo	Jiachen	UMD School of Medicine	Nuclear Med	Asst Professor
2011	Ulukus	Bassily	Raef	Pennsylvania State University	CSE	Postdoc
2012	Bergbreiter	Gerratt	Aaron	Ecole Polytechnique Federale de Lausanne	Neuro tech	Postdoc
2012	Chopra	Liu	Yen-Chen	National Cheng Kung University	ME	Asst Professor
2012	Espy-Wilson	Garcia-Romero	Daniel	Johns Hopkins University	Human lang	Res Scientist
2012	Ghodssi	Gerasopoulos	Konstantinos	University of Maryland	ISR	Postdoc
2012	Paley	Butail	Sachit	Indraprastha Inst of Info Tech Delhi	Control	Asst Professor
2012	Raghavan	Gunnec	Dilek	Oyzegin University	Industrial Eng.	Asst Professor
2012	Simon, Fritz	Ding	Nai	New York University	Psychology	Postdoc
2012	Tits	Alldredge	Graham	RWTH Aachen University	Mathematics	Postdoc
2013	Gupta	Chowdhury	Sagar	Purdue University	ME	Postdoc
2013	Khaligh	Wang	Haoyu	Shanghai Technical University	IS	Asst Professor
2013	Narayan	Tyagi	Himanshu	Indian Institute of Science	ECE	Asst Professor

2013	Paley	Severson	Tracie	U.S. Naval Academy	Weap/Sys Eng	Asst Professor
2013	Srivastava	Forte	Domenic	University of Connecticut	ECE	Asst Professor
2013	Ulukus	Shahzad (EE MS here)	Khurram	Mohammad Ali Jinnah Univ	EE	Asst Professor
2013	Yu	Sawaqed	Laith Sami	Jordan Univ of Sci and Tech	ME	Asst Professor
2014	Barg	Yu	Wei-Hsuan	Michigan State University	Mathematics	Postdoc/ Vis Asst Prof
2014	Paley	DeVries	Levi	U. S. Naval Academy	Weap/Sys Eng	Asst Professor
2014	Ulukus	Ozel	Omur	UC Berkeley	ECE	Postdoc
2015	Fu	Chau	Marie	Virginia Commonwealth Univ.	Business	Asst Professor
2015	Srivastava	Forte	Dominic	University of Florida	ECE	Asst Professor

Appendix 21: ISR Visiting Researchers, 2010–2015

Name	Title	Faculty	Research/Description
Sheng, Li	Faculty Research Assistant	Abed	stability theory, chaos synchronization, neutral networks
Burka, Maria K	Visiting Sr Research Scientist	Adomaitis	?? - joint affiliate with CHB
Hoffman, Robert L.	Visiting Research Associate	Ball	NEXTOR Collaborative Decision-Making project
Zhu, Chenxi	Assistant Research Scientist	Baras	network security
Ghasemi, Nader	Faculty Research Assistant	Baras	distributed estimation of Markov dynamical systems, the design of poer-efficient binary-quantizer for HMM state
Hovareshti, Pedram	Research Associate	Baras	collaborative control of autonomous agents as well as networked systems analysis
Liu, Zhixin	Visiting Associate Professor	Baras	network science; networked systems and multi-agent systems
Pouli,Vasiliki	Faculty Research Assistant	Baras	related to trust/security of communication networks
Stai, Eleni	Faculty Research Assistant	Baras	trust and security of communication networks
Tarraf, Daniel	Visiting Assistant Professor	Baras	control of hybrid systems
Okuda, Takayuki	Visiting Research Associate	Barg	algebraic combinatorics
Umetsu, Tomoki	Faculty Research Assistant	Bruck	Toshiba visitor; numerical analysis & experiments
Teramoto, Ryuichi	Faculty Research Assistant	Dasgupta	Toshiba visitor; accelerated stress testing of electronics
Pappas, Nikolaos	Faculty Research Assistant	Ephremides	network coding for wireless networks
Abedi, Ali	Visiting Associate Professor	Ephremides	wireless networks
Ephremidze, Lasha	Research Associate	Ephremides	wireless communications and spectral estimation
Huang, Song	Visiting Research Associate	Ephremides	theoretical analysis research on ad-hoc wireless networks
Jiazhi, Ren	Faculty Research Assistant	Ephremides	theoretical analysis research on ad-hoc wireless networks
Sagduyu,Yalin E.	Visiting Asst Research Scientist	Ephremides	wireless networking
Yu, Fengqin	Visiting Research Associate	Espy-Wilson	time-frequency analysis of speech signals based on the model of pronunciation mechanism
Brosch, Michael	Visiting Research Associate	Fritz	laboratory studies of the neural basis of auditory attention and neural modeling of brain functions
Leach, Nicolas	Trainee	Fritz	nucleus basalis in modulating attention and task-related plasticity in the auditory cortex
Ramezani,Vahid Reza	Visiting Research Associate	Fu	production/inventory control and supply chain management
Daniel, Jurgen H.	Assistant Research Scientist	Ghodssi	polymer MEMS, paper-like displays, flexible and printed electronics, novel printing systems, bioanalytical devices and sensors
Mitcheson, Paul	Visiting Assistant Professor	Ghodssi	develop novel microsystems for energy conversion & harvesting applications
Pekarek, Jan	Faculty Research Assistant	Ghodssi	observe and gain insight into BioMems and the advanced instrumentation available at UMD
Pekarkova, Jana	Faculty Research Assistant	Ghodssi	BioMems; prepare various types of biosensors using e.g. chitosan and characterize these biosensors
Tatic-Lucic, Svetlana	Visiting Associate Professor	Ghodssi	MEMS platforms for a variety of uses
Iwanaga, Kensuke	Faculty Research Assistant	Goldsman	Honda visitor; simulation for wide-gap semiconductor power devices

Jiashun, Liu	Faculty Research Assistant	Gupta	experimental and theoretical studies of assembly planning in virtual environment to support automated manufacturing
Masunaga, Takayuki	Faculty Research Assistant	Gupta	Toshiba visitor; investigate mechanical engineering technologies
Salonen, Veikko Tapio	Faculty Research Assistant	Gupta	simulation based system design
Yoshida, Satoshi	Faculty Research Assistant	Herrmann	Toshiba visitor; simulation-based systems design
Nakano, Tetsuaki	Faculty Research Assistant	Krishnaprasad	Honda visitor; intelligent and robust control for robotic systems
Kang, Taewoo	Faculty Research Assistant	La	dynamic spectrum allocation
Kim, Dong Yon	Visiting Research Associate	La	cross-layer optimization scheme in communication network systems
Sugimoto, Mariko	Faculty Research Assistant	Levine	Toshiba visitor; vibration control
Chang, Hyeong Soo	Visiting Associate Professor	Marcus	dynamic traffic engineering/management of MPLS domains
Urayama, Keiichiro	Faculty Research Assistant	Marcus/Fu	Toshiba visitor; production control methods for semiconductor manufacturing
Jakobsen, Lasse	Faculty Research Assistant	Moss	investigate the sound beam characteristics of big brown bats as they navigate known and unknown flight routes
Logiaco, Laureline	Trainee	Moss	neural recording experiments with echolocating bats engaged in behavioral task
Elliott, David L	Visiting Sr Research Scientist	n/a	bilinear systems
Watanabe, Shun	Visiting Assistant Professor	Narayan	quantum cryptography
Yao, Aihong	Visiting Professor	Qu	Energy-efficient design of embedded systems
Wu, Yuanming	Visiting Professor	Qu	Energy efficiency and trust in wireless sensor networks
Sun, Ziwen	Visiting Professor	Qu	Smart phone security
Lu, Xianling	Visiting Professor	Qu	Security for wireless sensor networks
Lee, Won Jae	Visiting Professor	Rubloff	energy storage nano devices
Luo, Xiaolong	Visiting Asst Research Professor	Rubloff	BioChip Collaborative
Duque Doncos, Daniel	Faculty Research Assistant	Shamma	auditory behavior and neurophysiology in the ferret
Englitz, Bernhard	Faculty Research Assistant	Shamma	spectrotemporal plasticity in the auditory cortex
Jin, Dezhe	Visiting Associate Professor	Shamma	explore state-dependent dynamics of cortical networks for auditory object recognition
Radtke-Schuller, Susanne	Visiting Research Associate	Shamma	neuroanatomical research in the NSL
Rinzel, John M.	Visiting Professor	Shamma	auditory perception, particularly auditory streaming

Appendix 22: ISR Postdoctoral Researchers, 2010–2015

Name	Title	Faculty Supervisor	General Area of Research / Description
Hasouneh, Monther A.	Research Associate	Abed/Balachandran	stability and stabilization of non-smooth systems, electric power system monitoring and control, swarm intelligence and wireless sensor networks
Ygouf, Marie	Research Associate	Aubailly	development of image processing and non-conventional adaptive optics imaging techniques through numerical analysis & experiments
John, Sarah	Research Associate	Aubailly/Vorontsov	numerical analysis of atmospheric turbulence effects on optical systems performance over long propagation paths
Churchill, Andrew	Research Associate	Ball	air traffic management
Glover, Charles Nathan	Research Associate	Ball	various topics in air traffic management
Ivanov, Vladimir Iankov	Research Associate	Baras	architectures for CPS; on frameworks for modeling and designing CPS and associated design tools
Jiang, Tao	Research Associate	Baras	wireless networks and autonomic networks; more specifically on problems of security, trust and network formation in such networks
Kyrtsos, Christina Rose	Research Associate	Baras	math model for Alzheimer's disease to study the effects of stress, altered glucose metabolism and dysregulated immune response on the systems as a whole
Matei, Ion	Research Associate	Baras	investigate model-based systems engineering approach and environments for collaborative control and inference systems
Perumal, Senni	Research Associate	Baras	modeling, simulation design and performance evaluation of mobile wireless adhoc networks and on validation of designs via detailed simulations
Purkayastha, Punyaslok	Research Associate	Baras	wireless networks and networked control systems.
Roy-Chowdhury, Ayan	Research Associate	Baras	modeling and simulation of wireless and satellite networks using OPNET and other simulators to transition the MANET emulator to the Systems Engineering and Integration Laboratory cluster machine
Yang, Shah-An	Research Associate	Baras	formal models for systems, testing and validation of systems, network security and information assurance
Tamo, Itzhak	Research Associate	Barg	advance the theory of group testing
Sylla, Pape Maguette	Research Associate	Barua	building compiler optimization components
Daw Perez, Zamira	Research Associate	Cleaveland	develop integrated approaches to the model-based design and verification of embedded control software
Tytell, Eric D.	Research Associate	Cohen	lamprey spinal cord and its interactions with the edge cells, the mechanoreceptors
Landford, Pamela	Research Associate	Cohen/ADVANCE	--unknown--
Pantelidou, Anna	Research Associate	Ephremides	the foundations of wireless networks and on cross-layer analysis and design
Khanagha, Vahid	Research Associate	Espy-Wilson	signal processing; compare and possibly combine techniques from various algorithms to develop a voice activity detector
Lu, Kai	Research Associate	Fritz	neural basis of sound perception, auditory attention, plasticity, learning and memory in the NSL
Ben-Yoav, Hadar	Research Associate	Ghodssi	develop next generation self-sustaining diagnostic micro and nano devices and systems for detection and characterization biofilms
Gerasopoulos, Kostas	Research Associate	Ghodssi	--unknown--

Ghosh, Ayan	Research Associate	Ghodssi	to develop next generation diagnostic micro and nano devices and systems for characterization of novel materials used in development of next generation energy storage devices
Gnerlich, Markus Hans	Research Associate	Ghodssi	microfabrication process development to produce a new flexible supercapacitor
Pomerantseva, Ekaterina	Research Associate	Ghodssi	materials characterization and development of micro and nano devices and systems for self-sustaining integrated microsystems
Bahari, Seyed Farshad	Research Associate	Gligor	sensor network security
Svec, Petr	Research Associate	Gupta	development of planning framework for virtual assembly and unmanned vehicles
Abdalla, Hisham	Research Associate	Horiuchi	bat echolocation
Afsari, Bijan	Research Associate	Krishnaprasad	inverse problems for reconstructing trajectories of biological and artificial agents moving in 3D
Aytekin, Murat	Research Associate	Moss	measurements and modeling the sonar beam patter of echolocating bats
Chiu, Chen	Research Associate	Moss	sensorimotor control, coordinated flight and aerodynamics by echolocating bats
Lee, Wu-Jung	Research Associate	Moss	analysis and modeling of the auditory scenes encountered by echolocating bats
Wohlgemuth, Melville	Research Associate	Moss	sensorimotor integration in the superiod colliculus of the echolocating bat
Cheng, Yi	Research Associate	Rubloff	research, synthesis, integration and evaluation of nanostructures
Gregorczyk, Keith	Research Associate	Rubloff	synthesis and in-situ characterization of advanced nanostructures for electrical energy storage
Hodzic, Vildana	Research Associate	Rubloff	design and develop NispLab-2; lead consultant for use and expansion of optical techniques in the NanoCenter and NispLab
Lathrop, Elizabeth	Research Associate	Rubloff	technical and scientific review and writing for the NEES/ ERFC program
Lin, Chuan-Fu	Research Associate	Rubloff	synthesis and characterization of nanostructures relevant to electrical energy storage
Noked, Malakhi	Research Associate	Rubloff	nanoelectrochemistry in energy storage
Predith, Ashley P.	Research Associate	Rubloff	support the research and scientific activities of the EFRC; assist with strategizing future directions of the research and efforts to secure additional funding
Banerjee, Parag	Research Associate	Rubloff	materials processing for energy devices
Atiani, Serin Ibrahim	Research Associate	Shamma	function and adaptive properties of the secondary auditory cortical areas
David, Stephen V.	Research Associate	Shamma	development of the Neural Systems Lab's custom data acquisition software and physiology database, assist other experimenters in the lab
Ma, Ling	Research Associate	Shamma	continue analysis of data collected during her PhD program, and finalize publications
Mesgarani, Nima	Research Associate	Shamma	speech detection and enhancement of voice identification
Sell, Gregory Kennedy	Research Associate	Shamma	assess human abilities to recognize voices and the factors that influence their competence as described in the Human & Algorithmic Speaker Robust project
Yin, Ping-Bo	Research Associate	Shamma	auditory cortex in the behaving ferret
Shechter, Barak	Research Associate	Shamma/ Fritz	analyze data from the tinnitus experience, collect the results into figures towards publication

Strait, Dana Lucille	Research Associate	Shamma/ Fritz	neural basis of sound perception, auditory attention, plasticity, learning and memory in the NSL
Francis, Nikolas	Research Associate	Shamma/ Kanold	investigate the neural correlates of auditory perception and cognition
Hertz, Daniel	Research Associate	Simon	auditory processing in human listeners, using magnetencephalography
Sabau, Serban	Research Associate	Tits	develop systematic methods for the design of optimal controllers that are subject to sparsity constraints
Liu, Ling	Research Associate	Vorontsov	development of new generation of free-space laser communications and optical energy projection systems
Polnau, Ernst Eduard	Research Associate	Vorontsov	experimental adaptive optics for free-space laser communication and active imaging applications
Lachinova, Svetlana	Research Associate	Vorontsov	the new CTA task; simulation, analysis and optimization of adaptive optical systems for free-space laser communication applications

Appendix 23: ISR Seminar Series and Speakers, 2002–Spring 2015

Advanced Networks Colloquia

Spring-Summer 2014

Friday, March 28, 2014 (11 am)
Codes on Graphs
David Forney
Massachusetts Institute of Technology

Friday, March 28, 2014 (3:30 pm)
Coding Theory and Access Control for Distributed Wireless Networking
Jie Rockey Luo
Colorado State University

Friday, July 18, 2014
On the optimality of treating interference as noise in competitive scenarios
Alex Dytso
University of Illinois at Chicago

Fall 2013

Friday, Aug. 23, 2013
Stability Analysis and Delay Optimality in Multi-Queue Multi-Server (MQMS) Systems
Ioannis Lambadaris
Department of Systems and Computer Engineering
Carleton University
Ottawa, Canada

Friday, Sept. 20, 2013
Challenges in Building Human Networks
Abdur Chowdhury
Co-founder, Alta Vista School
Former Chief Scientist, Twitter

Monday, Oct. 7, 2013
Cloud Radio Access Downlinks, with Backhaul Constrained Oblivious Processing
Shlomo Shamai
William Fondiller Professor of Telecommunications
Technion-Israel Institute of Technology

Tuesday, Oct. 8, 2013
Source Coding with Lists and Renyi Entropy
Amos Lapidoth
Professor of Information Theory
ETH Zurich

Friday, Oct. 11, 2013
Bandit Optimization with Large Strategy Sets and Applications
Alexandre Proutiere
Associate Professor, School of Electrical Engineering
TKTH, the Royal Institute of Technology, Sweden

Wednesday, Nov. 6, 2013
Navigating Internet Neighborhoods: Reputation, Its Impact on Security, and How to Crowd-Source It
Mingyan Liu
Professor, Dept. of Electrical Engineering and Computer Science
University of Michigan

Spring 2013

Tuesday, April 23, 2013
Data-Efficient Quickest Change Detection
Venu Veeravalli
ECE Department and Coordinated Science Lab
University of Illinois at Urbana-Champaign

Wednesday, May 8, 2013
Recursive distributional equations, endogeny, and belief propagation via three examples
Rajesh Sundaresan
Coordinated Science Lab
University of Illinois at Urbana-Champaign

Friday, May 10, 2013
Analyzing (Big) Data Boxes: Multi-Way Compressed Sensing of Low-rank Tensors with Sparse Latent Structure
Nikolaos Sidiropoulos
University of Minnesota--Minneapolis

Fall 2012

Friday, Nov. 30, 2012
Security and Game Theory: Key Algorithmic Principles, Deployed Applications, Lessons Learned
Milind Tambe
University of Southern California

Spring 2012

Friday, Feb. 3, 2012
*-Aware Software for Cyber-Physical Systems
John A Stankovic
University of Virginia

Friday, Feb. 17, 2012
The LiveLabs Testbed and Mobile Sensing-Based Applications
Archan Misra
School of Information Systems
Singapore Management University

Friday, Feb. 24, 2012
Low-Complexity Scheduling Policies for Achieving Throughput and Delay Optimality in OFDM Downlink Systems
Ness Shroff
The Ohio State University

Friday, March 2, 2012
Fundamentals of Molecular Nano-Communication Networks
Ian Akyildiz
Georgia Institute of Technology

Friday, March 23, 2012
XIA: An Architecture for an Evolvable and Trustworthy Internet
Peter Steenkiste
Carnegie Mellon University

Friday, March 30, 2012
Learning Equilibrium with a Minimum of Rationality
Peyton Young
James Meade Professor of Economics
Nuffield College
Oxford University

Friday, April 13, 2012
Extracting insight from large networks: implications of small-scale and large-scale structure
Michael Mahoney
Stanford University

Friday, April 20, 2012
Improving the Energy Efficiency of Data Centers
Tajana Simunic Rosing
University of California, San Diego

Friday, April 27, 2012
Network-based Statistical Models and Methods for Identification of Cellular Mechanisms of Action
Eric Kolaczyk
Department of Mathematics and Statistics
Boston University

Fall 2011

Friday, Sept. 9, 2011
State-Space Collapse via Drift Conditions
R. Srikant
University of Illinois at Urbana-Champaign

Friday, Sept. 16, 2011
Physics of Algorithms: Belief Propagation and Beyond
Michael Chertkov

Los Alamos National Laboratory

Friday, Sept. 23, 2011
Sampling Online Social Networks
Athina Markopoulou
University of California, Irvine

Friday, Sept. 30, 2011
Non-Bayesian Social Learning
Ali Jadbabaie
University of Pennsylvania

Friday, Oct. 7, 2011
Multi-Armed Bandit: Learning in Dynamic Systems with Unknown Models
Qing Zhao
University of California, Davis

Friday, Oct. 14, 2011
The Large Scale Curvature of Networks and its Implications for Network Management and Security
Iraj Saniee
Bell Laboratories

Friday, Oct. 21, 2011
Network Science and the Internet: Lies, Damned Lies, and Statistics
Walter Willinger
AT&T Laboratories

Friday, Oct. 28, 2011
What Have We Learned from Reverse-Engineering the Internet's Inter-Domain Routing Protocol?
Timothy Griffin
University of Cambridge

Friday, Nov. 4, 2011
Kalman and Kalman Bucy @ 50: Distributed and Intermittency
José M.F. Moura
Carnegie Mellon University

Friday, Nov. 11, 2011
Popularity vs. Similarity in Growing Networks
Dmitri Krioukov
University of California, San Diego

Friday, Nov. 18, 2011
Bilateral and Multilateral Exchanges for Peer-Assisted Content Distribution
Christina Aperjis
Hewlett-Packard Laboratories

Friday, Dec. 2, 2011
Using the Network Structure of Annotation Data to Gain Insights into Gene Interactions and the Organization of Biological Function
Michelle Girvan
University of Maryland

Friday, Dec. 9, 2011
Sequential Detection: Overview and Open Problems
George Moustakides
University of Patras

Brain-Based Systems Seminar Series

Spring 2015

Feb. 18
The Quest for the Philosopher's Stone of Human Brain Imaging
Matti Hamalainen
Associate Professor in Radiology, Harvard Medical School
Director, MEG Core, Martinos Center, MGH
Professor of Systems Neuroscience, Aalto University School of Science, Espoo, Finland

April 22
Developments in Microstructural Imaging of the Brain
Peter Basser
Eunice Kennedy Shriver National Institute of Child Health and Human Development
National Institutes of Health

Fall 2014

Oct. 22
Using stem cells to define human identity
Ronald McKay, Ph.D.
Lieber Institute for Brain Development

ISR Distinguished Lecturer Series

2015

Thursday, Feb. 5
Autonomous and Intelligent Systems at United Technologies Research Center
Andrzej Banaszuk
Program Leader, Sikorsky Program Office
United Technologies Research Center

Wednesday, March 25
Ecological Systems Research: How Mathematics Informs Our Understanding of Animal Movement and Global Change
Bill Fagan
Professor and Chair
Department of Biology, University of Maryland

2014

Thursday, Oct. 30
Microgrids for Promoting Power System Resilience, Reliability, and Economics
Mohammad Shahidehpour
Armour College of Engineering
Illinois Institute of Technology

2013

Monday, May 13
Flexibility in Power Systems
Daniel Kirschen
Donald W. and Ruth Mary Close Professor of Electrical Engineering
University of Washington

Thursday, Dec. 5, 2013
Control of Cyber-Physical Systems: Fundamental Challenges and Applications to Energy and Transportation Networks
Karl Henrik Johansson
KTH, the Royal Institute of Technology
Stockholm, Sweden

2012

Wednesday, March 14, 2012
Brain representations of structural and semantic information in natural movies
Jack Gallant
Helen Wills Neuroscience Institute
University of California, Berkeley

Tuesday, April 24
Coherent feedback control of quantum dynamical systems
Hideo Mabuchi
Professor of Applied Physics
Stanford University
Palo Alto, Calif.

Friday, Nov. 30
The Genesis of Coding Theory
Daniel Costello
Bettex Chair, Professor Emeritus
Department of Electrical Engineering
University of Notre Dame

2011

Friday, April 8, 2011
Large-Scale Wind/Marine Turbines: State-of-the-Art & Current Challenges
Yin Lu (Julie) Young
Associate Professor
Naval Architecture and Marine Engineering
University of Michigan
Ann Arbor, Mich.

Wednesday, May 4, 2011
A Vision for Computer Science: The System Perspective
Joseph Sifakis
CNRS Research Director
Schneider-INRIA Endowed Researcher Chair
Founder of Verimag Laboratory, and Director (1993-2006)
Verimag Laboratory

Tuesday, Sept. 20, 2011
Vacuum Microsystems for Energy Conversion
Roger T. Howe
Dept. of Electrical Engineering
Stanford Nanofabrication Facility
Stanford University
Palo Alto, Calif.

Monday, Oct. 24, 2011
How Watson Learns Superhuman Jeopardy! Strategies
Gerry Tesauro
IBM Research

2010

Tuesday, Sept. 14, 2010
Sparse Sensing with Coprime Sampling Lattices
P.P. Vaidyanathan
Professor of Electrical Engineering
Caltech Digital Signal Processing Group
California Institute of Technology

Friday, Oct. 8, 2010
Information Visualization for Knowledge Discovery
Ben Shneiderman
Department of Computer Science, UMIACS, ISR
University of Maryland

Monday, Oct. 11, 2010
Sensing, Control, and Decision Making with Limited Actions
Tamer Basar
Swanlund Endowed Chair
CAS Professor of Electrical & Computer Engineering,
Center for Advanced Study
Research Professor, Information Trust Institute
Research Professor, Coordinated Science Laboratory
University of Illinois Urbana-Champaign

2009

Thursday, Feb. 26
Game Theoretic Learning for Distributed Autonomous Systems
Jeff Shamma
Julian T Hightower Chair of Systems and Controls
Professor of Electrical and Computer Engineering
Georgia Institute of Technology

May 21
Characterizing General Anesthesia-Induced Loss of Consciousness
Emery N. Brown
Warren M. Zapol Professor of Anaesthesia
Harvard Medical School
Department of Anesthesia and Critical Care
Massachusetts General Hospital
Professor of Computational Neuroscience and Health Sciences and Technology
Massachusetts Institute of Technology

2008

Wednesday, April 16
4G Wireless Technology Vision
Siavash M. Alamouti
Intel Fellow, Mobility Group
Chief Technology Officer
Mobility Wireless Group
Intel Corporation

Friday, May 2
Applications of Formal Methods in Model-Based Development of Embedded Control Systems
Bruce Krogh
Professor, Electrical and Computer Engineering
Carnegie Mellon University

Thursday, Oct. 2
The Challenge of the Neocortex for Information Technology
Rodney Douglas
Professor of Neuroinformatics
Institute of Neuroinformatics (INI)
ETH/UZH, Zurich

Thursday, Nov. 14
Polarization codes and the rate of channel polarization
Emre Telatar
Professor
École Polytechnique Fédérale de Lausanne (EPFL)
Lausanne, Switzerland

2007

Tuesday, February 13
Understanding the Simulation of Mobility Models
Jean-Yves Le Boudec
Ecole Polytechnique Fédérale de Lausanne (EPFL)
Lausanne, Switzerland

Monday, March 26
Feedback Fundamentals: Old and New
Petar V. Kokotovic
Professor, Department of Electrical & Computer Engineering
University of California Santa Barbara

Monday, Oct. 15, 2007
Systems Biology: How Can Control Engineers Help to Understand Biology?
Frank Allgöwer
Director, Institute for Systems Theory and Automatic Control
Professor, Mechanical Engineering Department
University of Stuttgart, Germany

2006

Tuesday, March 7
Hybrid Systems and Control
S. Shankar Sastry
Director, Center for Information Technology in the Interest of Society
NEC Distinguished Professor of EECS and Professor of Bioengineering
University of California, Berkeley

Tuesday, May 2
Control Systems Theory and a Qualitative/Quantitative Approach to Systems Biology
Eduardo Sontag
Department of Mathematics
BioMaPS Institute for Quantitative Biology, Computer Science and Electrical and Computer Engineering Rutgers University

Tuesday, September 19
The Emerging Science of Spontaneous Order
Steven Strogatz
Professor, Theoretical and Applied Mathematics
Cornell University

Tuesday, November 7, 2006
Listening in a cocktail party with acoustic and electric hearing
Bob Carlyon
Medical Research Council
Cognition & Brain Sciences Unit
University of Cambridge
Cambridge, England

2005

Wednesday, March 9
Decoding the Human Genome by Multi-Species Sequence Comparisons
Eric D. Green, M.D., Ph.D.
National Human Genome Research Institute, National Institutes of Health

Tuesday, April 12
The Operational Semantics of Hybrid Systems
Edward A. Lee
Professor of Electrical Engineering and Computer Sciences, University of California at Berkeley

Tuesday, October 11
Robust and Adaptive Optimization:
A Tractable Approach to Optimization under Uncertainty
Dimitris Bertsimas, Ph.D.
Boeing Professor of Operations Research
Sloan School of Management; Operations Research Center
Massachusetts Institute of Technology

Tuesday, November 15
Signal Processing and Wireless Networks
H. Vincent Poor
George Van Ness Lothrop Professor in Engineering
Department of Electrical Engineering, Princeton University

2004

Friday, Feb. 20
Dynamics in Genetic Networks
Leon Glass, FRSC, Isadore Rosenfeld Chair in Cardiology and Professor of Physiology, McGill University, Montreal, Canada

Friday, April 16
From Hierarchies to Polyarchies: Visualizing Multiple Relationships
George G. Robertson, ACM Fellow and Senior Researcher, Microsoft Research

Wednesday, October 13
A Unified View of Temporal Difference Methods for Neuro-Dynamic Programming
Dimitri P. Bertsekas
McAfee Professor of Engineering, Laboratory for Information and Decision Systems
Massachusetts Institute of Technology

Tuesday and Wednesday, November 16 and 17
Cell Talk
Bhubaneswar "Bud" Mishra
Professor of Computer Science, Mathematics & Cell Biology (Courant Institute & NYU School of Medicine) New York University

2003

Friday, March 14
Swarm Intelligence
Eric Bonabeau, Icosystem Corp., Cambridge, Mass.

Friday, April 18
Scientific Discovery through Advanced Computing
Alan J. Laub
Office of Science, U.S. Department of Energy

Monday, Oct. 20 and Tuesday, Oct. 21
Automated Synthesis of High-Performance Planners and Schedulers
Douglas Smith
Kestrel Institute, Palo Alto, Calif.

Thursday, Dec. 18
New Perspective on Wolfram's 'New Kind of Science'
Leon O. Chua;
University of California, Berkeley
Berkeley, Calif.

2002

October 25
Video Re-Coding
Bede Liu
Princeton University

December 6
Algorithmic Aspects of the Internet
Christos Papadimitriou
University of California, Berkeley

Intelligent Automation, Inc. Colloquia Series

Spring 2015

Feb. 20
Distinguished Scholar-Teacher Lecture
Micro/Nano/Biosystems: The New 'Fantastic Voyage'
Reza Ghodssi
Herbert Rabin Distinguished Chair in Engineering
Director, Institute for Systems Research
Electrical and Computer Engineering and Institute for Systems Research

March 4
Adaptive Processing of Auditory Stimuli
Associate Professor Patrick Kanold
Department of Biology
and affiliate, Institute for Systems Research

April 1
Games for Engineering Problems—Examples and Simple Learning Rules
Associate Professor Richard La
Department of Electrical and Computer Engineering
and Institute for Systems Research

Friday, May 8
A Molecular View of ISR: Past, Present, and Future
Professor Raymond Adomaitis
Department of Chemical and Biomolecular Engineering
and Institute for Systems Research

Fall 2014

September 3
Nano Frontiers in Biomedical Engineering: Targeting Therapies to the Ear, Tooth, and Brain
Associate Research Scientist Didier Depireux
Institute for Systems Research

October 1
Sampling Beyond Nyquist: Structure, Geometry and Statistical Information
Assistant Professor Piya Pal
Department of Electrical and Computer Engineering
and affiliate, Institute for Systems Research

November 5
Robust and Scalable Signal Processing for High-Dimensional Dynamic Complex Neural Data
Assistant Professor Behtash Babadi
Department of Electrical and Computer Engineering
and affiliate, Institute for Systems Research

December 3
An Overview of Simulation Optimization
Professor Michael Fu
Robert H. Smith School of Business
and Institute for Systems Research

Spring 2014

February 5
Bio-Inspired Flow Sensing and Control for Autonomous Underwater Vehicles
Associate Professor Derek Paley
Department of Aerospace Engineering and
Institute for Systems Research

March 12
Energy Harvesting Wireless Communications
Professor Sennur Ulukus
Department of Electrical and Computer Engineering
Institute for Systems Research

April 2
Exploring Power Network Signatures for Information Forensics
Professor Min Wu
Department of Electrical and Computer Engineering
Institute for Advanced Computer Studies

May 7
Understanding and Mimicking How the Fly Hears
Associate Professor Miao Yu
Department of Mechanical Engineering
Affiliate, Institute for Systems Research

Fall 2013

September 6
Joint presentation with the Booz Allen Hamilton Distinguished Colloquium in Electrical and Computer Engineering
Cortical Encoding of Auditory Objects at the Cocktail Party
Associate Professor Jonathan Simon
Department of Electrical and Computer Engineering
Department of Biology
Institute for Systems Research

October 9
Inkjet-printed fluidic paper SERS devices for chemical and biological analytics
Assistant Professor Ian White
Fischell Department of Bioengineering
Affiliate, Institute for Systems Research

November 6
Current Status of Adaptive Optics Imaging through Deep Atmospheric Turbulence
Assistant Research Scientist Mathieu Aubailly
Director, Intelligent Optics Laboratory
Institute for Systems Research

December 4
Generalized Lagrangians: the Progress in Signal Processing and the Promise in Control
Assistant Professor Michael Rotkowitz
Department of Electrical and Computer Engineering and
Institute for Systems Research

Spring 2013

February 6
Network Equilibrium Models with a Focus on Energy
Professor Steven Gabriel
Department of Civil and Environmental Engineering
Affiliate, Institute for Systems Research

March 13
Scaling Down Robotics: Mobility, Mechanisms, and Motors for Microrobots
Assistant Professor Sarah Bergbreiter
Department of Mechanical Engineering and
Institute for Systems Research

April 3
Towards Robot-Assisted Neurosurgery under Continuous MRI
Associate Professor Jaydev Desai
Department of Mechanical Engineering
Affiliate, Institute for Systems Research

Fall 2012

September 5
The Conundrum of Scheduling in Wireless Networks: Who Should Transmit What, to Whom, When?
Professor Tony Ephremides
Institute for Systems Research
and Department of Electrical and Computer Engineering

October 3
Neural Models of 3D Spatial Orientation in Echolocating Bats
Associate Professor Timothy Horiuchi
Institute for Systems Research
and Department of Electrical and Computer Engineering

November 7
Information and Influence Propagation on Social Networks: The Least Cost Influence Problem
Professor S. "Raghu" Raghavan
Institute for Systems Research
and Robert H. Smith School of Business

December 5
Transportation 2.0: Towards Highly Efficient and Ultra-Compact Power Electronics Converters
Assistant Professor Alireza Khaligh
Institute for Systems Research
and Department of Electrical and Computer Engineering

Spring 2012

February 1
Information Visualization for Medical Informatics
Professor Ben Shneiderman
Department of Computer Science and UMIACS

March 7
Ants, Urns and Stochastic Approximations
Professor Armand Makowski
Institute for Systems Research
and Department of Electrical and Computer Engineering

April 4
Control of Magnetic Drug Targeting
Associate Professor Ben Shapiro
Institute for Systems Research
and Fischell Department of Bioengineering

May 2
Current Research in the Space Systems Laboratory
Associate Professor David Akin
Department of Aerospace Engineering

Fall 2011

Sept. 7
Nanostructures and Systems for Electrical Energy Storage
Professor Gary Rubloff
Institute for Systems Research and
Department of Materials Science and Engineering

Oct. 5
UMD Contributions to the Next Generation Air Transportation System
Associate Professor David Lovell
Institute for Systems Research and
Department of Civil and Environmental Engineering

Nov. 2
Robots with Language
Professor Yiannis Aloimonos
Department of Computer Science and University of Maryland Institute for Advanced Computer Studies

Dec. 7
Reconstructing Collectives
Professor P. S. Krishnaprasad
Institute for Systems Research and
Department of Electrical and Computer Engineering

Spring 2011

February 2
Towards Simulation-Based Computational Synthesis
Professor S.K. Gupta
Institute for Systems Research
and Department of Mechanical Engineering

March 2
Auditory Signal-Processing From Sound to Meaning—New Insights from Systems Neuroscience
Associate Research Scientist Jonathan Fritz
Institute for Systems Research

April 6
Component-based Architectures for System Synthesis (COMPASS)
Professor John Baras
Institute for Systems Research
and Department of Electrical and Computer Engineering

May 11
AESOP: A parallelizing compiler for high performance computing
Associate Professor Rajeev Barua
Institute for Systems Research
Department of Electrical and Computer Engineering

Fall 2010

September 1
Recent Research on Present and Future Air Traffic Management Challenges
Professor Michael Ball
Institute for Systems Research and Robert H. Smith School of Business

October 6
Systems Engineering Education at ISR and Ontology-Enabled Traceability Mechanisms
Associate Professor Mark Austin
Institute for Systems Research and Civil and Environmental Engineering Department

November 3
Energy and Thermal Issues in Modern Computer Systems
Associate Professor Ankur Srivastava
Institute for Systems Research
and Electrical and Computer Engineering Department

December 1
Bio Chips: Learning from Biology
Associate Professor Pamela Abshire
Institute for Systems Research
and Electrical and Computer Engineering Department

Spring 2010

February 3
Study of a Neuromechanical System: Going from Neurons to Vortices
Professor Avis Cohen
Institute for Systems Research and Department of Biology, Program in Neuroscience and Cognitive Science
Eric Tytell
Post-Doctoral Researcher
Department of Biology, Program in Neuroscience and Cognitive Science

March 3
Using Operations Research to Improve Planning for Public Health Emergencies
Associate Professor Jeffrey Herrmann
Institute for Systems Research and Department of Mechanical Engineering

April 7
Speech: The Holy Grail of User Friendliness in Computing
Professor Carol Espy-Wilson
Institute for Systems Research and Department of Electrical and Computer Engineering

May 5
Evolution of State-Dependent Risk Preferences in Social-Modeling Games
Professor Dana Nau
Institute for Systems Research and Department of Computer Science

Maryland Robotics Center Seminar Series (various sponsors)

Spring 2015 (Sponsored by Lockheed Martin)

Feb. 27
Robots Learning Action Plans by Watching YouTube Videos
Yiannis Aloimonos
Computer Science and UMIACS
Affiliate Faculty, ISR

March 13
Inference and Planning for Aggressive Autonomous Flight
Nicholas Roy
Associate Professor, Aeronautics and Astronautics
Massachusetts Institute of Technology

April 17
Scalable 3D fabrication of soft machines
Rob Shepherd
Assistant Professor
Mechanical and Aerospace Engineering
Cornell University

April 24
Design and Integration of Novel Field Robots and Robotic Exoskeletons
Pinhas Ben-Tzvi
Associate Professor
Mechanical and Aerospace Engineering
Founding Director, Robotics and Mechatronics Laboratory
George Washington University

Fall 2014 (Sponsored by Lockheed Martin)

Sept. 10
(Gliding) Robotic Fish: Swim or Not Swim
Xiaobo Tan
Electrical and Computer Engineering
Michigan State University
and ISR/ECE alumnus

Oct. 3
Analysis and Simulation for Robotic Systems Performing Contact Tasks: The Good, the Bad, and the Ugly
Jeff Trinkle
Program Director
National Robotics Initiative and Robust Intelligence
Information and Intelligent Systems Division
Computer and Information Science and Engineering
National Science Foundation
and
Director of the CS Robotics Lab
Department of Computer Science
Rensselaer Polytechnic Institute

Oct. 10
Virtual Reality: The Next Generation
Steve LaValle
Professor, University of Illinois
Research Scientist, Oculus/Facebook

Oct. 10
Soft Multifunctional Materials for Soft Robotics
Carmel Majidi
Assistant Professor
Mechanical Engineering and Robotics Institute
Carnegie Mellon University

Dec. 12
Cognitive Robotics and Human Robot Interaction
Greg Trafton
Head, Intelligent Systems Section
Naval Research Laboratory

Spring 2014 (Sponsored by Lockheed Martin)

April 11
Recent algorithms for the assignment problem in multi-robot task allocation
Dylan Shell
Department of Computer Science and Engineering
Texas A&M University

May 9
Computation of Robot Motion Plans from Complex High-Level Specifications
Lydia E. Kavraki
Noah Harding Professor of Computer Science and Bioengineering
Rice University

May 16
Secure state-estimation and control for dynamical systems under adversarial attacks
Paulo Tabuada
UCLA Electrical Engineering

Fall 2013 (Sponsored by Lockheed Martin)

October 11
Robots (and Informatics) to the Rescue.
Robin Murphy
Texas A&M University

October 14
Artificial mind with emotion and sociality.
Minoru Asada
Osaka University

October 25
Feedback Control of Bipedal Locomotion: Theory and Experiment
Jessy W. Grizzle
University of Michigan

Spring 2013 (Sponsored by Lockheed Martin)

February 22
Symbiotic Autonomy: Robots, Humans and the Web
Manuela M. Veloso
Carnegie Mellon University

March 1
Visual Guidance of Flight in Bees & Birds, & Applications to Robotics
Mandyam Srinivasan
Queensland Brain Institute
The University of Queensland

March 8
FIRST Robotics in Maryland – Inspiring STEM Excellence
Bill Duncan
Regional Director in Maryland for FIRST,
Executive Director of STEMaction, Inc.

April 5
Design and Control of Complex Dynamical Systems at United Technologies Corp
Sonja Glavaski
Control Systems Group Leader
United Technologies Research Center

April 26
Coordinated Robotics: From Agility to Perception
Thomas Bewley
Director, Flow Control and Coordinated Robotics Labs
University of California, San Diego

May 16
Grounding Natural Language in Robot Control and Perception Systems
Dieter Fox
Associate Professor, Department of Computer Science & Engineering
Director, UW Robotics and State Estimation Lab
University of Washington

Fall 2012 (Sponsored by Lockheed Martin)

November 2
Identification of Feedback Controllers in Locomoting Animals
Noah J Cowan
Johns Hopkins University

November 30
National Robotics Initiative & Innovation Corps
Richard Voyles
National Science Foundation

December 14
Collaborative Robot Tracking of Geophysical Flows: How Local Measurements Discover Global Structures
M. Ani Hsieh
Drexel University

Spring 2012 (Sponsored by Techno-Sciences, Inc.)

May 3
Modular & Reconfigurable Robots
Mark Yim
University of Pennsylvania

April 27
Why drive (autonomously) when you can fly (autonomously)?
Sanjiv Singh
Carnegie Mellon University

April 6
Self-Organization in Networks of Autonomous Systems
Daniela Rus
Massachusetts Institute of Technology

March 9
Applying Principles from Biology to the Design and Operation of Robots
Mark Cutkosky
Stanford University

February 17
Enabling Better Human-Robot Interaction Through Cognition
Alan C. Schultz
Naval Research Laboratory

Fall 2011 (Sponsored by Techno-Sciences, Inc.)

November 18
Stochastic Models in Robotics
Greg Chirikjian
Johns Hopkins University

October 28
Biologically-Inspired Approaches for Collaboration of Heterogeneous Autonomous Naval Systems
Marc Steinberg
Office of Naval Research

October 21
Planning and Decision-Making for Underwater Robot Teams: Algorithms and Experiments
Gaurav Sukhatme
University of Southern California

October 7
Biomimetic Millirobots
Ron Fearing
UC Berkeley

September 23
Algorithms for Feedback Motion Planning with examples using Walking Robots and Robotics Birds
Russ Tedrake
Massachusetts Institute of Technology

Spring 2011 (Sponsored by Techno-Sciences, Inc.)

April 29
Motion Planning for Physical Robotics
Dinesh Manocha
University of North Carolina

April 22
Robots and the Human
Oussama Khatib
Stanford University

April 1
Human-Centered Control Systems for Robot-Assisted Medical Interventions
Allison Okamura
Johns Hopkins University

February 25
Autonomous 3-D Flight and Cooperative Control of Multiple Micro Aerial Vehicles
Vijay Kumar
University of Pennsylvania

January 28
Hovering Quad-Rotor Control: A Comparison of Nonlinear Controllers Using Visual Feedback
Rogelio Lozano
Université de Technologie de Compiègne

Fall 2010

November 12
A National Robotics Effort
Henrick Christensen
Georgia Institute of Technology

October 29
Partitioned and Hybrid Methods for Visual Servo Control
Seth Hutchinson
University of Illinois at Urbana-Champaign

September 17
Nereus Hybrid Underwater Robotic Vehicle
Louis Whitcomb
Woods Hole Oceanographic Institution

Spring 2010

May 14
Microsurgery Assistant System for Retinal Surgery
Russell Taylor
Johns Hopkins University

April 30
Pursuit and Cohesion: Bio-inspiration for Collective Robotics
Professor P.S. Krishnaprasad
Institute for Systems Research and Department of Electrical and Computer Engineering

April 23
Generality and Simple Hands: Automation and Robotics
Matthew T. Mason
Carnegie Mellon University

Model-Based Systems Engineering Colloquia Series

Fall 2014

Monday, Sept. 22
Strategies for Applying Analytical Methods in Manufacturing
Peter Denno
Computer Scientist
Systems Integration Division
National Institute of Standards and Technology

Monday, Oct. 6
NSF Program Overview: Engineering and Systems Design (ESD) and Systems Science (SYS)
Chris Paredis
Program Director, Engineering and Systems Design (ESD) and Systems Science (SYS) programs
National Science Foundation

Fall 2013

Monday, Sept. 23, 2013
Model-Based Software and Systems Engineering: Elements of Seamless Development
Manfred Broy
Chair Software and Systems Engineering
Fakultat fur Informatik
Technische Universitat Munchen

Monday, Sept. 30, 2013
Smart Grids: End-to-End Cyber Physical Electric Energy Systems
Marija Ilic
Carnegie Mellon University

Monday, Oct. 7, 2013
Models of Time for Safety Critical Systems
Partial vs. Total Order—Polychronous vs. Synchronous
Sandeep Shukla
Hume Center for National Security and Technology
Virginia Tech Arlington Research Center

Monday, Oct. 14, 2013
Achieving Systems Understanding through MBSE-Centric Analytics
Christopher Oster
Space Systems Architect
Lockheed Martin

Monday, Oct. 21, 2013
Integrated Modeling and Analysis to Support Model-Based System Developments
Hongman Kim
Phoenix Integration

Monday, Oct. 28, 2013
Systems Engineering and Innovation in Control--An Industry Perspective and an Application to Automotive Powertrains
Tariq Samad
Honeywell Automation and Control Solutions

Friday, Nov. 8, 2013
Pluggable Analysis Viewpoints for Design Space Exploration
Michael Masin
IBM Research – Haifa Lab

Monday, Nov. 11, 2013
System Engineering of GM's Global Automotive Electronics, Controls and Software Product Line: Current Practice and Challenges
Joseph D'Ambrosio
GM Research & Development

Monday, Nov. 25, 2013
Fair Control under Resource Constraints
Sandra Hirche
Technishe Universitat Munchen

Monday, Dec. 2, 2013
Intelligent Digital Manufacturing: Closing the gap between design and manufacturing
Tolga Kurtoglu
Xerox PARC

Tuesday, Dec. 17, 2013
A Derivative-Free Trust-Region Method for Biobjective Optimization
Sujin Kim
National University of Singapore

Spring 2013

Monday, Feb. 25, 2013
From Validating Models to Validating Systems
Peter Denno
National Institute of Standards and Technology

Monday, April 1, 2013
Models for Geometric Composability of Engineered Physical Systems
Vijay Srinivasan
National Institute of Standards and Technology

Friday, April 12, 2013
Analysis and Simulation of Embedded Control Performance using Jitterbug and TrueTime
Karl-Erik Arzen
Lund University, Sweden

Monday, April 15, 2013
UML: Once More with Meaning
Ed Seidewitz
Ivar Jacobson International

Monday, May 13, 2013
Extending SysML for Integration with Solver-based Simulation Tools
Conrad Bock
National Institute of Standards and Technology

2012

Monday, Feb. 13, 2012
A Step Beyond The State Of The Art Robust Model Predictive Control Synthesis Methods
Sasa Rakovic
University of Maryland

2011

Monday, Sept. 19, 2011
Logical Analysis of Hybrid Systems
André Platzer
Carnegie Mellon University

Monday, Sept. 26, 2011
Modelica—A Cyber-Physical Modeling Language for Systems Engineering and the OpenModelica Environment
Peter Fritzson
Linköping University

Monday, Oct. 10, 2011
Model Integration Challenge in the Design of Cyber Physical Systems
Janos Sztipanovits
Vanderbilt University

Monday, Oct. 31, 2011
Model-Based Systems Engineering with SysML: Problem Definition, Analysis and Optimization
Chris Paredis
Gtech

Monday, Nov. 7, 2011
Building Algebraic Structures with Combinators
Timothy Griffin
University of Cambridge

Monday, Nov. 21, 2011
On the development of tools for system design
Allessandro Pinto
United Technologies Research Center

Monday, Nov. 28, 2011
Logical Modeling for Engineering
Conrad Bock
National Institute of Standards and Technology

Monday, Dec. 5, 2011
On A Framework for Data and Specification-Driven Inverse Mulitscale Design of Materials
John G. Michopoulos
Naval Research Laboratory

Microsystems Seminar Series

Spring 2015

Feb. 20
Micro/Nano/Biosystems:
The New 'Fantastic Voyage'
ISR Director Reza Ghodssi
University of Maryland Distinguished Scholar-Teacher Lecture and IAI Colloquium

March 25
All-in-One Droplet Microfluidic Systems for Bioassays
Tza-Huei Jeff Wang
Mechanical Enginering, Biomedical Engineering and Oncology
Johns Hopkins University

April 23
Integrated Analytical Microsystems for Life Science Research in Outer Space Aboard Autonomous Small Satellites
Antonio Ricco
Chief Technologist, Small Payloads and Instrumentation
NASA Ames Research Center

May 5
Organs on a Chip
Shuichi Takayama
Micro/Nano/Molecular Biotechnology Lab
University of Michigan
A Maryland NanoCenter NANOCOLLOQUIUM

Fall 2014

Oct. 2
Spatial and Temporal Control of Biological Systems at the Microscale
Elliot Hui
University of California, Irvine
Mechanical Engineering Seminar co-sponsored with the Microsystems Initiative

Oct. 9
Army Research Laboratory Bioscience and Bioengineering Research Initiatives
Vicky Bevilacqua
Army Research Lab

Oct. 23
Precision Measurement and Engineering of Reconstituted Membrane Proteins
John Marino
National Institute of Standards and Technology

Nov. 10
Laser-assisted fabrication techniques for low-cost flexible sensors, actuators, and microsystems
Babak Ziaie
Purdue University

Dec. 11
Biomechanics at the micro and nano scale
Nathan Sniadecki
University of Washington

Spring 2014

Feb. 26
Nanoengineered Devices for Energy Transport and Conversion
Evelyn Wang
Massachusetts Institute of Technology

March 5
Make Me Look! To SEE and Understand Your Research
Felice Frankel
Massachusetts Institute of Technology; Harvard University
*Co-sponsored by Campus Visualization Partnership Lecture Series; Department of Computer Science; Institute for Advanced Computer Studies (UMIACS); Maryland NanoCenter; Department of Materials and Nuclear Engineering

April 15
Magnetic Microsystems - What? Where? When? Why? How?
David Arnold
University of Florida

May 8
Biological Information Processing and Biomedical Intervention through Microfluidic Technologies
Abraham Lee
University of California, Irvine

Fall 2013

Sept. 20
Detection of Volatile Organic Compounds using Piezoresistive Microcantilever Sensors with Metal Organic Frameworks
Peter Hesketh
Georgia Institute of Technology

Oct. 15
The Lensless Microscope: Computational Microscopy, Sensing and Diagnostics for Telemedicine and Global Health Applications
Aydogan Ozcan
University of California, Los Angeles

Nov. 19
Nonlinear MEMS Resonance
Gary Fedder
Carnegie Mellon University

Dec. 6
Acousto-Opto Fluidics for Lab-on-a-Chip
Tony Jun Huang
The Pennsylvania State University

Spring 2013 (Sponsored by Qualcomm)

Feb. 19
Quartz MEMS—Only a Matter of Time!
Srinivas Tadigadapa
The Pennsylvania State University

March 27
Atomic Layer Deposition for Applications in Nano/Micro-ElectroMechanical Systems
Victor Bright
University of Colorado Boulder

April 11
Using Nonlinearity to Enhance Micro/NanoSensor Performance
Kimberly Turner
University of California Santa Barbara

April 29
Engineering Quantum Information Processing Systems
Jungsang Kim
Duke University

May 10
Using MEMS to Build Devices and Packages at the Same Time
Thomas Kenney
Stanford University

Fall 2012 (Sponsored by Qualcomm)

Oct. 11
Electrochemistry and Biochips
Yosi Shacham-Diamand
Tel-Aviv University

Nov. 29
Implantable Microsystems for Quantitative Measurement of Biomolecules for the Management of Hemorrhagic Shock
Anthony Guiseppi-Elie
Clemson University

Dec. 6
Wireless Health
Mehran Mehregany
Case Western Reserve University

Spring 2012

Feb. 23
Innovative Optical Microsystems for Medicine and Other Applications
Hans Zappe
University of Freiburg

Feb. 28
The Mechanics of "Small"
Taher Saif
University of Illinois

March 15
Microfluidics: Cells on Chip for Disease Diagnosis
Mehmet Toner
Harvard University

April 5
Optofluidics for Bio-Analytics and Energy Applications
David Erickson
Cornell University

May 3
Femtosecond Laser-Assisted Biophotonics
Adela Ben-Yakar
University of Texas

Fall 2011

Sept. 20
Vacuum Microsystems for Energy Conversion
Roger Howe
Stanford University
⋆ This lecture is also part of ISR Distinguished Lecturer Series ⋆

Oct. 11
Engineering Adaptive Interfaces to Damaged Nervous Systems
Joel Burdick
California Institute of Technology

Dec. 8
Machine-Brain Interfaces
Jack Judy
DARPA Microsystems Technology Office

Spring 2011

Feb. 16
Carbon Nanotubes
John Hart
University of Michigan

March 3
Wireless Medical Microsystems
Mark Allen
Georgia Institute of Technology

April 20
Optical Biosensors and Systems Integration
Frances Ligler
Naval Research Laboratory

May 10
Next-Generation Proteomics
Amy Herr
University of California, Berkeley

Fall 2010

Oct. 21
Wireless Telemetry of Neutral Signals from Freely Moving Dragonflies
Reid Harrison
Intan Technologies, LLC
Anthony Leonardo
Howard Hughes Medical Institute

Nov. 11
Energy Harvesting Research at Imperial College London: A Holistic View
Paul Mitcheson
Imperial College London

Dec. 8
MEMS for Mechanobiology
Beth Pruitt
Stanford University
UTRC Control and Dynamical Systems Invited Lecture Series

Spring 2015

Jan. 23
From Local Network Structure to Global Graph Spectrum
Victor Preciado
University of Pennsylvania

April 10
Optimal Quantization and Quantized Approximations in Stochastic Control
Serdar Yuksel
Queen's University

April 14
Modeling and Control of Anesthesia
Joao Lemos
Technical University of Lisbon, Portugal

Fall 2014

Sept. 12
Formal Methods for Dynamical Systems
Calin Belta
Boston University

Sept. 26
Dynamical models containing stochastic and worst-case interactions with applications to multi-agent systems
Andrew Teel
Professor, Electrical and Computer Engineering
University of California, Santa Barbara

Spring 2014

Feb. 7
Overview of placement, allocation, scheduling and guidance of actuators and sensors in distributed parameter systems
Michael Demetriou
Worcester Polytechnic Institute

UTRC Control and Dynamical Systems Lecture Series

Spring 2015

Jan. 23
From Local Network Structure to Global Graph Spectrum
Victor Preciado
University of Pennsylvania

April 10
Optimal Quantization and Quantized Approximations in Stochastic Control
Serdar Yuksel
Queen's University

April 14
Modeling and Control of Anesthesia
Joao Lemos
Technical University of Lisbon, Portugal

May 1
Coupled Oscillators for Estimation and Control
Prashant Mehta
University of Illinois Urbana-Champaign

Fall 2014

Sept. 12
Formal Methods for Dynamical Systems
Calin Belta
Boston University

Sept. 26
Dynamical models containing stochastic and worst-case interactions with applications to multi-agent systems
Andrew Teel
Professor, Electrical and Computer Engineering
University of California, Santa Barbara

Spring 2014

Feb. 7
Overview of placement, allocation, scheduling and guidance of actuators and sensors in distributed parameter systems
Michael Demetriou
Worcester Polytechnic Institute

Appendix 24: Master of Science, Systems Engineering Degree

Degree requirements

Candidates for the degree must comply with the general requirements for the master's thesis and non-thesis options, which are those of the University of Maryland Graduate School. You must fulfill all requirements within five years.

The thesis option requires a total of 30 credit hours: 24 hours of coursework and six hours for the thesis project. The coursework includes 18 credits for the six core courses (four courses from the systems engineering core and two courses from the management core) and two elective courses. The elective courses must be taken from one specialization area. The thesis project demonstrates the practical implications of systems engineering principles. You may relate the project to a practical industrial system or to an ISR research activity, with supervision by your academic advisor or another ISR faculty member. Because of its research component, we recommend this option for those who want to pursue a Ph.D.

The non-thesis option requires each student to obtain a total of 30 credit hours of coursework to complete the program (four courses from the systems engineering core, two courses from the management core, and four elective courses). The elective courses must be taken from not more than two specialization areas. In addition, students must complete a scholarly paper. Expectations of the scholarly paper: While less detailed and complex than the thesis, the scholarly paper also contributes to systems engineering research. For example, a student might chose to write a literature review, identify and propose a solution to a systems problem encountered on the job, or prepare a systems case study. You prepare the scholarly paper under the supervision of your academic advisor, have it read by at least one additional ISR faculty member, and approved by the MSSE graduate director.

Core curriculum

The following courses are required of all MSSE students:

ENSE 621 Systems Concepts, Issues and Processes (3)

ENSE 622 Systems Requirements, Design and Trade-Off Analysis (3)

ENSE 623 Systems Projects, Validation and Verification (3)

ENSE 624 Human Factors in Systems Engineering (3)

ENSE 621, ENSE 622, and ENSE 623 may not be taken out of sequence.

The following *management core courses* are required of all MSSE students:

ENSE 626 System Life Cycle Analysis and Risk Management (3)

ENSE 627 System Quality and Robustness Analysis (3)

Core course descriptions

ENSE 621 Systems Concepts, Issues and Processes (3)

Prerequisite: permission of department.

This course is an introduction to the professional and academic aspects of systems engineering. Topics include: systems engineering activities, opportunities and drivers; case studies of systems failures; models of system lifecycle development; introduction to model-based systems engineering; representations for system structure, system behavior, system interfaces and systems integration; reactive (event-driven) systems, systems-of-systems, measures of system complexity; visual modeling of engineering systems with UML and SysML; simplified procedures for engineering optimization and tradeoff analysis. Software tools for visual modeling of systems with UML and SysML. Students will complete a project for the frontend development of an engineering system using UML/SysML.

ENSE 622 Systems Requirements, Design and Trade-Off Analysis (3)

Prerequisite: ENSE 621 and permission of department.

This course builds on material covered in ENSE 621/ ENPM 641, emphasizing the topics of requirements engineering, system-level design and trade-off analysis. Topics include: requirements engineering processes; representation and organization of requirements; implementation and applications of traceability; capabilities of commercial requirements engineering software; system-level design; design structure matrices; principles of modular design; component- and interface-based design methods; multi-objective optimization-based design and tradeoff; approaches to system redesign in response to changes in requirements, reliability, trade-off analysis, and optimization-based design. Students will complete a project focussing on the development of requirements and their traceability to the system-level design of an engineering system.

ENSE 623 Systems Projects, Validation and Verification (3)

Prerequisite: ENSE 622 and permission of department.

This course builds on material covered in ENSE 621/ ENPM 641 and ENSE 622/ENPM 642. Topics will cover established and emerging approaches to system validation and verification including: inspection, testing, and traceability; writing validation and verification plans; formal approaches to system validation and verification; specification-based testing; role of logic in system validation and verification; automaton models of computation, timed automaton; model-based design and model checking for reactive systems. Students will be introduced to software

tools for specification-based testing, model-based design and model checking. Students will work in teams on semester-long projects in systems engineering design and formal approaches to system validation and verification.

ENSE 624 Human Factors in Systems Engineering (3)

Prerequisite: permission of department.

This course covers the general principles of human factors, or ergonomics as it is sometimes called. Human Factors (HF) is an interdisciplinary approach toward dealing with issues related to people in systems. It focuses on consideration of the characteristics of human beings in the design of systems and devices of all kinds. It concerns itself with the assignment of appropriate functions for humans and machines – whether the people serve as operators, maintainers, or users of the system or device. The goal of HFs is to achieve compatibility in the design of interactive systems of people, machines, and environments to ensure their effectiveness, safety and ease of use.

ENSE 626 System Life Cycle Analysis and Risk Management (3)

Prerequisite: permission of department.

This course covers topics related to estimating the costs and risks incurred through the lifetimes of projects, products and systems. In addition, treatment is given to methods that determine the drivers of costs and risks and then propose the most effective alternatives to reducing them. The course covers relevant analytic tools from probability and statistics and also important managerial and organizational concepts. Extensive use will be made of case studies and examples from industry and government.

ENSE 627 System Quality and Robustness Analysis (3)

Prerequisite: permission of department.

This course covers systems engineering approaches for creating optimal and robust engineering systems and for quality assurance. It provides an overview of the important tools for quality analysis and quality management of engineering systems. These tools are commonly used in companies and organizations. Focus will be placed on the Baldrige National Quality Program, ISO 9000 certification, 6-sigma systems, and Deming total quality management to examine how high quality standards are sustained and customer requirements and satisfactions are ensured. The Taguchi method for robust analysis and design is covered and applied to case studies. Issues of flexible design over the system life cycle are addressed. Statistical process control, international standards of sampling, and design experimentation are also studied.

ENSE 698 Special Topics in Systems Engineering (1-3)

Prerequisite: ENSE 621

Courses intended for a high degree of specialization in systems engineering are offered by visiting or regular systems engineering faculty. Example: Case Studies in Systems Engineering.

ENSE 799 Master's Thesis (6)

Prerequisite: 9 credit hours of required core courses.

Each student who chooses the thesis degree option is required to complete a systems design project which involves the application of systems engineering concepts, principles and theories. The systems thesis project can be related to systems applications with joint supervision from industry (when applicable).

MSSE areas of specialization and electives

Choose from among 10 specialization areas — or create your own.

- Communications and networking systems
- Computer and software systems
- Control systems
- Manufacturing systems
- Operations research
- Process systems
- Transportation systems
- Robotics
- Signal processing systems
- Cybersecurity

Elective courses

You may choose from these approved courses within each specialization. You may, with approval from your academic advisor and the MSSE graduate director, substitute courses having adequate systems content. Not all electives may be offered in the semester desired. You have the responsibility to satisfy any prerequisites required. The list was last revised in August 2010.

Alternatively, with the approval of your academic advisor and the MSSE graduate director, you may create your own area of specialization (e.g., Bio-Engineering Systems and Supply Chain Management). You must obtain their approvals before you register for any of the courses in the customized specialization.

To obtrain current information about the courses listed below, visit the course catalog of the University of Maryland Graduate School.

Communication and Networking Systems

ENEE 426 Communication Networks
ENEE 620 Random Processes in Communication & Control
ENEE 621 Estimation and Detection
ENEE 623 Digital Communications
ENEE 625 Multi-User Communication
ENEE 626 Error Correcting Codes
ENEE 627 Information Theory
ENEE 691 Optical Communication Systems

Computer and Software Systems

CMSC 421 Introduction to Artificial Intelligence
CMSC 435 Software Engineering
ENEE 644 Computer-Aided Design of Digital Systems
ENEE 645 Computers and Optimization
ENEE 646 Digital Computer Design
ENCE 688R Advanced Topics in Civil Engineering: Civil Information Systems

Control Systems

ENAE 602 Spacecraft Attitude Dynamics & Control
ENAE 635 Helicopter Stability & Control
ENAE 641 Linear System Dynamics
ENAE 642 Atmospheric Flight Control
ENAE 743 Applied Nonlinear Control
ENAE 788G Advanced Dynamics
ENAE 788K Topics in Aerospace Engineering: Estimation and Control of Stochastic Systems
ENEE 620 Random Processes in Communication & Control
ENEE 660 System Theory
ENEE 661 Non-Linear Systems
ENEE 664 Optimal Control
ENEE 762 Stochastic Control
ENME 605 Advanced Systems Control

Manufacturing Systems

ENME 600: Engineering Design Methods
ENME 608: Engineering Decision Making ENME 610: Engineering Optimization
ENME 808B: Emerging Manufacturing Processe

Operations Research

BMGT 830 Linear Programming
BMGT 831 Extension of Linear Programming & Network Analysis
BMGT 833 Integer Programming
BMGT 834 Probabilistic Models
BMGT 835/CMSC 764 Simulation of Discrete-Event Systems
AMSC607 Advanced Numerical Optimization
ENAE 681 Engineering Optimization
ENCE 627 Decision Analysis for Engineering
ENCE 724 Nonlinear Programming in Project Management
ENCE 725 Probabilistic Optimization in Project Management
ENEE 664 Optimal Control
ENEE 762 Stochastic Control
ENME 607 Engineering Decision Making
ENME 610 Engineering Optimization

Process Systems

ENRE 602 Reliability Analysis
ENRE 670 Risk Assessment for Engineers

Robotics

CMSC 722 AI Planning
CMSC 733 Computer Vision
CMSC 828L Robot Motion Planning
ENAE 692 Introduction to Space Robotics
ENAE 788X Planetary Surface Robotics
ENEE 605 Design and Fabrication of Micro-Electro-Mechanical Systems (MEMS)
ENEE 769X Principles and Methods in Robotics
ENME 808V A Mathematical Introduction to Robotics
ENME 808T Control of Networked Robotic Systems

Signal Processing Systems

ENEE 620 Random Processes in Communication & Control
ENEE 630 Advanced Digital Signal Processing
ENEE 631 Digital Image Processing
ENEE 632 Speech and Audio Processing
ENEE 633 Statistical Pattern Recognition
ENEE 634 Space-Time Signal Processing
ENEE 731 Image Understanding

Cybersecurity

CMSC 414 Computer and Network Security
CMSC 631 Program Analysis and Understanding
CMSC 737 Fundamentals of Software Testing

Appendix 25: Professional Masters in Systems Engineering Degree

This option, offered by the Institute for Systems Research, requires the completion of all six courses from the systems engineering core and four electives.

Admission Requirements:

Completed applications are reviewed and considered for admission on a case-by-case basis. Full admission as a degree seeking student requires the following prerequisites:

- A bachelor's degree, GPA of 3.0 or better, in engineering or a closely related discipline; Computer Science, Physics, Applied Mathematics, or Physical Sciences from an accredited institution.
- Courses in mathematics (Calculus I, II, III, & Differential Equations) are required to be considered for admission.

Further admissions requirements

The Professional Master of Engineering (ENPM) Program and the Graduate Certificate in Engineering (GCEN) Program are open to qualified applicants holding a regionally accredited baccalaureate degree in engineering or a related field.

In addition to submitting a Graduate School application with fee, we require the following for evaluation:

- Official copies of transcripts for all universities attended and degrees awarded
- Personal Statement
- Three (3) letters of recommendation (current/previous employers or professors). For those students applying for the GCEN Program, letters of recommendation are not required*
- The Graduate Record Exam (GRE) is not required for application to either the ENPM or GCEN programs
- US citizens/permanent residents/international applicants with foreign credentials, if your native language is not English and you do not hold a degree from an institution in the US, you may be required to submit proof of English proficiency via TOEFL or IELTS scores.

**While not guaranteed, applicants with an undergraduate GPA of less than 3.0 might be admitted on a provisional basis if they have demonstrated a satisfactory experience in another related graduate program and given strong letters of recommendation. In this case, for those students applying for the GCEN Program, two (2) recommendation letters are required as well.*

For faster processing of your application, please send official transcripts directly to our office. Also, please have your recommenders use the online form available when you complete your ASF (application supplement form). If letters are being mailed, please send them to our office as well.

Degree requirements

Masters Degree

30 Credits / 10 Courses

Certificate Degree

12 Credits / 4 Courses

Master of Engineering core courses

ENPM641 Systems Concepts, Issues, and Processes (3)

Prerequisite: Permission of ENGR-CDL-Office of Advanced Engineering Education. Also offered as: ENSE621. Credit only granted for: ENPM641 or ENSE621.

An introduction to the professional and academic aspects of systems engineering. Topics include: systems engineering activities, opportunities and drivers; case studies of systems failures; models of system lifecycle development; introduction to model-based systems engineering; representations for system structure, system behavior, system interfaces and systems intergration; reactive (even-driven) systems, systems-of-systems, measures of system complexity; visual modeling of engineering systems with UML and SysML; simplified procedures for engineering optimization and tradeoff analysis. Software tools for visual modeling of systems with UML and SysML. Students will complete a project for the front-end development of an engineering system using ULM/SysML.

ENPM642 Systems Requirements, Design and Trade-Off Analysis (3)

Prerequisite: ENPM641 or ENSE621; or permission of ENGR-CDL-Office of Advanced Engineering Education. Also offered as: ENSE622. Credit only granted for: ENPM642, ENSE602, or ENSE622.

This course builds on material covered in ENSE621/ ENPM641, emphasizing the topics of requirements engineering, system-level design and trade-off analysis. Topics include: requirements engineering processes; representation and organization of requirements; implementation and applications of traceability; capabilities of commercial requirements; engineering software; system-level design; design structure matrices; principles of modular design; component- and interface-based design methods; multi-objective optimization-based design and tradeoff; approaches to system redesign in response to changes in requirements, reliability, trade-off analysis,and optimization-based design. Students will complete a project focussing on the development of requirements and their traceability to the system-level design of an engineering system.

ENPM643 Systems Projects, Validation and Verification (3)

Prerequisite: ENSE622 or ENPM642; and permission of ENGR-CDL-Office of Advanced Engineering Education. Also offered as: ENSE623. Credit only granted for: ENPM642 or ENSE623.

This course builds on material covered in ENSE621/ ENPM641 and ENSE622/ENPM642. Topics wil cover established and emerging approaches to system validation and verification including; inspection, testing, and traceability; writing validation and verification plans; formal approaches to sytem validation and verification; specification-based testing; role of logic in system validation and verification; automation models of computation, timed automation; model-based design and model checking for reactive systems. Students will be introduced to software tools for specification-based testing, model-based testing, model-based design and model checking. Students will work in teams on semester-long projects in systems engineering design and formal approaches to system validation and verification.

ENPM644 Human Factors in Systems Engineering (3)

Prerequisite: Permission of ENGR-CDL-Office of Advanced Engineering Education. Also offered as: ENSE624. Credit only granted for: ENPM644 or ENSE624.

This course covers the general principles of human factors, or ergonomics as it is sometimes called. Human Factors (HF) is an interdisciplinary approach for dealing with issues related to people in systems. It focuses on consideration of the characteristics of human beings in the design of systems and devices of all kinds. It is concerned with the assignment of appropriate functions for humans and machines, whether the people serve as operators, maintainers, or users of the system or device. The goal of HF is to achieve compatibility in the design of interactive systems of people, machines, and environments to ensure their effectiveness, safety and ease of use.

ENPM646 System Life Cycle Cost Analysis and Risk Management (3)

Prerequisite: Permission of ENGR-CDL-Office of Advanced Engineering Education. Also offered as: ENSE626. Credit only granted for: ENPM646 or ENSE626.

This course covers topics related to estimating the costs and risks incurred through the lifetimes of projects, products and systems. In addition, treatment is given to methods that determine the drivers of costs and risks and facilitate determination of the most effective alternatives to reducing them. Relevant analytic tools from probability and statistics and important managerial and organizational concepts. Extensive use is made of case studies from industry andgovernment.

ENPM647 Systems Quality and Robustness Analysis (3)

Prerequisite: Permission of ENGR-CDL-Office of Advanced Engineering Education. Also offered as: ENSE627. Credit only granted for: ENPM647 or ENSE627.

This course covers systems engineering approaches for creating optimal and robust engineering systems and for quality assurance. It provides an overview of the important tools for quality analysis and quality management of engineering systems. These tools are commonly used in companies and organizations. Focus is placed on the Baldrige National Quality Program, ISO 9000 certification, six-sigma systems, and Deming total quality management to examine how high quality standards are sustained and customer requirements and satisfactions are ensured. The Taguchi method for robust analysis and design is covered and applied to case studies. Issues of flexible design over the system life cycle are addressed. Statistical process control, international standards for sampling, and design experimentation are also studied.

Electives

The remaining courses for the degree are electives.

Appendix 26: Review Committee, 2010 NSF Review of ISR

Team members

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