

## CONNECT

NEWSLETTER OF THE COORDINATED SCIENCE LABORATORY VOL. TWO, NO. 1 | 2011

Coordinated Science Laboratory  
University of Illinois - College of Engineering  
1308 West Main St.  
Urbana, IL 61801

Non-profit Organization  
U.S. Postage  
PAID  
Permit No. 75  
Champaign, IL 61820

## Professional and research ethics

continued from front page

A multidisciplinary research team will gather existing information, generate new innovative curricular materials and create interactive collaboration tools that will help scientists and engineers incorporate ethical issues and reasoning into their pedagogy, research and practice. The grant also funds several other partner institutions and organizations around the country who will contribute content and expertise to the project. These partner institutions include the National Academy of Engineering and the Public Responsibility in Medicine and Research organization.

"A key focus of this grant is to explore the merging of several important digital library technologies. It is our hope that this work will serve as a model for all other online resource centers," says Mischo, head of Illinois' Grainger Engineering Library Information Center.

In addition, experts from the University and across the country will advise the center through its Education, Ethics, Futures, Steering and Technical Committees.

The portal infrastructure will be physically located in the Grainger Engineering Library Information Center at Illinois and will be built around the HUBZero e-learning and collaboration platform. The grant work will feature the development of HUBZero extensions that will allow the integration of custom federated search applications, extended content harvesting and database technologies and true preservation and archiving repository technologies.

ILLINOIS



60 YEARS OF  
COORDINATED SCIENCE  
LABORATORY  
1951-2011  
ENGINEERING AT ILLINOIS

## 60TH ANNIVERSARY

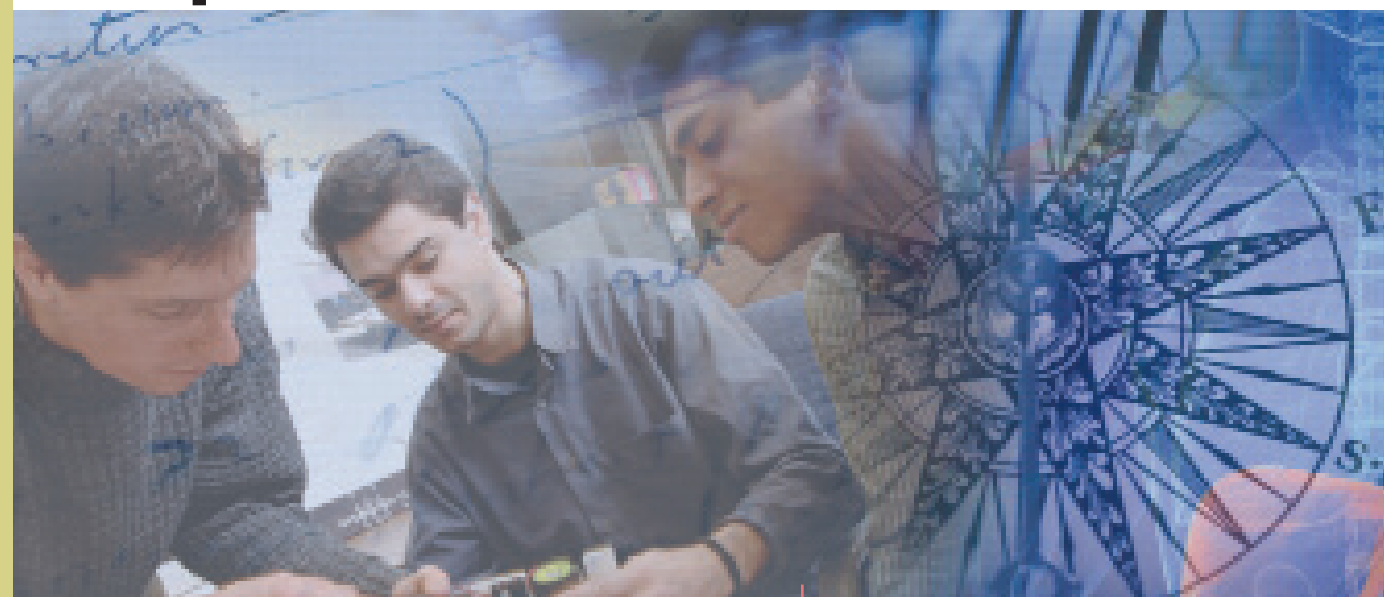
Celebrate with us!  
60th Anniversary festivities begin this spring, with the Diamond Anniversary Spring Lecture series held in B02 CSL:

- March 14 – Prof. Ruzena Bajcsy, Berkeley
- March 28 – Prof. Miroslav Krstic, UCSD
- May 2 – Prof. Sergio Verdú, Princeton

They will culminate in the fall with the CSL *60th Anniversary Symposium: Building Interdisciplinary Excellence with Societal Impact* on Oct. 28, 2011. The event will celebrate CSL's impact on technology in the past, while looking forward to how our research will transform the future.

Learn more at [www.csl.illinois.edu/60](http://www.csl.illinois.edu/60).

[www.csl.illinois.edu](http://www.csl.illinois.edu)



## CSL introduces \$5 million center for professional and research ethics

With the support of a \$5 million grant from the National Science Foundation, the new National Center for Professional and Research Ethics aims to put ethics information a click away.

NCPRE, which has its headquarters in CSL, will create, gather and disseminate information about professional and research ethics in science, mathematics and engineering through an online portal and other sources.

The portal will give comprehensive access to resources related to ethics for teachers, students, researchers, administrators and other audiences. As such, it will provide information and expertise for instructors who teach ethics, students with questions about research integrity, researchers and engineers who encounter ethical challenges in practice, administrators in universities and businesses who oversee ethics and compliance policies, scholars who conduct research on professional and research ethics, and others with questions or interests in these areas.

"Almost everybody wakes up everyday and wants to do the right thing," said Center Director C. K. Gunsalus, CSL research professor and professor of business. "Many people who face ethical dilemmas know the general principles but not necessarily how to apply them in the complexity that real-life professional and research practice present. The Center seeks to create an online environment that encourages the life-long development of ethical practices through materials and interaction with other professionals."

The center will draw on the University's collective strength in engineering, digital library technologies, mathematics, medicine, business and law, among other fields. Co-principal investigators include Taft Broome, Howard University (Civil Engineering); Nicholas Burbules, University of Illinois (Education); Michael Loui, University of Illinois, (CSL and Electrical and Computer Engineering); and William Mischo, University of Illinois (University Library).

continued on back mail page



CSL researchers are using game theory to gain competitive advantage on the battlefield.

Tamer Başar and his team of collaborators received a \$7.5 million Department of Defense Multidisciplinary University Research Initiative (MURI) award to form a better understanding of how teams of humans and machines make decisions and develop more reliable and secure multi-layer networks where team interactions take place.

The project emphasizes the study of communication and information acquisition and exchange between agents of different types in an adversarial environment, such as the battlefield. It is expected to have a dramatic impact on the most critical issues of inference, decision-making and overall situational awareness.

"Our national security and economic health depends on our ability to provide robust, timely and accurate responses to challenges that arise in complex networked environments where humans and machines with varying capabilities and intents interact. Our work addresses that need, and is expected to have a dramatic impact on the most critical issues of inference, decision making, and overall situational awareness," said Başar, Swanlund Chair and a professor of electrical and computer engineering.

In addition to Başar, CSL researchers Geir Dullerud, Negar Kiyavash, Cedric Langbort and R. Srikant, along with six faculty from Georgia Tech, Stanford, UC-Berkeley and the University of Maryland, are also participating. The professors come from a variety of backgrounds, in-

cluding engineering (electrical, computer, industrial, mechanical and aerospace), computer science and economics.

The Air Force Office of Scientific Research will fund this project for five years. In total, the DoD funded 32 MURI projects out of the 411 white papers originally submitted to the program in December.

Langbort, an assistant professor of aerospace engineering, says that in a modern battlefield decisions are made by multiple agents in different locations. These agents can be humans or machines and share information through networks. This introduces new vulnerabilities, and new ways for adversaries to be strategic.

"Instead of fighting directly on the battlefield, they can just fight at the network level by either physically breaking into it or, in a more covert but still dangerous way, strategically modifying the information it carries," Langbort says.

The network attacks could be multifarious, including cognitive jamming, data tampering, malicious gossiping, disruption of physical links and servers, and hacking. They can also be stealthy, like a timing attack.

"The goal of this project is to understand how these strategic disruptions impact decision making and to architect the network, information flow and decision algorithms themselves so that vulnerability to adversarial acts is minimized," Başar says. "For that, it is important to model the assumptions that agents make about each other and the adversary, and humans and machines build such assumptions very differently."

The team is using the framework of game theory, which is concerned with adversaries whose goals are non-aligned and who are competing with each other.

Dullerud, a professor of mechanical engineering, added that the team will examine the many levels of game theory, asking questions such as: What are the exact ways in which large numbers of both people and machines interact? What information do they share and how accurate is it? Are they telling the truth?

"An interesting aspect is that if you look more closely at what appears to be a single modeling entity, it may well be a simplification of a game that is being played out on a smaller spatial or temporal scale, so one really has a game of games," Dullerud said.

To gain a better understanding of computer and human interaction, Dullerud is developing a distributed robotics testbed using a network of hovercraft and other autonomous vehicles that can interact with both human and machine-based decision makers. "We'd like to have a cyberphysical network comprised of humans and machines to help us experimentally determine what we need to know in order to systematically predict the behavior of a potentially large-scale human-machine network."

Dullerud believes CSL's multidisciplinary history will contribute to the success of the project. "Also, education-wise, this is a very innovative project that will open up many opportunities for both graduate and undergraduate research training," he said.



### Celebrating 60 Years of Science

Since 1951, the Coordinated Science Laboratory has changed the way people interact with technology.

If you've ever watched a program on a plasma TV, used a cell phone or upgraded to a faster computer, you've benefited from some of CSL's many innovations. In 2011, we celebrate 60 years of scientific breakthroughs, many of which have built the underlying infrastructure that run today's technologies.

What has been the secret to CSL's success? Since its inception, CSL has remained true to its core belief: that innovation thrives when disciplinary excellence and interdisciplinary strength combine to create real-world impact.

### Disciplinary Excellence

CSL has always been home to many of Illinois' top researchers, who in the beginning, focused on addressing urgent military needs associated with the Korean War.

Under the direction of innovative Illinois physicists, one of its first early successes was the electrostatic vacuum gyroscope, a super compass that allowed submarines to navigate while submerged for months. The researchers created a friction-free environment that could preserve the motor of the gyroscope for years, taking physics – and submarines – to greater depths.

### Interdisciplinary Strength

In the 1960s, CSL researchers demonstrated the power of collaboration with the invention of PLATO. Experts in physics, electrical engineering, computing, medicine and the social sciences converged at CSL to create the world's first interactive computer learning system, on which students learned, interacted and were graded.

PLATO foreshadowed many technologies that have only recently come to pass: touch screens, plasma displays, online chat rooms, multiplayer gaming, cable modems, smart phone lines, instant messaging, blogging and e-newsletters.

### Real-World Impact

From televisions to cell phone networks to high-powered computers, CSL's impact is literally everywhere. Work in the '60s on plasma technology set the stage for today's high-definition displays. New architectures have significantly increased computing power and speed, leading to faster machines. And research in communications has led to more reliable, secure cellular networks.

CSL has also been the seedbed for institutes that have been created to focus on specific research initiatives – starting with PLATO, which led to the computer-based Education Research Laboratory. More recently, CSL's reliability and security expertise led to the formation of the Information Trust Institute, while CSL faculty interest in international collaboration helped initiate the Advanced Digital Sciences Center in Singapore.

Today, CSL researchers are continuing to merge disciplinary excellence and interdisciplinary strength with amazing results. Our researchers are working on using "mind-reading" techniques to enhance life for the disabled, creating new models for energy and economic systems, developing lower-power, more reliable computer chips and gaining a better understanding of weather patterns to improve communication tools, just to name a few.

As the new director of CSL, it's my pleasure and privilege to help provide the foundation for future breakthroughs. As we celebrate the innovations of the past 60 years, we eagerly look forward to transforming the next 60.

William H. Sanders



Managing Editor: Kim Gudeman  
Contributing Writers: Allison Copenbarger, NCSA; April Dahlquist, CSL; Rick Kubetz, COE; and Tom Moore, ECE.

Comments and suggestions are welcome. Please send them to [kgudeman@illinois.edu](mailto:kgudeman@illinois.edu).



## CSL alum Sunil Kumar brings business savvy to Booth School

Sunil Kumar got his first taste of control theory's power to change industry as a graduate student in the Coordinated Science Laboratory.

As a doctoral student under advisor P.R. Kumar, Sunil Kumar tackled the inefficiencies of manufacturing semiconductor chips. While actual manufacturing time took less than a day, plants often took weeks to move chips through the fabrication process, primarily because of congestion. Kumar used stochastic control theory to analyze the resulting delays in the plants.

These days, Kumar, who graduated from Illinois with a Ph.D. in electrical and computer engineering in 1996, is still using engineering to change the face of business – and is teaching others to do the same. He was recently named dean of the prestigious University of Chicago Booth School of Business, a role he officially assumed on Jan. 1.

"In some ways, it feels like a dramatic career change, but in reality it's not," said Kumar,

who joins Booth from Stanford University, where he most recently served as the business school's senior associate dean for academic affairs. "Control finds many applications in the social sciences. The emphasis is quite different than in engineering, but even my work today is not that far removed from research conducted at CSL."

While Kumar insists that his merging of engineering and business isn't unique – many economics students study control theory, for example – his appointment as Booth's dean may signal that more engineers are destined for executive suites.

Only consider what the C-suite has to gain: At Stanford, Kumar began work on developing a mathematical model to determine optimal ticket pricing for airlines. Using heuristic algorithms, the model predicts how consumers will respond to tickets offered at a certain price at a certain point before departure time. In a dynamic system such as air travel, which is significantly influenced by stochastic variability, Kumar aims to mitigate the impact of randomness. The model could help the service industry in general maximize efficiency and resources.

In addition to his connections with industry, Kumar has also proven to be an innovative educator. At Stanford, he co-developed a widely used factory simulator for teaching operations

management. The simulator, "Littlefield Technologies," has been used in classes at more than 50 business and engineering schools. At the University of Chicago, he will continue teaching and pursuing his research as time allows.

"Business school graduates of today have to confront a world where enterprises are comprised of complex technological, material, service and financial interactions," said P.R. Kumar, a professor of electrical and computer engineering at Illinois. "Sunil's analytical strength and modeling capabilities, coming from his engineering side, combined with an excellent broad based understanding of business issues, well equip him to lead Booth in its education and research efforts. I am sure his appointment will stand Booth in good stead and is a very wise and far-reaching choice."

Kumar holds a bachelor's degree in engineering from Mangalore University in Surathkal and a master's degree in engineering from the Indian Institute of

Science in Bangalore. He chose to pursue his doctorate at Illinois after meeting P.R. Kumar during a trip his future advisor made to India. After graduating from Illinois, he joined the Stanford business faculty. Along with serving as senior associate dean, he was also the Fred H. Merrill Professor of Operations, Information, and Technology.

At the University of Chicago, he plans to use his position to provide the resources required for Booth faculty to maintain areas of strength while focusing on areas identified for growth.

"Our MBA programs are very highly ranked and it takes a lot of work to keep them very highly ranked," he said. "I also plan to do a lot of engagement of alumni and help ensure that our students find access to a very good network of alums to support them in professional development."

He hopes that his engineering background will help better prepare students for the real world.

"Engineering is a prescriptive discipline in that people build things to solve real-world problems," Kumar said. "Not all social sciences are like that. But business has to be run; it can't just be studied. Engineers have a very healthy appreciation for application, which can only help industry."



## The rat's whiskers! NSF-funded research may aid heart patients

A rat finding its way in the dark. A seal detecting the path of a fish. A naked mole rat finding food. These animals all use their whiskers to survive.

Inspired by instances like these found in nature, CSL researcher Douglas L. Jones and his collaborators, Principal Investigator Chang Liu and Professors Mitra Hartmann and Alan Kadish, all of Northwestern University, are engineering a multi-modal sensing "skin."

The project is funded through the National Science Foundation's Emerging Frontiers in Research and Innovation (EFRI) program. The four-year grant totals \$620,000.

The researchers hope to create an artificial skin with whiskers attached for further sensing abilities. The whiskers would be used to send information about how close the skin is to an upcoming object and how to properly react.

This type of function is necessary for performing precise actions. For example, if a robotic arm wanted to pick up an egg and move it, the arm has to grip the egg tight enough to hold it, but loose enough not to crush it. If the robot had whiskers coming off the edges, the robot could sense how near the egg was and make the proper adjustments.

"We want to build a multi-modal sensor that can do several different types of sensing, the same way our skin can," said Jones, a professor of electrical and computer engineering.

The basis for the whisker technique comes from nature. When rats are crawling

around in the dark, their whiskers are one of their main sources for sensing the environment, Jones said. Likewise, human eyelashes sense an object coming towards the eye and signal the eyelid to close.



One application for the whisker research is creating a whiskered catheter tip to be used during certain cardiac procedures to help prevent atrial fibrillation. To enter the heart, the catheter must wind through the body and then precisely, with the

right amount of pressure, touch the heart atrium. Having whiskers on the catheter would allow a surgeon to move quickly, know where he was in the heart and identify how close he was getting to the spot he needed to hit.

The team is working with a surgeon to ensure the method is practical in the operating room.

While the research at Northwestern University is focusing more on the sensor development, the biology of whisking animals and the cardiac catheterization, Jones' research consists of finding the best sensor configurations and processing the sensor data from the multi-modal system.

He is working on the problem with ECE graduate students Erik Johnson and Cagdas Tuna.

"Hopefully the development of the engineering process is accelerated if we use what biology has already learned," Jones said.

Jones believes that the emerging frontier of bio-inspired sensors will help detect the environment in new ways: "The opportunity of collaborating with biologists will speed up the learning curve of building the models."

### ALLERTON ENERGIZES ATTENDEES WITH POWER KEYNOTE

The Allerton Conference on Communication, Control & Computing drew nearly 500 people to the annual event Sept. 29-Oct. 1 — including a record number of non-UI attendees.

Plenary speaker Ben Hobbs, the Theodore M. & Kay W. Schad Professor in Environmental Management at Johns Hopkins University, was a big draw with his talk about electric power technologies of the future, such as Ameren's new smart meter, and the new markets that will support these technologies.

For more information about the Allerton Conference, please visit [www.csl.illinois.edu/allerton](http://www.csl.illinois.edu/allerton).



## NSF funds Expedition into reliable, efficient nanoscale computing

By Kim Gudeman

Rakesh Kumar is on an expedition to overcome unreliable nanoscale computer components with variability-aware software and hardware techniques.

Led by Kumar, the Coordinated Science Laboratory has received a \$10 million National Science Foundation (NSF) Expeditions in Computing grant, along with five other universities, that will fundamentally change hardware-software interactions, producing a new generation of computers that are adaptive and energy efficient.

The five-year grant will provide solutions for the semiconductor industry as manufacturers build increasingly smaller components, circuits and chips even as they become less reliable and more expensive to produce. The variability in their behavior, from device to device and over their lifetimes – due to manufacturing, aging-related wear-out and different operating environments – is largely ignored by modern computer systems.

"Work at Illinois will be focused on steering the effects of variability such that software can recognize and adapt to it. We

will also focus on identifying the appropriate hardware/software interfaces for exposing hardware variability to software," said Kumar, a CSL researcher and professor of electrical and computer engineering.

The multi-university center will be led by the University of California, San Diego. Other participating universities include the University of California, Los Angeles; the University of Michigan; Stanford University; and the University of California, Irvine.

The research team will develop computing systems that will sense the nature and extent of variation in their hardware circuits, and expose these variations to compilers, operating systems and applications to drive adaptations in the software stack.

"The biggest advantage of such large projects is that you can re-examine the entire system stack as opposed to investigating piecemeal solutions," added Kumar.

Software experts will develop models and abstractions to expose the hardware's variable specifications accurately and compactly, and to create mechanisms for

the software to react to variable hardware specifications. Hardware researchers will be focused on more efficient design and test methods to ensure that device designs exhibit well-behaved variability characteristics—ones that a well-configured software stack can easily communicate with and influence.

Variability-aware computing systems would benefit the entire spectrum of embedded, mobile, desktop and server-class applications by dramatically reducing hardware design and test costs for computing systems, while enhancing their performance and energy efficiency. Many in-demand applications – from search engines to medical imaging – would also benefit, but the project's initial focus will be on wireless sensing, software radio and mobile platforms of all kinds – with plans to transfer advances to the marketplace.

"The research conducted through this prestigious grant will provide the backbone for the next class of computing systems," said Ilesanmi Adesida, dean of Illinois' College of Engineering and CSL researcher.



### With a \$2.5 million grant from the Air Force, Venu Veeravali will develop the theoretical base for dynamic information collection and fusions.

Venu Veeravali, an ECE professor and director of the Illinois Center for Wireless Systems (ICWS), will lead a multi-university team that includes researchers from Syracuse University and Boston University to work on this five-year project.

Future Air Force missions may consist of swarms of sensor-rich, intelligent, armed, unmanned autonomous aerial vehicles that will provide persistent and ubiquitous situational awareness, intelligence and support for ground operations. In this new sensing paradigm, it will be possible to manage and control multiple degrees of freedom in the information gathering system, ranging from sensor operating modes to physical control of the platforms carrying the sensors. The goal is to efficiently use this rich and diverse set of information sources towards mission-critical situational awareness.

"This project is aimed at developing a comprehensive framework for control of information collection, fusion and inference from diverse modalities, that will lay the foundation for the next generation of Intelligence, Surveillance and Reconnaissance (ISR) systems," Veeravali said.

The framework and methodologies developed during the course of the project can have applications in other areas such as crisis mitigation, disaster recovery and search-and-rescue missions.

### Kiyavash is AFOSR Young Investigator

Rick Kubetz, College of Engineering

Negar Kiyavash, an assistant professor in industrial and enterprise systems engineering (ISE), is one of 43 scientists and engineers who submitted winning research proposals through the Air Force's Young Investigator Research Program (YIP).

Operated under the auspices of the Air Force Office of Scientific Research, the YIP's objective is to foster creative basic research in science and engineering, enhance early career development of outstanding young investigators, and increase opportunities for the young investigators to recognize the Air Force mission and the related challenges in science and engineering.

Kiyavash's research interests are in information theory and statistical signal processing with applications to computer, communication, and multimedia security. In her winning YIP proposal, she plans to investigate information-theoretic approaches to network forensics.

### TWAS Fellow Kumar promotes research, education in developing world

By April Dahlquist, CSL

P. R. Kumar was elected as an Associate Fellow in The Academy of Sciences for the Developing World (TWAS).

Based in Trieste, Italy, TWAS promotes scientific excellence for sustainable development in the developing world. About 85 percent of the fellows are from the developing world, and the remaining 15 percent, called associate fellows, are from developed countries. Kumar was one of five people in the developed world to receive the honor this year.

For years, P.R. Kumar has been an unofficial education and research ambassador to Indian and Chinese universities. As a member of TWAS, Kumar hopes to expand on his work in that region and the rest of the world.

### Students win greenest self-built cluster

By Allison Copenbarger, NCSA

Led by CSL researchers Bill Gropp and Wen-mei Hwu, a group of Illinois students took third place in a supercomputer-building competition —Green500—at SC10 in November. In addition, their cluster was named the greenest self-built cluster.

The project is part of an independent study course led by Gropp, the Bill and Cynthia Saylor Professor of Computer Science, and Hwu, the AMD Jerry Sanders Chair of Electrical and Computer Engineering. NCSA's Mike Showerman provided cluster-building expertise and assistance.



### Shanbhag receives Newton GSRC Industrial Impact Award

By Tom Moore, Electrical & Computer Engineering

CSL researcher Naresh Shanbhag recently received the Richard A. Newton GSRC Industrial Impact Award from the Gigascale

Systems Research Center (GSRC), part of the Focus Center Research Program (FCRP) established by DARPA and SRC. The award honors GSRC principal investigators whose projects and/or concepts have had substantial industrial impact.

Shanbhag, a professor of electrical and computer engineering, received the award for his work described in a series of papers on the concept of Algorithmic Noise Tolerance (ANT). In his research, Shanbhag came up with a novel approach to design energy-efficient and robust circuit and systems. Previously, circuits and architectures were designed to be error-free. Shanbhag proposed permitting circuits to make errors and correct them in order to save power and enhance reliability, much as is done in communication links. This allows for less costly manufacturing of the integrated circuits in nanoscale process technologies.

## Tweet This: It's The Year of Social Media

From novel features of Twitter to providing a public accountability through blogging, "The Year of Social Media" seminar series aims to help Illinois students and faculty stay on top of the evolving world of social media. The series, organized by Professors Christian Sandvig (Communications, CSL) and Karrie Karahalios (Computer Science), features speakers from industry and academia who are experts in the latest trends.

The series is sponsored by the Illinois Informatics Institute, the Coordinated Science Laboratory and the College of Media.

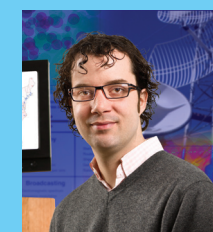
The first four lectures, given by Fernanda Viégas of Google, Baratunde Thurston of *The Onion*, Eytan Adar of the University of Michigan and William Dutton of Oxford, drew audience members from Engineering, Library and Information Science, Art, History, Law, Media, English and more.



### Upcoming seminars include:

- March 2011: Daniel Gatica-Perez (IDIAP) (exact date TBA)
- April 5, 2011: Eszter Hargittai (Northwestern)
- April 2011: David Weinberger (Harvard) (exact date TBA)

Learn more: <http://go.illinois.edu/socialmedia>



### Sandvig in the Blogosphere

When not teaching or organizing "The Year of Social Media" series, CSL researcher Christian Sandvig is a regular blogger for the Huffington Post—primarily focusing on new technology and policy. He has also

blogged for NPR Marketplace Tech Report.

He first starting blogging as a way to "jot down notes" for himself. After interacting with other prominent bloggers, he realized his efforts could serve a broader audience.

"I shared a graduate reading list in technology policy in August and I received what amounts to a thoughtful and relevant extra bibliography of suggestions in the comments section for that post," he said. "Hopefully my reading list also helped someone else."

### Sandvig Links:

Huffington Post: <http://www.huffingtonpost.com/christian-sandvig>  
Personal Blog: <http://blogs.law.harvard.edu/niftyc/>  
Reading list: <http://blogs.law.harvard.edu/niftyc/archives/459>