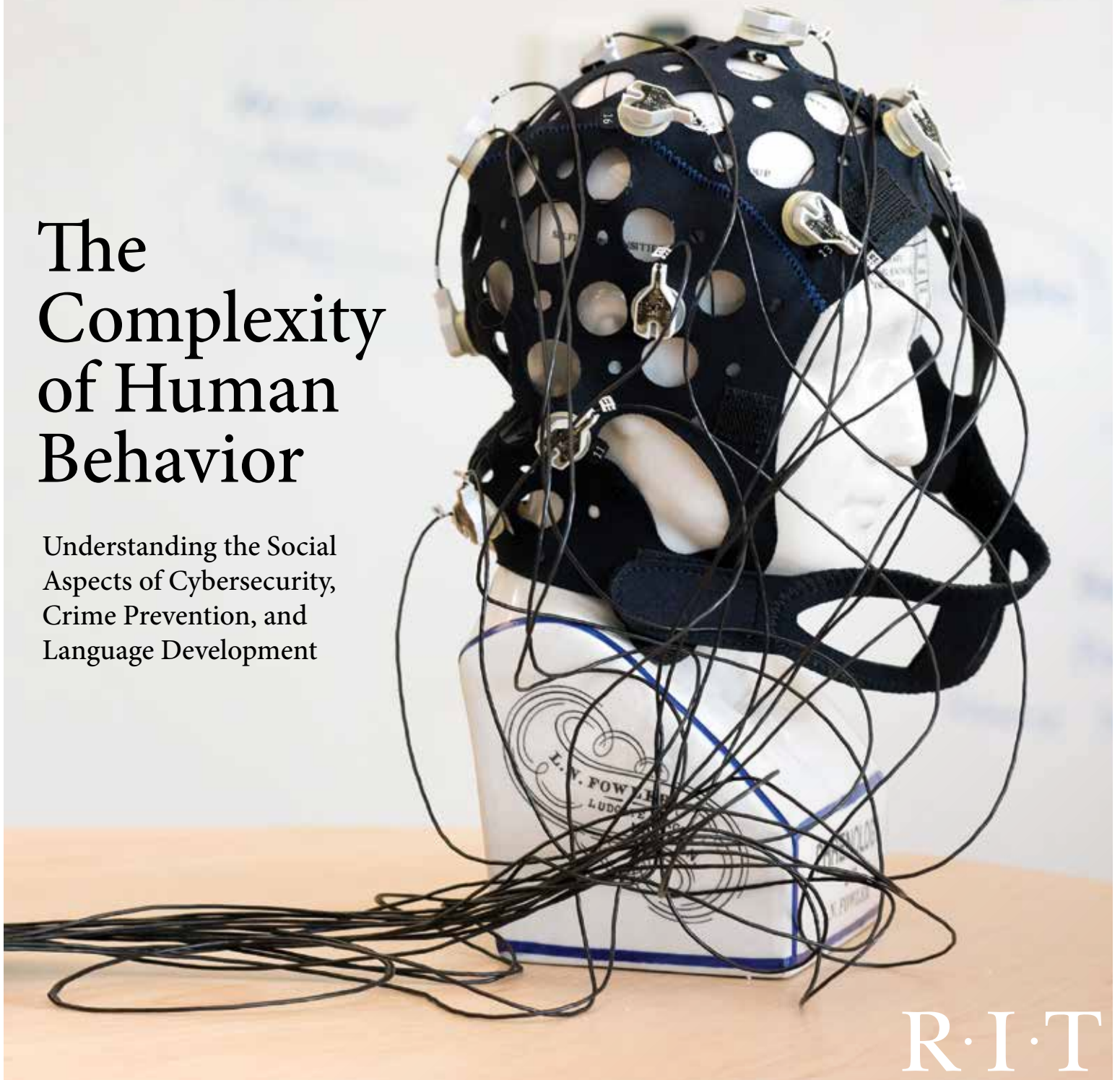


SPOTLIGHT ON

HUMANITIES · SOCIAL SCIENCES

## The Complexity of Human Behavior

Understanding the Social Aspects of Cybersecurity, Crime Prevention, and Language Development



## RESEARCH at RIT

The Rochester Institute of Technology  
Research Report—Fall/Winter 2017-18

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# Creating Well-Rounded Students

It is our pleasure in this edition of *Research at RIT* to shine the light on some of the outstanding work being done in the humanities and social sciences, especially in the way it is contributing to some of the largest research endeavors on our campus.



It is hard to ignore or underestimate the role that the humanities and social sciences play in the building and execution of top-tier research programs. Federal funding agencies are increasingly

looking for interdisciplinary or multi-disciplinary research. In addition, they want to see education and training programs that produce well-rounded students who, while technically strong, also excel at the so-called soft skills.

It would be hard indeed to build the type of strong research programs RIT aspires to without the contributions of our faculty, staff, and students who focus on the humanities or social sciences. These world-class programs are the result of wonderful cross-college collaborations.

Some of our most prestigious research areas, such as criminal justice and cybersecurity, focus on both the social and the technical aspects of their disciplines. To truly understand what is going on and hopefully develop the appropriate mitigation plans, it is also important to understand the human aspects and intrinsic motivations.

For example, for more than 15 years, students and faculty associated with the Center for Public Safety Initiatives have helped law enforcement officials determine what programs may help prevent crime.

Faculty and student researchers in

the Center for Cybersecurity are working to better understand and address real-world challenges in cybersecurity through projects that analyze past incidents, by studying the current state of phishing on social media, and by modeling how attackers will strike in the future.

The Center on Cognition and Language at RIT's National Technical Institute for the Deaf is the premier location in the world for researching how deaf people develop, learn, grow, and live.

I would also like to mention the role that the humanities and social sciences play in our sustainability programs across campus. Those who study sustainability realize that the "three-legged stool" of sustainability is economic, environmental, and social. We could not have built our outstanding reputation in sustainability if it were not for the contribution of our faculty, students, and staff who are focused on the social aspects of sustainability.

I hope you enjoy reading about some of the outstanding research involving the humanities and social sciences. I am confident that this is an area in which we will continue to excel. We will do more in the way of interdisciplinary research and make good on our new President David Munson's promise to create leaders who are citizens of the world.

Best regards,

Ryne Raffaele  
Vice President for Research  
and Associate Provost



## Transforming America's Manufacturing

**American manufacturing is on the upswing. Rochester Institute of Technology is dedicated to helping in this transformation while protecting global resources.**

RIT's Golisano Institute for Sustainability was selected by the U.S. Department of Energy to lead its new Reducing Embodied-Energy and Decreasing Emissions (**REMADE**) Institute—a national coalition of leading universities and companies that will forge new clean energy initiatives deemed critical to keeping U.S. manufacturing competitive. REMADE, under the RIT-led Sustainable Manufacturing Innovation Alliance, includes

more than 100 partners.

We are a proven leader in applied research, remanufacturing, policy development, technology transfer, and sustainable manufacturing.

RIT is now involved with seven institutes in the "Manufacturing USA" federal program, including five institutes at the "Tier 1" level. This places RIT among the top five most involved universities transforming a new U.S. economy.

Let's accelerate America's manufacturing.

### RIT's "Manufacturing USA" initiatives:

- **AIM Photonics**  
(American Institute for Manufacturing Integrated Photonics)
- **America Makes** (Additive Manufacturing and 3D printing)
- **ARM** (Advanced Robotics Manufacturing)
- **Digital Manufacturing and Design Innovation Institute**
- **Next Flex** (Flexible Hybrid Electronics)
- **REMADE**  
(Reducing Embodied-Energy and Decreasing Emissions)
- **Clean Energy Smart Manufacturing Innovation Institute**

*RIT is also home to the New York State Center for Advanced Technology in Additive Manufacturing and Multifunctional Printing (AMPrint Center) and the New York State Center of Excellence in Advanced & Sustainable Manufacturing.*

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Rochester Institute of Technology is home to leading creators, entrepreneurs, innovators, and researchers. Founded in 1829, RIT enrolls 19,000 students in more than 200 career-oriented and professional programs, making it among the largest private universities in the U.S.

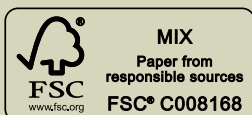
The university is internationally recognized and ranked for academic leadership in business, computing, engineering, imaging science, liberal arts, sustainability, and fine and applied arts. RIT also offers unparalleled support services for deaf and hard-of-hearing students. The cooperative education program is one of the oldest and largest in the nation. Global partnerships include campuses in China, Croatia, Dubai, and Kosovo. Visit us at [www.rit.edu](http://www.rit.edu).

### Contact Information

To learn more about research opportunities on campus, contact us directly or through the RIT research website at [www.rit.edu/research](http://www.rit.edu/research).

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**On the Cover** **cover** **Research Awards and Honors** **32**



The electroencephalogram is used in the Center on Cognition and Language to detect electrical activity in the brain. Testing electrical activity is one way to study how language impacts learning.



RIT's faculty, staff, and students have received significant national and international recognition for their research in a host of fields. A summary of awards and honors is provided.

**Making a Difference:** James Winebrake, dean of RIT's College of Liberal Arts, encourages interdisciplinary collaboration to help students have an impact on the world and lead lives of consequence.



# Research in the Humanities and Social Sciences at RIT Grows

by Greg Livadas

Humanities and social sciences research at RIT represents a diverse array of scholarship that includes work in traditional disciplines as well as interdisciplinary areas such as cybersecurity, personal health care, sustainability, cognition among individuals who are deaf, ethics within engineering, and studies to prevent crime.

## Long-term Investment

Some people may be surprised by just how big a role the humanities and social sciences play in the education of students attending a university called Rochester Institute of Technology.

Even in its pre-RIT days when the Mechanics Institute added English to the curriculum in 1899, the board of directors felt that technical professional instruction alone did not constitute a complete education.

“The manual course which should be strong is weak inasmuch as it contains too much manual and too little mental work,” said the institute’s board of directors then, according to Dane R. Gordon, who wrote *Rochester Institute of Technology: Industrial Development and Educational Innovation in an American City 1829-2006*.

“The barriers between science, technology, and humanities have been eroded in the past years,” said Gordon, who joined RIT as a philosophy faculty member in 1962 and served as department chair and acting dean of RIT’s College of Liberal Arts before retiring in 2000. “Now, there are quite a lot of interdisciplinary studies encouraging social science, humanities, and technology students to work together.”

Research in these areas continues to grow as well.

Humanities are found in every college at RIT, including the National Technical Institute for the Deaf, where leading researchers study the way deaf and hard-of-hearing individuals comprehend information and communication.

More than \$20 million in external funding from local, state, and federal

agencies and foundations has been awarded to support research projects involving the College of Liberal Arts in the past five years. This year saw a record \$5.43 million in external funding, said Dean James Winebrake. Additional support for research comes from within RIT in seed funding and research fellowships, which provide time for faculty to conduct research and develop proposals for external sponsors.

“Research in the humanities is a long-term investment in the future,” said Russell Wyland, acting director of the National Endowment for the Humanities’ Division of Research Programs.

“What we know about ourselves as a culture is the result of generations of scholars who have helped us understand our past. We are seeing more and more collaborative work being done that brings humanities insights and methods to fields such as medicine, science, technology, and the social sciences,” Wyland said. “This work is connecting disciplines together in exciting ways that will open up new perspectives in our past and future.”

## Diverse Offerings

The importance of the humanities and social sciences at RIT has never been stronger, and strategic plans for the future education of students strongly encourages interdisciplinary collaboration among those studying liberal arts and those studying science, technology, engineering, and mathematics.

All of RIT’s baccalaureate students take courses in the College of Liberal Arts as part of their majors in all other colleges at RIT, and more than 20 percent of all

student credit hours from all RIT undergraduates are taken in COLA classes.

More than 600 students are earning undergraduate degrees in one of the 14 majors offered at COLA: advertising and public relations, communication, criminal justice, digital humanities and social sciences, economics, human-centered computing, international and global studies, journalism, museum studies,

philosophy, political science, psychology, public policy, and sociology and anthropology. Some of these majors, such as human-centered computing and digital humanities and social sciences, are offered in partnership with other colleges on campus. In addition, a new BS degree in applied modern language and culture was recently approved by New York state and will be enrolling students in the next academic year.

Social sciences and humanities research at RIT is as diverse as the courses offered. It includes scholarship in areas as varied as cybersecurity, personal health care, sustainability, human and animal cognition, engineering ethics, crime prevention, and new revelations on the histories of Love Canal, composer Joseph Haydn, and



**History Shapes the Future:** More than 100 years ago, the importance of a broad education was emphasized at the Mechanics Institute, which became RIT.

energy storage, to name a few.

Research is even being done now about last year's presidential election for a new book titled *Nasty Women and Bad Hombres: Historical Reflections on the 2016 Presidential Election*.

Co-edited by Christine Kray, associate professor in the Department of Sociology and Anthropology; Tamar Carroll, associate professor in the Department of History; and Hinda Mandell, associate professor in the School of Communication, the book is made possible with a seed grant from the College of Liberal Arts and is under review with the University of Rochester Press.

"It will be a scholarly attempt to make sense of the 2016 presidential election looking at historical ties, gender, and racial themes through personal essays," Mandell said.

### Following Technological Advances

Research with evolving technology brings greater potential for new applications.

Prime examples are two signature research area grants, one involving cybersecurity with Josephine Wolff, assistant professor in the Department of Public Policy, and one involving personal health care with Assistant Professor Emily Prud'hommeaux and Associate Professor Cecilia Ovesdotter Alm, both in the Department of English. They are researching ways spoken or written language can help determine whether someone may have early-stage Alzheimer's disease, be in a certain emotional state, or may be autistic and have unique communication needs.

Professor Jonathan Kruger, chair of the Department of Performing Arts and Visual Culture, is working with RIT's College of Applied Science and Technology and College of Imaging Arts and Sciences on audio engineering and composing music for video games and films.

### Beyond the Lab

Caroline DeLong, an associate professor in the Department of Psychology, has been conducting research on dolphins, whales, fish, bats, penguins, honeybees, and humans for 20 years on a variety of topics including visual and auditory object perception and tool use.



**Documenting History:** Christine Kray, left, associate professor in the Department of Sociology and Anthropology; Hinda Mandell, center, associate professor in the School of Communication; and Tamar Carroll, associate professor in the Department of History, are collaborating on a book about the 2016 presidential election.

Her current research involves perception in North American river otters and tool use in Bornean orangutans at Rochester's Seneca Park Zoo.

"I'm interested in understanding how animals experience the world," she said. "They have a different set of sensory abilities than we do. They see and hear differently than we do."

Her research can be used to inform conservation efforts. River otters are again swimming in Rochester-area waters after the zoo became instrumental in repopulating them in the region in the 1990s. Research DeLong is doing can be used in future conservation efforts for the otters. "We need to know more about their perceptual and cognitive abilities in case their population is threatened again," she said.

DeLong is also involved in collaborative marine mammal research projects with colleagues in Florida and California.

DeLong is director of RIT's Comparative Cognition & Perception Lab ([www.rit.edu/DeLonglab](http://www.rit.edu/DeLonglab)), where one project is

focused on long-term memory in goldfish. If the fish can differentiate between a circle and a square, it will get fed.

"The idea that fish have a three-second memory is a myth," she said. "My fish can remember a visual task for more than three months."

Several undergraduate and graduate students are also involved as research assistants.

"The research is also giving students a valuable experience they can carry with them, and some go on to attain a master's degree or Ph.D. in psychology and other fields," she said.

### Interdisciplinary Collaboration

RIT's Strategic Plan 2025 states RIT "will select, invest in, and foster interdisciplinary and trans-disciplinary research areas of focus where RIT's assets align with growing opportunities." The recent addition of a digital humanities and social sciences bachelor's degree is one example.

"Research conducted in the College of Liberal Arts often reaches into other





**At the Zoo:** Caroline DeLong, an associate professor in the Department of Psychology, has been doing comparative cognition research at RIT for more than 10 years, including working with North American river otters for more than five years. DeLong, with clipboard, conducts tests with Sara the otter at Rochester's Seneca Park Zoo with fourth-year psychology students Henry Rachfal, center, and Kathryn Gardner, left.

colleges at RIT” Winebrake said. “The interdisciplinary culture here helps bring science, technology, and the liberal arts together. This interdisciplinarity creates a very positive influence on our students, who need to understand the important interconnections across disciplines if they want to have an impact on the world and lead lives of consequence.”

In February, RIT became the newest university designated as part of the Grand Challenge Scholars Program, a national initiative to train future engineering and non-engineering professionals to play a significant role in solving major challenges of the 21st century.

The National Academy of Engineering identified more than a dozen challenges that if solved through collaborations between individuals involved in science, engineering, and the liberal arts, could positively impact complex societal issues.

“Addressing global challenges—such as providing clean water or restoring urban infrastructure—requires understanding and analysis that goes beyond the

problem’s technical dimensions,” Winebrake said. “To solve these problems, students need to understand not only advanced technology, but also the social, cultural, political, ethical, and economic dimensions of these problems. This program brings together engineering students and liberal arts students to work collectively on solving global challenges through innovative curricula and project-based work.”

Ryne Raffaele, vice president for research and associate provost, is pleased with the mark RIT research is making in the field of the humanities and social sciences at RIT.

“It has been quite gratifying watching the steady increase in sponsored research awards over the last five years under Dean Winebrake’s leadership,” Raffaele said. “The most dramatic increase has been in the number of COLA faculty who are serving as co-principal investigators on sponsored research awards being led by principal investigators across the entire campus.”

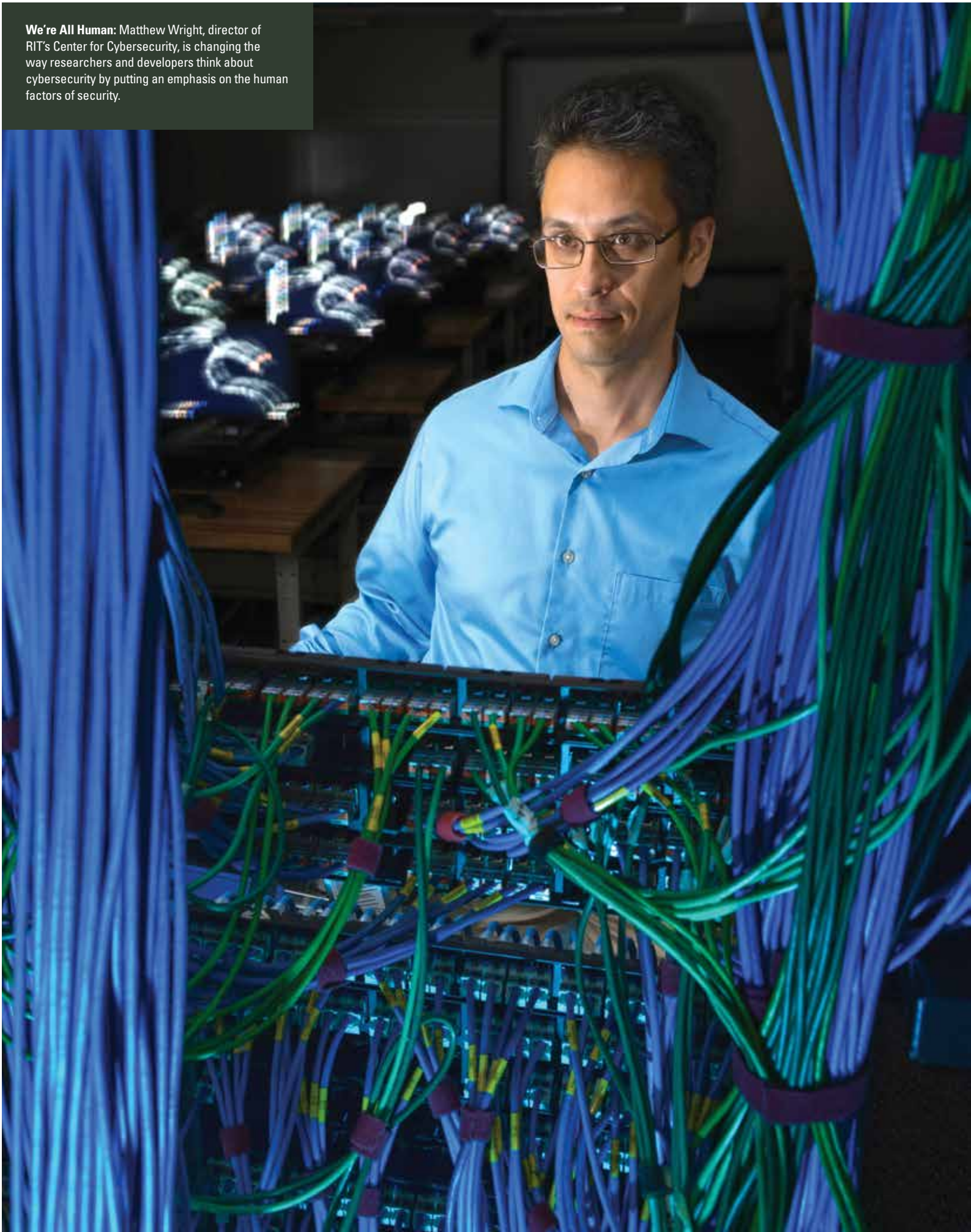
Currently, 23 COLA faculty members are principal investigators or co-principal investigators, compared to 14 in 2007.

And the benefactors of such research collaboration among colleges within RIT are the students, who will gain greater awareness and understanding of issues and solutions outside their primary majors, and will be more marketable after graduation when they start their careers.

“At RIT we have always strived to produce well-rounded students,” Raffaele said. “For many, this implies a good grounding in liberal arts and social sciences. The collaborative research relationships formed by our faculty in liberal arts with our other colleges ensure that we are offering well-rounded educational experiences for our students outside the traditional classroom for years to come.”

**On the Web**  
College of Liberal Arts  
[www.rit.edu/cla](http://www.rit.edu/cla)

**We're All Human:** Matthew Wright, director of RIT's Center for Cybersecurity, is changing the way researchers and developers think about cybersecurity by putting an emphasis on the human factors of security.



# Human-Centered Cybersecurity

## A New Approach to Securing Networks by Scott Bureau

RIT’s cybersecurity experts are studying the past, present, and future of cybersecurity to gain a better understanding of the role that humans—and their behavior—play in keeping our technology secure.

### A New Center for Cybersecurity

Ninety-one percent of all breaches start with an email.

A teacher clicks on a link and it redirects to a malicious website. Or a CEO accidentally downloads an attachment that triggers a ransomware attack. Users can even unknowingly give their personal login and password away while trying to log onto a fake website that is designed to look real.

There is a common link in these and almost every other cybersecurity problem, said Matthew Wright, director of RIT’s Center for Cybersecurity. “It involves people.”

That’s why Wright is working with other researchers at RIT to think beyond the technology and focus on a human-centered approach to cybersecurity.

“While most research attention in cybersecurity is on technology—from cryptography on chips to using machine learning to detect attacks—many security problems are due to people,” said Wright. “Understanding and designing for the human beings using, administering, and even attacking our computing systems is the key to making them more secure, not just on paper but in practice.”

Yes, the internet has given us Snapchat and virtual banking, but these online activities come with the risk of cyber threats. Professional criminal organizations are building malware and running scams to steal money and personal information. At the same time, military secrets, critical infrastructure, and even elections are under assault.

In 2016, more than 4 billion digital records were exposed in cyber breaches against companies, including attacks on Yahoo and LinkedIn. That number

skyrocketed from the 1 billion records compromised in 2013, according to a report from Risk Based Security.

RIT is helping to address these challenges as a leader in computing security education and research.

Through the Center for Cybersecurity, founded in 2016, the university is bringing together expertise from across RIT. Faculty and student researchers are working to better understand and address these real-world challenges in cybersecurity through projects that analyze past incidents, by studying the current state of phishing on social media, and by modeling how attackers will strike in the future.

“We are developing the next generation of cybersecurity experts and we want to continue enriching our educational offerings,” said Bo Yuan, chair of RIT’s Department of Computing Security. “We’re doing this by creating opportunities for students and faculty to engage in cutting-edge research and industry experiences.”

The interdisciplinary center is funded by a \$1 million signature research grant from RIT and \$1 million from the B. Thomas Golisano College of Computing and Information Sciences. The center includes two parts—the Security Assessment and Forensic Examination (SAFE) Lab and research laboratory.

In the SAFE Lab, industry and education collide, as student pentesters are hired to test a business’s networks, create a report, and make recommendations about its cybersecurity needs. Here, companies are able to verify the security of their networks, systems, and services, while giving students real-world experience.

In the research lab, faculty and student researchers from across the campus are coming together to develop human-

### Cyber Breaches Through the Years

**2006 TJX Breach:** Attackers crack the Wi-Fi encryption of two Marshalls stores, find their way into the databases of TJX—parent company of Marshalls and TJ Maxx—and steal payment card, social security, and driver’s license numbers belonging to 45.7 million customers.

**2011 DigiNotar Compromise:** Dutch certificate authority DigiNotar discovers that it has been compromised—an attacker tunneled through its 157 firewall rules, bypassed multiple levels of physical security and keycard requirements, and issued rogue certificates for domains including google.com, CIA.gov, and others.

**2012 South Carolina Department of Revenue Breach:** Millions of tax records, social security numbers, and other personal information for more than 75 percent of the population of South Carolina are stolen after a South Carolina Department of Revenue employee unwittingly clicks on an embedded link in a phishing email.

**2013 Spamhaus Denial-of-service Attacks:** The Spamhaus Project, a nonprofit organization that compiles and distributes lists of DNS servers, IP addresses, and domains known to be used by spammers, begins experiencing an unusually large volume of traffic to its website in retaliation for blacklisting Dutch hosting company Cyberbunker. *(Continues on next page.)*

## Cyber Breaches Through the Years

(Continued from previous page.)

### 2013 Chinese PLA Unit 61398

**Espionage:** Security firm Mandiant releases a detailed report describing the years of cyber espionage activities it linked to Unit 61398 of the Chinese People's Liberation Army. The Chinese army of hackers stole trade secrets, business plans, and legal documents from aerospace, satellite, and telecommunications companies in the U.S.

### 2014 Gameover ZeuS Takedown:

The FBI, working along with private companies, research universities, and international law enforcement agencies, successfully seizes the computer servers being used to operate Gameover ZeuS, a massive international botnet that distributed CryptoLocker, one of the early successful strains of ransomware.

**2014 Sony Breach:** A group calling itself "Guardians of Peace" publicly releases a trove of internal emails, scripts, and spreadsheets from Sony Pictures Entertainment over several months, allegedly in retaliation for a forthcoming film mocking North Korea.

### 2015 Office of Personnel Management Breach:

The U.S. Office of Personnel Management (OPM) reveals a breach, in which it would later be discovered that personal information belonging to more than 20 million current and former federal employees had been stolen from its computer systems.

**2015 Ashley Madison Breach:** Ashley Madison, a website intended to help users pursue extramarital affairs, is breached, leading to the public disclosure of records associated with millions of the site's users.

### 2016 Mirai Dyn DDoS Attack:

Cybercriminals launch a malware called Mirai that infects more than 100,000 Internet of Things devices and conducts major distributed denial-of-service attacks against Domain Name System (DNS) provider Dyn, disrupting Twitter, Netflix, PayPal, Pinterest, and the PlayStation Network for several hours.

### 2017 Equifax Data Breach:

The personal data of 143 million Americans is compromised and Equifax, one of the nation's three major credit bureaus, reveals that it was attacked between mid-May and July.

## Someone is sending my friends friend requests pretending to be me.

Report Something



How do I report someone who is sending my Facebook Friends Friend requests my account has been hacked? My password is so complex already and I just because of the same issue. How can this happen??

Asked about 2 years ago by [redacted]

438 Votes · 98 Followers · Seen by 38,984

**You've Been Hacked:** Questions like this one, posted to Facebook's Help Community, have become a daily occurrence for social media users who complain about complex passwords. Even Facebook co-founder and CEO Mark Zuckerberg had his Twitter and Pinterest accounts hacked in 2016 because he may have reused a password. RIT researchers are exploring new systems for creating memorable but safe passwords.



centered projects that will help people and organizations get and stay ahead of their adversaries.

Wright's own research pulls from the lessons of cognitive psychology. He is developing a system designed to generate random passwords that are also easy for people to remember.

Other researchers are using natural language processing to mine software repositories.

The work will create a better understanding of how security bugs happen and ways that developers can avoid making those mistakes in the future.

"There's no silver bullet for cybersecurity problems," Wright said. "But gaining a better understanding of how humans play a role in the past, present, and future of cybersecurity might teach us the best spots to aim."

### Learning from Past Cases

Those who do not learn from history are doomed to repeat it. These are words that Josephine Wolff lives by.

As an assistant professor of public policy and faculty affiliate of the Department of Computing Security, Wolff serves as a bridge between the technology world and social sciences. Through her work observing and questioning cyberattacks of the past, she hopes to uncover lessons for the future.

"A lot of today's cybersecurity incidents are actually taking advantage of technology that we already know how to fix," said Wolff. "Oftentimes, the failure is in the decision making."

By looking at a series of cybersecurity incidents over the course of the past decade, Wolff is tracing their economic effect, legal aftermath, and their impact

📄 Ask a Question

pretending to be me? Does this mean changed it less than six months ago



**Know Your History:** Josephine Wolff, assistant professor of public policy and faculty affiliate of computing security, studies the whole lifecycle of past cyberattacks in order to ask the right questions about the future of cybersecurity.

on the current state of technical, social, and political lines of defense. Through funding from the New America Cybersecurity Initiative, a nonpartisan think tank, she plans to publish her research as a book in 2018.

Wolff started by looking at one of the first large-scale breaches—the 2006 breach of TJX, the parent company of Marshalls and TJ Maxx. Computer hacker Albert Gonzalez and his co-conspirators cracked the Wi-Fi encryption of two Marshalls stores in Florida, quickly found their way into the company databases, and stole payment card, social security, and driver's license numbers belonging to 45.7 million of the chain's customers.

"It's a dangerous narrative to say that all you need to do is update Wi-Fi encryption and you're all set," Wolff said. "I ask, who do we hold responsible for

ensuring this security—the retailers, the credit card companies, the software developers, or maybe the hardware manufacturers?"

Wolff has also looked at who is bearing the cost and how they try to make sure someone else ends up with the bill. "Are we making good policy decisions about how liability is assigned to different actors involved in breaches?"

Her research explores financially motivated breaches, cyber espionage incidents, and revenge-motivated breaches. She is also observing how insurance has emerged around cybersecurity and how companies implement safety measures, such as two-factor authentication.

Skimping on cybersecurity can't be seen as a way to cut costs, Wolff said. Cybersecurity can't be an afterthought.

### Phishing in the Present

With more available attack vectors and stronger hackers, it has become harder for users to keep themselves safe. Sovantharith Seng, a computing and information sciences Ph.D. student from Cambodia, is working to change that.

When deciding what to study in graduate school, Seng debated between his love of working with people in student affairs and his background in computer science.

"I found a compromise in the field of usable security," said Seng. "Here, I get to work with psychology and social behavior to take a human approach to the security problem."

At RIT, Seng is beginning research into the social engineering attack known as phishing. A traditional phishing attack will try to steal personal infor-



**Social Cybersecurity:** Sovanharith Seng, a computing and information sciences Ph.D. student, understands that cybersecurity is just as much about the psychology and social behavior of people as it is about the coding. If people are rushing to complete a task on their computer or phone, security is certainly not their priority.

mation or deliver malware by fooling a user through malicious email attachments or fake websites.

However, Seng is looking toward the growing trend in phishing today—social media.

Attackers can use LinkedIn to target a company’s most influential people, who may have access to trade secrets. Or scammers could create a duplicate Facebook account of a clergy member and send out a link asking the congregation to donate money to a “good cause.”

“I am conducting a small study with a simulated Facebook interface, where users scroll through a newsfeed and see multiple posts from their Facebook friends,” Seng said. “I ask

participants, ‘would you click on this and why?’”

Through the survey, Seng hopes to better understand the important context factors of Facebook posts that influence a user’s decision of whether or not they interact with a post.

Seng wants to know why they think it might be a scam and what actions they would take after encountering this kind of post.

In the future, he hopes someday to work with social media companies to help detect and combat phishing on their platforms.

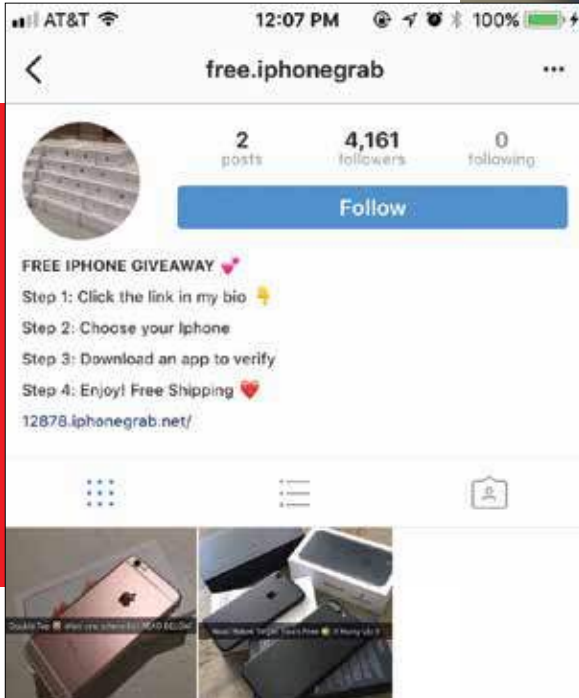
“But we need to stay aware, because nothing works completely,” said Seng. “You will see another phishing attack in your lifetime, I guarantee that.”

### **The Future of Cyber Defense**

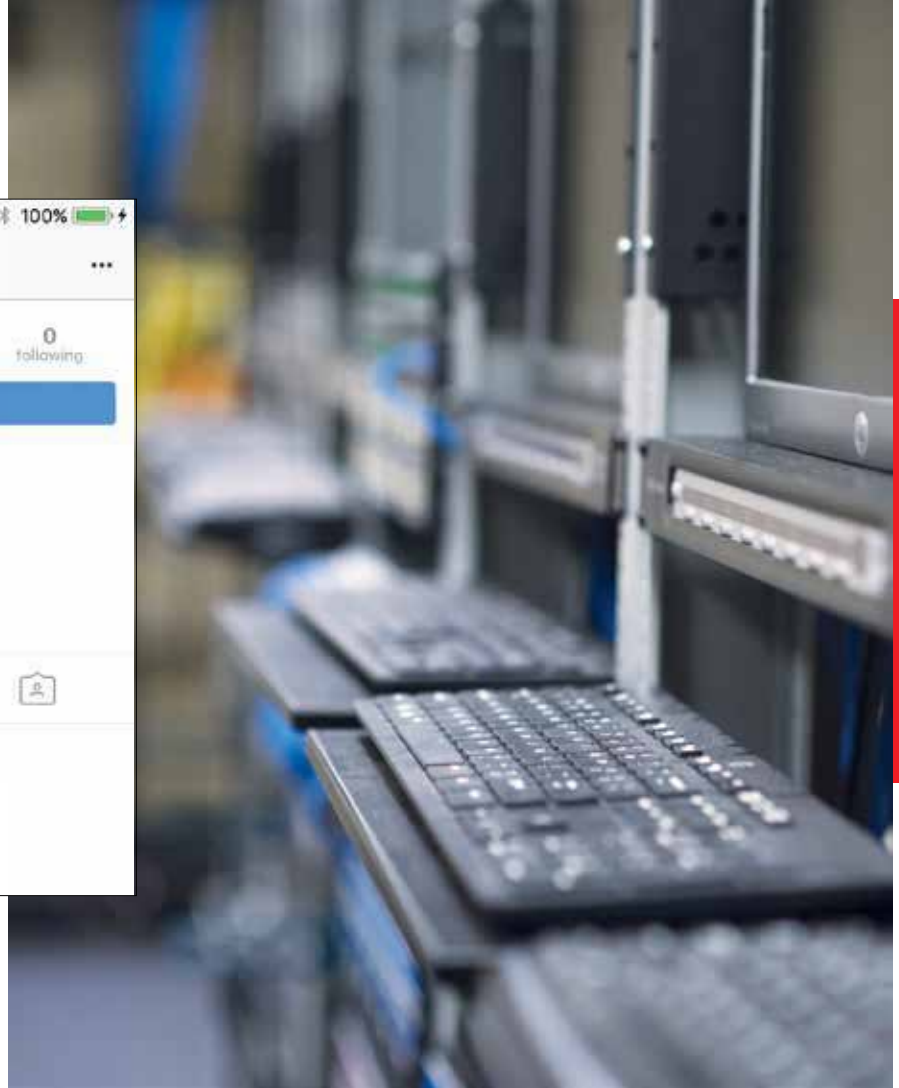
While there is currently no crystal ball for cybersecurity attacks, RIT researchers are working on one.

Led by Shanchieh Yang, RIT’s department head of computer engineering, researchers are getting into the mind of hackers and modeling their attacks. Using tools from machine learning, data analytics, and theories in criminology, Yang hopes to develop algorithms and models that help experts predict which security technologies and practices are the most effective for protecting networks given hackers’ behavior and tactics.

“Attackers can be eccentric, but they are still human beings,” said Yang. “We hope to discover and explore their attack



**Let's Go Phishing:** Despite its name, this Instagram account does not send users a free iPhone. It's a phishing scam that intends to fool users. Phishing scams have become an easy way for attackers to steal login credentials and gain access to your accounts.



**Mind of a Hacker:** Using criminology theories and machine learning, RIT faculty and student researchers are getting into the mind of a hacker to create models that predict when and how computing systems might be attacked.

strategies and patterns of behavior for achieving their goals.”

Working with an interdisciplinary team of faculty from engineering and computing, Yang is developing a system to characterize attack patterns and combinations of exploit behaviors that attackers use. They even hope to reveal additional attack scenarios that may not have been known before. Part of their model and system development is based on interviews with student pentesters who attended RIT’s annual Collegiate Penetration Testing Competition, held each fall.

Funded by more than \$800,000 in grants from the NSF and NSA, the research seeks to quantify what might happen in an attack.

And the key word is might, said Yang. “In a simulation, we might find that a particular machine was attacked a high percentage of the time,” said Yang. “It doesn’t necessarily mean that the machine has more vulnerabilities—it’s just that the typical path of a hacker leads to that computer. Now we have a suggestion of where to enhance our security.”

Additionally, Yang has been part of a research project through the Intelligence Advanced Research Projects Activity (IARPA) to develop methods that forecast cyber incidents. Using data from social media and other non-conventional indicators, the tool aims at generating early warnings of cyber incidents before they happen.

“The success of the project will lead to a proactive cyber defense,” said Yang, “likely preventing some critical information espionage and financial losses from even taking place.”

But in the end, Yang’s best advice for preventing cyber breaches for individuals is to always stay under the radar. “Don’t expose yourself and let anyone know that you have information worth stealing.”

#### On the Web

RIT’s Center for Cybersecurity  
[www.rit.edu/cybersecurity](http://www.rit.edu/cybersecurity)

**Crime Prevention:** CPSI Director John Klofas, right, and Deputy Director Irshad Altheimer, left, meet with criminal justice students weekly about their research projects.



## Criminal Justice Team Studies Crime Trends for Prevention

by Greg Livadas

The Center for Public Safety Initiatives is a unique collaboration among RIT, the City of Rochester, and criminal justice agencies in New York.

### Preventing Crime

Criminal Justice Professor John Klofas heads one of RIT's longest running research programs, the work coming from the Center for Public Safety Initiatives (CPSI).

For more than 15 years, students and faculty associated with the center have helped law enforcement officials determine what programs may help prevent crime, although Klofas feels giving students the experience to do the research and publishing their findings is just as important.

"There's no place in the country that does any of this," Klofas said. "Our students have a great experience and it turns out well for them."

About 40 people—including 10 to 12 criminal justice students—typically work at CPSI with a \$2 million annual budget that is totally funded through various sources and contracts outside of RIT, including federal and state agencies such as the Bureau of Justice Statistics, the National Institute of Justice, and the state Division of Criminal Justice Services (DCJS).

Their findings are posted in reports on the CPSI website and have been about

perceptions the public has about police, community concerns and desires, homicide rates, domestic violence, recidivism of parolees, and most recently perceptions of opioid addiction.

"There's a commitment to evidence-based initiatives. Data can be useful in addressing public safety issues, and we have helped fill the void," Klofas said. "This is a new skillset, different than the skillset police officers bring. And that's a big change, one that requires efforts by local jurisdictions and monitoring of the implementation of the programs. The police are very supportive of this."

### Gathering Data

CPSI was created after Rochester began a research partnership in 2000 to address the problem of lethal violence in the city. That led to reformation of crime analysis at the Rochester Police Department and the model for the Monroe Crime Analysis Center (MCAC) and other analysis centers across the state supported by DCJS.

The local analysis center's key staff began as RIT students, many of them criminal justice students, working for

CPSI. It was a logical link because RIT already was teaching students research on crime analysis, Klofas said.

"The opportunity to really combine research with an experiential learning experience is very important," Klofas said. "And our students are addressing social issues and problems. The work of the center is really oriented toward locally relevant research. The ability to help communities gather and use data at the local level is important."

Klofas and the center's deputy director, Irshad Altheimer, an associate professor of criminal justice, regularly meet with the students to discuss their progress. One student each week makes a presentation to the group with their findings, often involving graphs of data on slides.

"I like the whole analytical side of things, looking at data to see if intervention would work," said Nate Le Mahieu, a graduate criminal justice student from Hortonville, Wis., who works as a research assistant at CPSI.

Le Mahieu helped conduct a survey of nearly 350 people who attended last spring's Imagine RIT: Innovation and Creativity



Festival about their views on opioid addiction and treatment options. The results showed few thought drug abusers should be treated as criminals, and 90 percent believed anti-overdose medications should be more available. The data suggests “the value of reframing our thinking about the nature of drug problems and society’s response to them,” the survey report concludes.

## Results

Findings from CPSI’s research have resulted in changes. Rochester officials passed an ordinance requiring electronic reporting by pawn stores after a CPSI study questioned whether items traded might be legally pawned or stolen. And police increased enforcement and worked more closely with businesses that buy scrap metal after their study showed a direct correlation to an increase in copper thefts when the price paid for copper rises.

“We’re providing a substantial amount of information the Rochester Police Department is working on,” Klofas said. “And we’re seeing interest from other police departments across the country in what we’re doing.”

Another recent study found that dispute-related crime is on the rise in the City of Rochester.

“More than 60 percent of shootings are traced to ongoing disputes,” Klofas said. That statistic helps police assess the risk of violence, letting them intervene before problems escalate.

“RIT’s program is very strong in research and statistics,” said Mark Gorthy ’90 (criminal justice), who works for the Rochester Police Department as managing analyst at the Monroe Crime Analysis Center. “We work very closely with them and their students doing practical research. I can’t stress enough the importance of the partnership with RIT and CPSI. It has just been tremendous.”

It has been beneficial for CPSI alumni as well, who have gone on to work for police departments and mapping and crime analysis companies. Six have earned or are earning their Ph.D.s.

In a project that has been underway for several months, a CPSI student spends three days a week downtown compiling

## Recent Projects

Here are a few projects from RIT’s Center for Public Safety Initiatives:

### Gun Involved Violence Elimination (GIVE)

Researchers visit police departments and parole, probation, and district attorney offices in 17 counties across the state to evaluate strategies involving problem-oriented policing and focused deterrence. Strategies have involved identifying “hot spots” most prone to gun violence, focusing deterrence against violent gangs or groups considered responsible for most gun violence, increased supervision of those on parole or probation, and outreach to interrupt cycles of violence to prevent retaliation.

### Swift, Certain, and Fair

New York state’s Department of Probation will implement this program on Jan. 1. Based on Hawaii’s Opportunity Probation with Enforcement (HOPE) initiative used for drug offenses, swift, definitive consequences will be implemented for probation and parole high-level offenders through a collaboration of various criminal justice agencies. The CPSI will evaluate its effectiveness.

### Community Views on Criminal Justice

Business owners, church leaders, and others in the community are surveyed to determine their thoughts on police and the criminal justice system. The focus groups document the perceptions the community has, whether or not those perceptions are accurate.

### Project Safe Neighborhoods

A large database is being compiled with data associated with gun violence in Rochester in hopes of preventing future crime by identifying, assessing, and

intervening in situations where the probability of dispute-related gun violence is believed to be high. If trends such as times of day, days of the week, locations, or other variables are high when shootings occur, police can attempt to step up patrols or take other preventive measures.

### Pawn Shop Analysis

A series of five papers can be found on the CPSI website ([www.rit.edu/cpsi](http://www.rit.edu/cpsi)) related to pawn shops in Rochester. Although many may be legitimate businesses, questions of crime and stolen property remain a focus for law enforcement fearing some shops may be in business to buy stolen property. Most shops are located in areas of Rochester with poverty and high burglary risk. More than 20 percent of items sold were jewelry, but televisions and cameras were also often pawned. Of customers determined to be “highly active pawners,” 84 percent had previously been arrested.

### Walmart Project

In 2010, more calls (1,114) were made to 911 to respond to the Walmart location on Hudson Avenue in Rochester than to any other location in the city. The study looked at the call volume, nature, and time spent on the calls and what time of day the calls occurred. They concluded nearly half of the calls were for larcenies, and peak calls were from 2 to 7 p.m., with Fridays being the day with most calls. The calls were also compared to calls to respond to the Walmart in nearby Gates, N.Y.

a database of information from every shooting in Rochester where someone was injured or killed. Hundreds of variables are included, including whether the victim and suspect knew one another or had previous arguments, the time of day, the education of those involved, and even the weather.

“There’s not another database like that in the country,” Klofas said. “It’s groundbreaking.”

Gorthy agrees. “I think it will give the most detailed view on the context and nature of the shooting incidents,” he said. “Our analysts are using these tools to identify patterns before anyone else would.”

## On the Web

Center for Public Safety Initiatives  
[rit.edu/cpsi](http://rit.edu/cpsi)



**In the Classroom:** Kelly Norris Martin, associate professor of communication, teaches an undergraduate qualitative research methods class.

## Research Will Help Prepare Students for Jobs in Photonics and Optics

by Jane Sutter

Amid the national discussion about skills gaps in filling STEM jobs, a trio of RIT researchers is diving into whether that gap exists in the optics and photonics industry in Rochester. Their research will help guide what changes need to take place in the classroom to better prepare students for entry-level jobs in those fields.

### Applying Research to the Classroom

Benjamin Zwickl, assistant professor of physics; Kelly Norris Martin, associate professor of communication; and Anne Emerson Leak, post-doctoral researcher in science education, constitute an interdisciplinary team utilizing a nearly \$400,000 Education and Human Resources Core Research grant from

the National Science Foundation.

The acronym POWER aptly describes their effort: Photonics and Optics Workforce Education Research. The trio's study focuses on four areas:

- How employees use math, physics, and communication skills in the workplace.
- How employers evaluate competency in these skills.

- The differences in required training for Ph.D.-level academic researchers versus engineers and technicians in industry.
- The ways that higher education and on-the-job training combine for STEM workforce development.

Zwickl noted that there's an abundance of research on how professors can more effectively teach students in the classroom



**Benjamin Zwickl**

but not much research on how students apply their learning in entry-level jobs.

Zwickl, Martin, and Leak are getting multiple perspectives by interviewing not only employers and employees in industry but also graduate-level students and their advisers. The interviewees fill a variety of roles, from associate professor to Ph.D. student, and from technicians to engineers.

### Viewpoint of Employees

A unique aspect of their research is talking directly to employees who are in their first jobs after graduation, as opposed to much of the current research that focuses on surveys with CEOs and managers about the skills needed for STEM jobs. “We’re trying to talk specifically with entry-level employees themselves about what (skills) are you using every day, what did you feel prepared with (when you started the job), and what do you wish you had had more training in” while a college student, Martin said.

Talking to employees offers a micro view of the day-to-day skills they use, as opposed to getting a macro view from a manager about the skills that are important to a company, Zwickl noted. That micro view is essential knowledge for faculty to be able to transform the undergraduate curriculum.

In terms of workforce readiness and the often talked about skills gaps, their research shows that a lot of companies have a wide variety of innovative on-the-job training programs to bridge those gaps, Zwickl said. The optics and photonics fields are interdisciplinary, and because most new employees arrive with a background in one area, such as physics or engineering, “companies are always going to have to do something to bridge the expertise that a student has now.”

Some employers were very happy with the technical skills and training that recent graduates had, and if there was a gap, the employers provided

in-house training or continuing education opportunities, Martin noted.

### Strong Communication Skills

One key focus of the research is on communication skills and what employees in the photonics and optics industries need to be successful. While managers may say that good communication skills are vital, they may not be screening job candidates specifically for those. For example, a hiring manager will scrutinize a job applicant’s college transcript to determine course work in technical skills but may not look for evidence of strong communication ability, Zwickl said.

While some hiring managers may require a job applicant to write a paper during the interview process or do a presentation, that’s not the norm, Martin said. Managers don’t often inquire about whether the applicant has taken classes in communication or demonstrated communication skills through extra-curricular activities such as clubs.

The same holds true for Ph.D. advisers who are screening students for graduate work, Zwickl said.

Strong communication skills tend to become more important when employees are being considered for a promotion or a supervisory role, Martin said. “As far as moving up in the company, it’s essential if you are going to go into management.”

Leak pointed out that in science classes, students use communication as a means to an end, such as producing a Power-Point presentation to show results or writing a lab report, but teaching communication skills as an end in itself is not typically done.

### An Impact on Science Education

About 40 percent of physics majors pursue a graduate degree, so the researchers are also interviewing faculty who are supervising graduate students in a research setting, with the idea being that the students are working as entry-level research scientists. “The things that could make a grad student really productive and creative in working with a researcher could be the same things that make an industry employee really innovative and

productive,” Zwickl said.

The data the researchers are collecting will also be useful to the development of broader science education literature, tying into the new national Next Generation Science Standards (NGSS) for K-12 students and helping to make science education relevant, Leak said.

One next step is for the researchers to do comparisons related to types of companies and size of companies and how their expectations for employees vary. A small company may need an entry-level staffer to wear multiple hats, as opposed to a larger company having more narrowly defined job duties, Leak said.

Zwickl, Martin, and Leak are collaborating on a related initiative. They recently



**Anne Emerson Leak**

received a \$98,000 AIM Photonics grant to lead a New York state workforce needs assessment study to determine the training needed to fill future jobs related to photonics integrated circuits. Similar research is taking

place at other institutions around the country.

Also related to Zwickl and Martin’s work in Rochester is a collaboration between RIT and the University of Wisconsin-Madison. The project is called EMPOWER—Exploring Multiple Postsecondary Opportunities through Workforce and Education Research. Zwickl, Martin, and post-doctoral researcher Susan Rothwell are studying how communication, teamwork, problem-solving, and self-directed learning are valued and learned in STEM fields in four cities—Denver, Houston, Seattle, and Raleigh, N.C. RIT received \$650,000 from the National Science Foundation for the study.

### On the Web

**POWER**  
[www.rit.edu/power](http://www.rit.edu/power)

**EMPOWER**  
[empowerstem.com](http://empowerstem.com)



## Researchers Study How Deaf People Learn, Grow

by Vienna McGrain

The Center on Cognition and Language, created in 2016, is the only center of its kind in the world led by a deaf director and staffed primarily by deaf researchers.

### Fulfilling a Need

Peter Hauser is a strategist—executing a carefully orchestrated plan to establish his Center on Cognition and Language at RIT’s National Technical Institute for the Deaf as the premier location in the world for researching how deaf people develop, learn, grow, and live.

Hauser is inspiring an army of dedicated and talented student and faculty researchers to follow his lead and make a difference in the education, health, and wellness of deaf people for generations to come. Back in the early 2000s, Hauser was the first-ever practicing deaf neuropsychologist to

work alongside physicians in diagnosing conditions such as learning disabilities, attention disorders, dementia, and depression in deaf and hard-of-hearing patients. But as Hauser’s career progressed, along with an increasing clinical workload, he realized that diagnoses were often made based on



**Research:** Peter Hauser, professor and director of NTID's Center on Cognition and Language, connects with student Sarah Kimbley, left, and post-doctoral fellow Tiffany Panko on the research projects they are spearheading. Kimbley and Panko are just two of the many students and faculty who work closely with Hauser to establish solid research related to the health and well-being of deaf people.

decades of studies of only hearing subjects. Further investigation revealed a significant lack of research using deaf and hard-of-hearing subjects.

“There was and still is a dire need for research on deaf individuals’ language, cognitive function, memory, and intelligence, which all play a role in understanding and diagnosing conditions and understanding how we learn and develop,” said Hauser. “There were times that I thought to myself, ‘How can I diagnose my deaf patients when the only basis for understanding I have is using irrelevant research?’ And while I truly loved working one-on-one with patients and physicians, I felt that I needed to impact the physical and mental

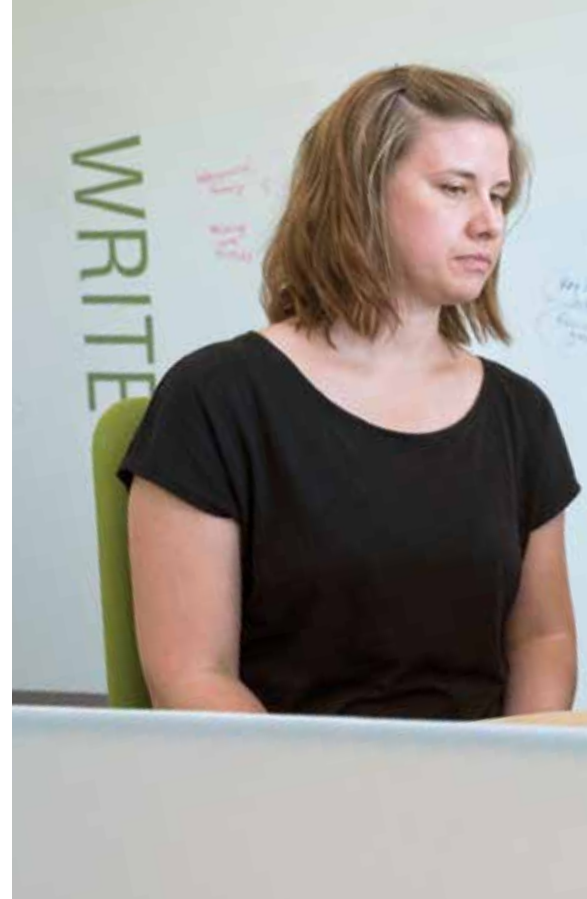
well-being of deaf people, as well as their access to education, in a different way.”

After years of writing grants to secure funding and conducting his own research, Hauser created NTID’s Center on Cognition and Language in 2016—the only center of its kind in the world led by a deaf director and staffed primarily by deaf researchers. The center produces interdisciplinary and collaborative discoveries on the cognitive, language, and socio-cultural factors that affect deaf individuals’ learning, well-being, and health, and equally as important, shares these discoveries with other researchers, hospitals, schools, and clinics. Research projects are funded by the National Science

Foundation, the National Institutes of Health, and NTID.

“I would dream of starting this research center, and some days I didn’t think it would ever happen,” said Hauser. “But every day, I made little decisions based on closing in on that dream.”

Hauser is also passionate about developing future generations of deaf researchers and scientists in social, behavioral, and biomedical research disciplines and provides mentorship programs for deaf scholars. The center is home to two NIH-funded training programs committed to fostering aspiring deaf scientists’ development by providing outstanding mentored research experiences and one NSF-funded program to broaden the participation of deaf students in sign-language research.



**This Electroencephalogram (EEG)** is used in the Center on Cognition and Language to detect electrical activity in the brain. Testing the electrical impulses in the brain is one useful method to help study how aspects of language impact deaf individuals' cognition and learning.

### Building an Army

RIT student Sarah Kimbley began her work in the center as an undergraduate. She works in the center's Deaf x Lab, Sign Language Lab, and the Deaf Health Lab, and this fall is a scholar in the Rochester Bridges to the Doctorate program, which selects top RIT graduate students who are deaf or hard-of-hearing and wish to pursue a doctoral degree.

Kimbley, an experimental psychology graduate student from Lakeland, Fla., is working on several projects including studying health literacy and understanding individuals' feelings about being deaf. She is also comparing temporal sequence processing in deaf children and how language acquisition and audition may mediate neurocognitive functions like working memory, executive function, and sequence learning.

"Researchers claim deaf children with cochlear implants have a cognitive deficit

#### Mentorship Programs

**Rochester Bridges to the Doctorate:**  
[deafscientists.com](http://deafscientists.com)

**Rochester Post-doc Partnership:**  
[www.urmc.rochester.edu/academic-research-careers-deaf-scholars.aspx](http://www.urmc.rochester.edu/academic-research-careers-deaf-scholars.aspx)

**Broadening the Participation of Deaf Students in Sign Language Research program:** Provides the top deaf and hard-of-hearing students from higher education institutions across the United States with mentored opportunities in sign language research.

that is due to a lack of auditory input," said Kimbley. "However, our research

proposes an alternative explanation. Language deprivation has a greater impact than auditory deprivation. In other words, not being exposed to language within the first five years can be harmful for cognitive functioning. We are predicting that our developmental study will show us that language fluency will have an impact while hearing level has little or no impact on cognitive functioning, specifically temporal sequence processing."

The center staff works with and mentors students at all educational levels from first-year to graduate students, and beyond.

Tiffany Panko '08, '09 (applied arts and sciences, MBA) is a post-doctoral fellow in the center who graduated from RIT with concentrations in premedical and psychological studies and from the



**Hands-on Learning:** Professor Peter Hauser works with post-doctoral fellow Tiffany Panko, left, and student Sarah Kimbley in NTID's Center on Cognition and Language.

University of Rochester in 2016 with a medical degree. The Rochester native has studied and worked alongside Hauser off and on from as far back as 2004.

"I just can't seem to get away from Peter," jokes Panko. "As an undergraduate, I was in a class that he taught—Biological Basis of Mental Disorders, which was the class where I realized that I could blend my love of psychology with medicine and working with people. Last year, I wasn't sure what I wanted to do with my residency, so I contacted Peter and he told me that he could really use my expertise in the Deaf Health Lab. I'm working on a big five-year project that connects Rochester, Chicago, and Flint, Mich., and more than 1,000 deaf, hard-of-hearing, and hearing people. All of these areas provide racial, ethnic, and economic diversity—rich research environments."

The project, a partnership with the University of Michigan, will provide information on how to better provide preventive health and health care information to the diverse deaf and hard-of-hearing community. Eye trackers in the lab help Panko and others study how deaf users navigate health websites. The goal is to gain information on how different groups within the deaf community learn differently in order to customize how information can be delivered to these marginalized populations.

"I have learned so much about psychology and academic research during my time working here in the center, but more importantly, I have learned to become more confident in myself and my ability to achieve my goals," added Kimbley.

Kimbley and Panko, who is also deaf,

## Labs

NTID's Center on Cognition and Language houses five labs, each focusing on a different aspect of deaf life.

**Deaf Studies Laboratory**—investigates how stigma about deaf people has an impact on those individuals' education, health, and careers.

**Deaf x Laboratory**—investigates how the deaf experience shapes cognition, including attention and the executive functions using behavioral science tasks, electroencephalography, and eye tracking to understand the effects of language and hearing on cognition in adults and cognitive development in children.

**Sign Language Laboratory**—investigates issues in sign-language acquisition, educational interpreting, and sociolinguistics, including language variation and language attitudes.

**Deaf Health Laboratory**—establishes research related to the deaf community on preventive health, health literacy, health knowledge, and the deaf experience in health care.

**Deaf Math-Science Language and Learning Lab**—focuses on language learning and conceptual understanding in mathematics and science.

are just two of the 14 students, four staff members, and seven NTID faculty members who support Hauser and the center's labs through their research.

"We bring together experts from different levels of education and different backgrounds including, but not limited to, linguists, physicians, cognitive scientists," he added. "We bring them together for the first time in the same environment. The whole is greater than the sum of its parts. We are creating new types of science that just aren't possible without this one-of-a-kind collaboration."

## On the Web

**NTID Center on Cognition and Language**  
[www.ntid.rit.edu/ncccl](http://www.ntid.rit.edu/ncccl)

**Making Connections:** Sara Schley, director of NTID's Research Center for Teaching and Learning, is using a National Science Foundation grant to connect hearing and deaf communities with the goal of improving STEM learning.





# Investigating Ways to Enhance Learning for Deaf Students Beyond Notetaking

by Vienna McGrain

National Technical Institute for the Deaf researchers are working to improve education and provide more support for deaf and hard-of-hearing students.

## National Science Foundation Grant

As a deaf student majoring in psychology, Joshua Mora looks for ways to enhance his learning in scientific environments that are traditionally comprised of hearing peers and faculty.

In order to fulfill his and other students' needs for diverse methods of information dissemination and a greater understanding of learning styles within the deaf and hard-of-hearing community, a new project has been launched—one that uniquely connects hearing and deaf communities and will result in effective STEM learning for deaf and hard-of-hearing students.

Since this past spring, the National Technical Institute for the Deaf's Faculty Learning Communities program has been developing training and "accessibility toolkits" for faculty in STEM disciplines who are searching for viable ways to adapt their teaching methodologies to accommodate the learning needs of their deaf and hard-of-hearing students. The communities—facilitated by hearing and deaf faculty pairs in similar disciplines—brainstorm alternative learning ideas, propose experiments, and test the efficacy of the alternatives.

Sara Schley, director of NTID's Research Center for Teaching and Learning and principal investigator, said the project, which was funded through a three-year, \$443,200 grant from the National Science Foundation, combines faculty engagement in instructional change, universal design for teaching and learning, and student-centered pedagogy that all ultimately enhance inclusiveness within the classroom. Co-principal investigator on the grant is Stephanie Cawthon from The University of Texas at Austin.

"Faculty members who teach deaf and



**Sara Schley**, principal investigator of the Faculty Learning Communities project, leads a session of faculty and students who are gathered to brainstorm strategies that promote inclusivity for deaf and hard-of-hearing students in STEM disciplines. RIT/NTID student AJ Passarelli, a student research assistant working with faculty mentors, offers suggestions to the group.

hard-of-hearing students may assume that notetaking services and interpreting services, for example, are tools that sufficiently provide an adequate learning environment," Schley said. "While these services certainly assist the students with their learning, we've found that there are many other ways that instructors can adapt their teaching styles to enhance the learning environment for our students. This project is meant to provide

relevant information to our faculty in a supportive way."

## One Scenario

Schley cites one example. Inside the classroom, faculty may explain complicated STEM concepts by showing slides while sign-language interpreters translate the information to a deaf student. However, it's extremely difficult for deaf and hard-of-hearing students to look



**Active Learning:** From left to right: RIT/NTID students Kyle Blakely, Jessica Luu, and Brian Johnson-Pasqua implemented new presentation methods in Assistant Professor Jennifer O’Neil’s class that encouraged student learning and engagement among deaf, hard-of-hearing, and hearing students.

at slides while watching an interpreter. This often results in the student missing valuable dialogue and classroom interaction.

In the scenario mentioned above, added Schley, faculty may experiment with pausing after showing a slide or writing on a white board and checking for “eyeballs” in order to be sure that students have finished reading the information and are ready to shift their focus back to the instructor or the interpreter.

Students like Mora, a fourth-year student from Fremont, Calif., who view this project as an opportunity for them to thrive in RIT’s rigorous educational setting, are serving in mentorship roles—valuable resources for hearing faculty

who are encouraged to seek feedback and perform “dry runs” on potential strategies. Mora also believes the project offers a forum where an exchange of ideas will increase student engagement.

“If a teacher has concerns about how to make curricula accessible, we are available to provide guidance,” he said. “This project has a direct impact on student engagement and motivation in the classroom, and I think it will ultimately encourage more deaf and hard-of-hearing students to enter STEM fields with confidence.”

Schley sees a steady progression in the advancement of the initiative. RIT’s Teaching and Learning Services, a unit of the Innovative Learning Institute, is

developing a “toolkit” website that can be readily accessed by faculty looking to expand their instructional methodologies. And as the project develops over the next few years, Schley said that the learning communities will be asked to investigate applications using more advanced technology such as “flipped” learning. In this case, faculty might add cues for students that encourage them to pause and review a graphic explanation after seeing a captioned explanation.

### Individualized Instruction

Robert Garrick, a manufacturing and mechanical engineering technology professor in RIT’s College of Applied Science and Technology, teaches future



**Jennifer O'Neil**, assistant professor of mechanical engineering technology, participated in the Faculty Learning Communities project this past spring semester. Here, O'Neil implemented a new presentation method in her class that facilitated engagement between her deaf and hard-of-hearing students and hearing students.

engineers using a technology-rich, interactive learning environment with hundreds of instructor and student videos in a classroom with 10 interactive projectors.

“I am especially interested in this project to understand how we, as instructors, can improve accessibility with the emerging multimedia tools we use,” said Garrick. “Our teaching and accessibility techniques are hopefully evolving as quickly as our technology tools in order to provide individualized instruction while giving continuous feedback to each student based on their needs.”

Jennifer O'Neil, assistant professor of mechanical engineering technology, joined the RIT faculty in 2016. While

she has always focused on building course work around different teaching pedagogies that promote improved student learning and engagement, she felt that her participation in this project would sharpen her skills working with a diverse and unique student population—RIT’s deaf and hard-of-hearing students.

“I am continuously striving to improve my teaching effectiveness,” said O'Neil. “Before I was faced with any challenges in the classroom, I decided to join the learning community to learn alternative strategies to improve student engagement and retention, but more importantly to make meaningful changes in the classroom that would enhance the learning experience for all students.”

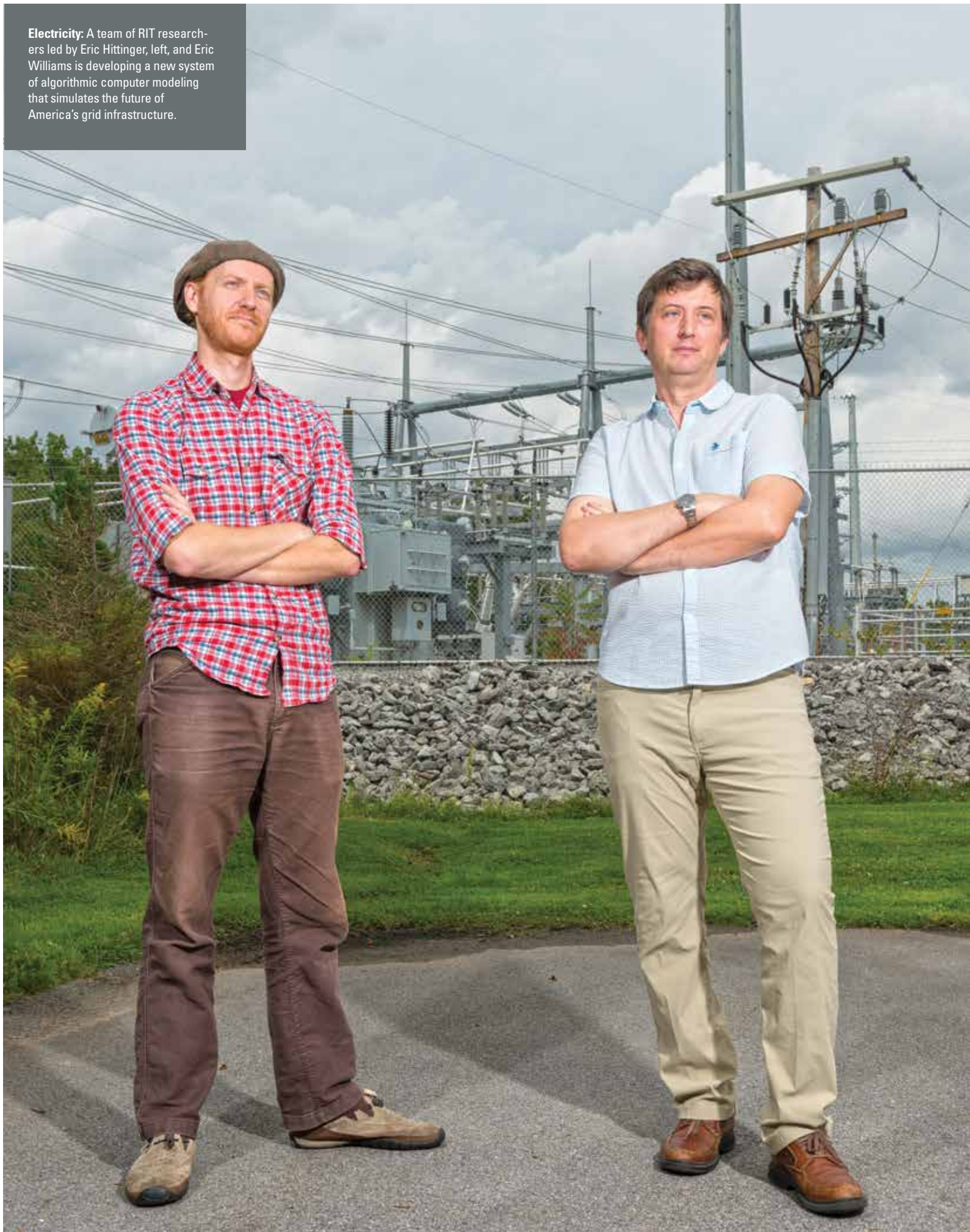
Schley added that, simply put, the project is about the best way to engage in collaborative learning because there are many different kinds of learners in the same classroom.

“We’re helping our faculty to take a little more time to think about meeting the needs of their students and designing activities that don’t depend on a particular channel of information. This is about good teaching.”

#### On the Web

**Access and Inclusion Project**  
<http://bit.ly/NTIDaccessibility>

**Electricity:** A team of RIT researchers led by Eric Hittinger, left, and Eric Williams is developing a new system of algorithmic computer modeling that simulates the future of America's grid infrastructure.



# Optimizing the U.S. Electrical Grid

by Luke Auburn

RIT researchers are developing a system of algorithmic computer modeling that will help policymakers produce and use electricity more efficiently.

## Best Practices

The way the U.S. manages its electrical grid has major economic and environmental consequences for the world. The American economy makes hundreds of billions of dollars in annual revenue by generating electricity, but the electricity system also produces massive amounts of greenhouse gases and other air pollutants.

A cross-disciplinary team of RIT researchers is determined to help federal and state policymakers find the best way to produce and use America's electricity, with the goal of simultaneously reducing costs and making the grid more sustainable.

The team, led by Eric Williams, associate professor in the Golisano Institute for Sustainability, and Eric Hittinger, assistant professor of public policy, is developing a new system of algorithmic computer modeling that simulates the future of America's grid infrastructure.

The project, funded by a \$310,000 grant from the National Science Foundation, started in 2014 and is on pace to be completed next summer. Two graduate students are helping Hittinger and Williams carefully collect and organize data and build the new model: Naga Srujana Goteti, a Ph.D. sustainability student from India; and Raxon Carvalho of India, who is pursuing his master of science in sustainable systems.

## New Technologies

Policymakers are faced with the difficult task of determining how to use subsidies and tax policies to support emerging renewable energy technologies without knowing how future fuel prices, electricity demand, and technology will change. The long-term nature of these decisions adds to their complexity. Infrastructure investments have locked-in effects that can last

for decades and may delay the adoption of new and improved technologies.

"New technologies like wind and solar are quickly getting cheaper, and depending on how cheap they get, they can be an economic part of the U.S. electricity system," said Williams, principal investigator. "We want to help policymakers determine what technologies we should support, how much, and for how long."

Existing models such as the U.S. Department of Energy's National Energy Modeling System (NEMS) use fixed inputs and do not do a good job of accounting for uncertainty, but the RIT researchers are taking a novel approach by building uncertainty directly into their model. "We want to help make decisions that are robust against the whims of politics and changes in the markets," said Hittinger, co-principal investigator.

Most existing models require fixed inputs for variables that are unstable, such as the price of natural gas. Williams notes that "natural gas prices are about a third of what they were 10 years ago due to hydrofracking, and this was a surprise to basically everyone."

The RIT researchers are admitting they do not know what variables such as the price of natural gas will be and instead enter a range of possibilities.

"The model won't produce one answer; those who use it will instead get a range and determine how comfortable they are living within that range of possibilities," said Williams. "The challenge for us as scientists is how to tackle uncertainty in a scientific way while communicating those results to non-scientists who are not used to dealing in numerical uncertainties."

Although the principal investigators are from different fields, their work together has been a natural fit. "We have similar interests and both look at energy,

## Modeling Future Energy Usage



**The Future:** As new technologies like wind and solar get cheaper, the challenge for policy makers is determining what to support, how much, and for how long.

but we have different skills," said Williams. "I look at technological progress and Eric (Hittinger) is an expert on electrical systems." Williams said the two have also bonded over a love of bicycling.

Ultimately the researchers are looking for a pragmatic solution to ensuring the world's environmental health. "We are serious about assessing the economics of the situation and finding solutions that are good for the planet and its people," said Williams.

Once the model is complete, the researchers will host workshops in Washington, D.C., and New York City to present their model to federal and state policymakers.

### On the Web

National Science Foundation Award Abstract  
[bit.ly/ElectricityGrid](http://bit.ly/ElectricityGrid)



**Undergraduate Research:** College students from across the country participated in the Research Experiences for Undergraduates program in Computational Sensing this summer. The 10-week program, funded by the National Science Foundation, involved research in sensory data such as visual-linguistic multimodal image understanding, cognition and narration, comparison of online vs. face-to-face learning, and more.

## Undergraduates Team up with RIT Faculty on Computational Sensing Research

by Jane Sutter

Can sensing technology reveal how readers make sense of narrated experiences in social media? What can sensing tell us about how online vs. face-to-face learning contexts influence students? Can sensory data processed with an algorithm accurately predict how a person rates a video clip? Thanks to a National Science Foundation grant, undergraduate students worked with RIT faculty to gain valuable experience in research projects such as these.

### Valuable Career Preparation

For 10 weeks in the summer of 2017, 10 undergraduates from around the country participated in the Research Experiences for Undergraduates (REU) Site in

Computational Sensing at RIT. Led by faculty members Cecilia Ovesdotter Alm and Reynold Bailey, the students had transformative experiences that included not only doing in-depth research but also

learning skills necessary for careers in research.

REU programs exist all over the United States, with RIT leading among higher education institutions in New York state



**Interdisciplinary:** Associate professors Cecilia Ovesdotter Alm, center, from the College of Liberal Arts, Computational Linguistics and Speech Processing Lab, and Reynold Bailey from the B. Thomas Golisano College of Computing and Information Sciences, Computer Graphics and Applied Perception Lab, worked with students on interdisciplinary research projects.

with a total of eight in 2017. The focus of other REU programs at RIT varies from organic photovoltaic devices to imaging in the physical sciences.

“The intent of these programs is to give undergraduate students experience with the research process early on in their careers,” Bailey said.

That experience helps students shape their career paths and provides a boost when it comes to applying to graduate school. “It opens up so many doors to students when they get involved with research as an undergraduate,” Bailey said. “I’m a perfect example. I went right into a Ph.D. program because I had some undergraduate research experience.”

That opportunity drew participant David Nester, who attends Eastern Mennonite University in Virginia, to apply to the REU. “This program gives good experience with high-level research and academic exposure that you can’t really get anywhere else. It helps me to prepare for grad school and professional environments that you don’t get in regular undergraduate programs.”

But the benefits go well beyond the academic leg-up. “It is exciting that students are contributing to fundamental computational sensing research in projects with numerous benefits for society,” Alm said.

Participant Nse Obot, who attends the University at Buffalo, agreed. “I really like that you get to devote yourself to research.” Obot said that he has found it hard to find time for research while juggling his academic load during the school term.

The undergraduate students teamed up

with RIT faculty and Ph.D. students to conduct research on understanding human behaviors and cognitive processes using sensing technologies in several projects.

### **Different Backgrounds and Perspectives**

Diversity is a hallmark of the REU in Computational Sensing as Alm and Bailey pointed out. The students hailed from a variety of institutions, ranging from Indiana University (about 48,000 students) to Eastern Mennonite University (about 1,200 students). “These are students from diverse backgrounds, which is incredibly important in research,” Alm said. The program attracted students from a wide number of underrepresented groups in computing.

Participant Nikita Haduong, who attends Indiana University, agreed. “I think this program is also really good for finding colleagues, not necessarily in the same field but related to it, so you get a diverse perspective.” Haduong chose this REU program because she’s interested in natural language processing.

The REU program is also interdisciplinary. Alm is on the faculty in the College of Liberal Arts, while Bailey is a faculty member in the B. Thomas Golisano College of Computing and Information Sciences. Faculty mentors and workshop facilitators also reflect the diversity and interdisciplinary nature of the program, Alm noted. The grant of approximately \$360,000 supports three consecutive summers of student cohorts.

There are already success stories from the program’s first year (summer 2016).

Three of the teams have published in peer-reviewed venues and one student (who has since entered a Ph.D. program) presented her research at the Council on Undergraduate Research REU Symposium at the National Science Foundation.

Along with conducting research, REU participants received valuable experiences in other areas such as learning how to write a technical paper and how to conduct a critique of peers’ work. Students gave lightning talks (short presentations) that were reviewed by faculty not only from RIT but also from Malmö University in Sweden via remote video connection. Another event offered insights into graduate school and research across REUs. Students further reached out to the community at a local library where they presented demos of sensing devices to patrons of all ages.

The REU experience culminated with the 26th Annual Undergraduate Research Symposium at RIT, at which RIT students along with students visiting in REU programs had the opportunity to present their research.

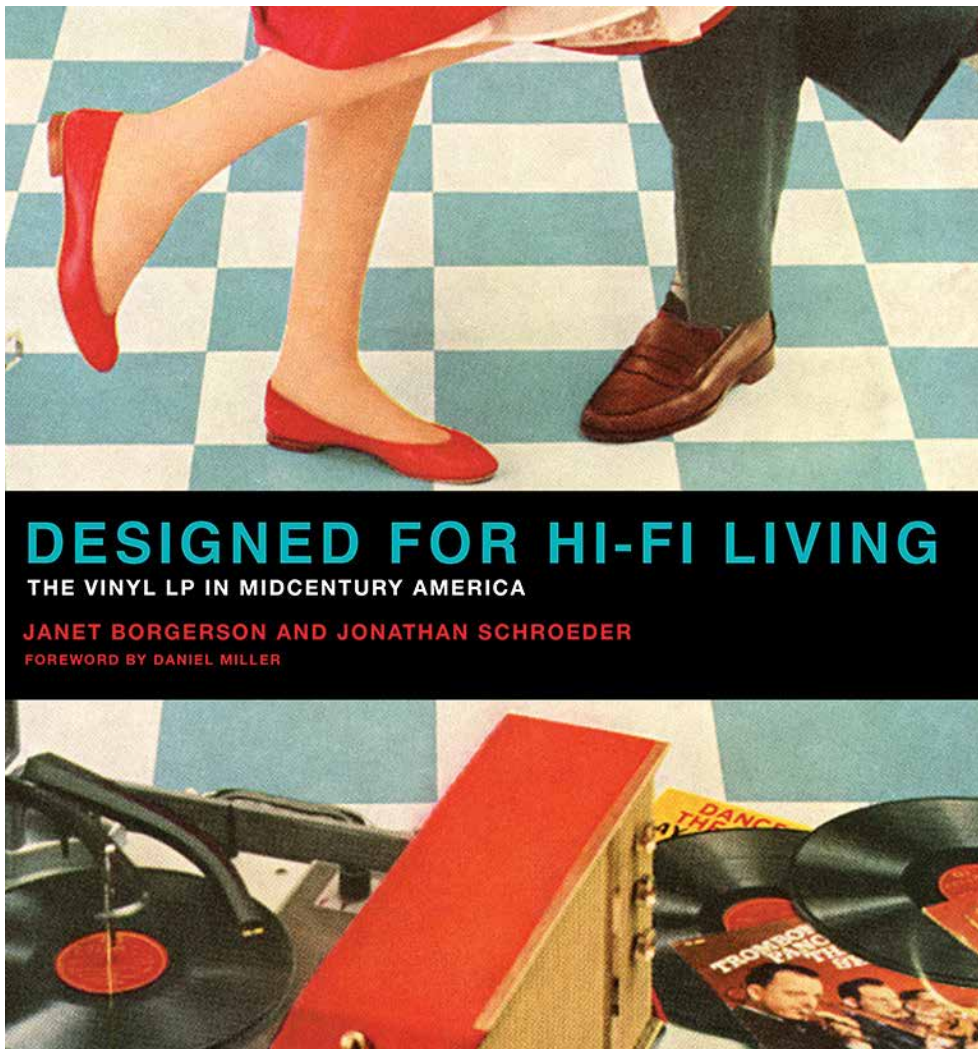
To be accepted to the REU in Computational Sensing, students underwent an application and review process by a selection committee of RIT faculty. Recruitment for summer 2018 is underway.

### **On the Web**

**Research Experiences for Undergraduates in Computational Sensing**  
<https://cs.rit.edu/~reu/>

# Faculty Research Yields Several Books by Greg Livadas

University research doesn't always involve a cleanroom, white coats, or bubbling beakers. In many cases, research is done by digging through dusty documents, interviewing people who have unique stories to tell, or gathering information about historical events. A culmination of such research is putting the findings in a book.



**Designed for Hi-Fi Living:  
The Vinyl LP in Midcentury America,**  
by Janet Borgerson and  
Jonathan Schroeder.

Long before the internet, iCloud, and podcasts, vinyl records were king. Not only did record albums help define a generation or two with their music, but album covers sometimes suggested ways Americans should live, entertain, and travel while giving a glimpse about what U.S. life is like to the rest of the world.

*Designed for Hi-Fi Living: The Vinyl LP in Midcentury America*, by Rochester writer Janet Borgerson and Jonathan Schroeder, RIT's William Kern Professor in Communications, looks at the designs of nearly 150 album covers. It's the culmination of more than 20 years of collecting records and more than two years of research involving graphic design, communication, photography, and history.

"Janet and I have been writing about record albums and album cover design for a while," Schroeder said. After a presentation about the subject at the Consumer Culture Theory Conference in Tucson, colleagues asked for more.

"There are albums that have to do with entertaining, having dinners at home, and having a backyard barbecue, some with liner notes and recipes," he said. "Radio show hosts sometimes talked on the record in an entertaining way telling how to have a dinner party. It's almost like what *Martha Stewart Living* magazine is today."

The albums were sometimes sold at grocery stores and given as house-warming gifts.

He said a number of famous photographers and designers were responsible for album cover designs. Some are even being rereleased "as campy collectibles, as funny, kitschy objects."

Part of Schroeder's research, supported from the William A. Kern Endowment and a book club grant from the College of Liberal Arts, enabled him to travel to the University of Missouri in Kansas City to research a collection of a Capitol Records executive. The company released a series of 400 records from capitals of the world from 1955 to 1970 in an effort to introduce American audiences to foreign music.

It is published by MIT Press.





**Agnès Varda between Film, Photography, and Art**, by Rebecca DeRoo.

Agnès Varda, a prolific film director, photographer, and artist whose career spans more than six decades, is the subject of a book, *Agnès Varda between Film, Photography, and Art*, by Rebecca DeRoo, assistant professor in the Department of Performing Arts and Visual Culture.

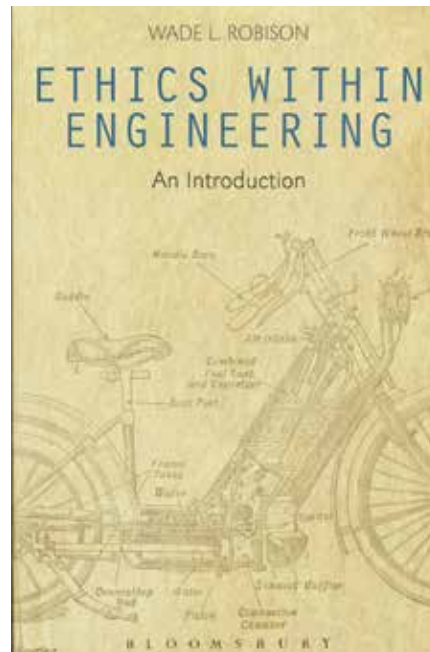
Varda, viewed as the “mother” of the French New Wave movement of the 1950s and ’60s, worked in multiple media, often combining aesthetics and global politics. That formative period in French film continues to be taught in film and visual studies, language, and culture courses, DeRoo said, yet scholars have often struggled to understand how Varda produced groundbreaking film without training in cinema.

“Over the past several years, I’ve benefited from an unprecedented opportunity to work with Varda,” DeRoo said. “I conducted a series of interviews to fill in gaps in the written record, carried out research in her personal archives, and watched her film on location and edit her work in her studio. This research yielded a new history of her work and prompted me to reconsider some of the core narratives of modern cinema.”

In contrast to a traditional director study, the book shows how deeply Varda drew

inspiration from photography and art history and shows how her revolutionary new cinematic aesthetic emerged from an interdisciplinary dialogue among the arts.

The book, published by the University of California Press, was made possible with grants from the College of Liberal Arts and fellowships from the National Endowment for the Humanities, the American Association of University Women, the American Philosophical Society, and the Paul and Francena Miller Research Fellowship.



**Ethics Within Engineering: An Introduction**, by Wade Robison.

Engineering students need to think about the ethical aspects of what they do, because engineering any artifact—whether a bridge, software, or something seemingly as simple as an electrical switch—can unintentionally cause harm.

That’s the inspiration of *Ethics Within Engineering: An Introduction*, written by Wade Robison to help engineering students understand the ramifications of their work.

The book, published by Bloomsbury Publishing, features several case studies in which design has resulted in unexpected consequences, including toaster design, the layout of burners and knobs on a stove, and software responsible for a plane crash.

“I hope the students will come away with a realization they’re engaged in an ethical

enterprise as well as a mechanical one,” said Robison, the Ezra A. Hale Professor in Applied Ethics at RIT. “Engineers think of themselves as being in a purely quantitative discipline—they do numbers. My point is that engineering requires enormous imagination, ingenuity, and artistic ability in order to solve an engineering problem in a way that’s both elegant and safe.”

Robison taught engineering classes for several years at RIT and wanted to make sure undergraduate engineering students realized they were engaging in “an ethical enterprise,” not just solving problems.

“Most engineers automatically eschew the decisions that would lead to harmful consequences,” Robison said. “But whatever choice you make when designing something will cause harm or benefits.”

Robison said he hopes his book will be adopted in engineering classes as supplemental reading.



**Radio and the Politics of Sound in Interwar France 1921-1939**,

by Rebecca Scales.

The period between World War I and World War II may be best remembered for The Great Depression, but it also was an era when the mass media of radio transformed everyday experiences for millions of people.

Rebecca Scales, an associate professor of history at RIT, examined the impact of

radio and broadcast sound on French society in her book, *Radio and the Politics of Sound in Interwar France, 1921-1939*.

Scales first became interested in radio as a graduate student.

“There was significant scholarly literature examining how visual media such as newspapers, film, and photography affected people’s interactions with their world,” she said. “But very little had been written about sound.”

France’s first public radio program was broadcast in 1921 from a transmitter on the Eiffel Tower.

By 1930, France was the only European nation with both state-run and commercial radio stations.

“That created a set of debates about what the new medium of radio should do,” Scales said. “While we often think of radio as a domestic medium consumed primarily by people in their homes, crowds flocked to loudspeakers on city streets to listen to political speeches, and schoolchildren tuned in to radio lessons from their classrooms.”

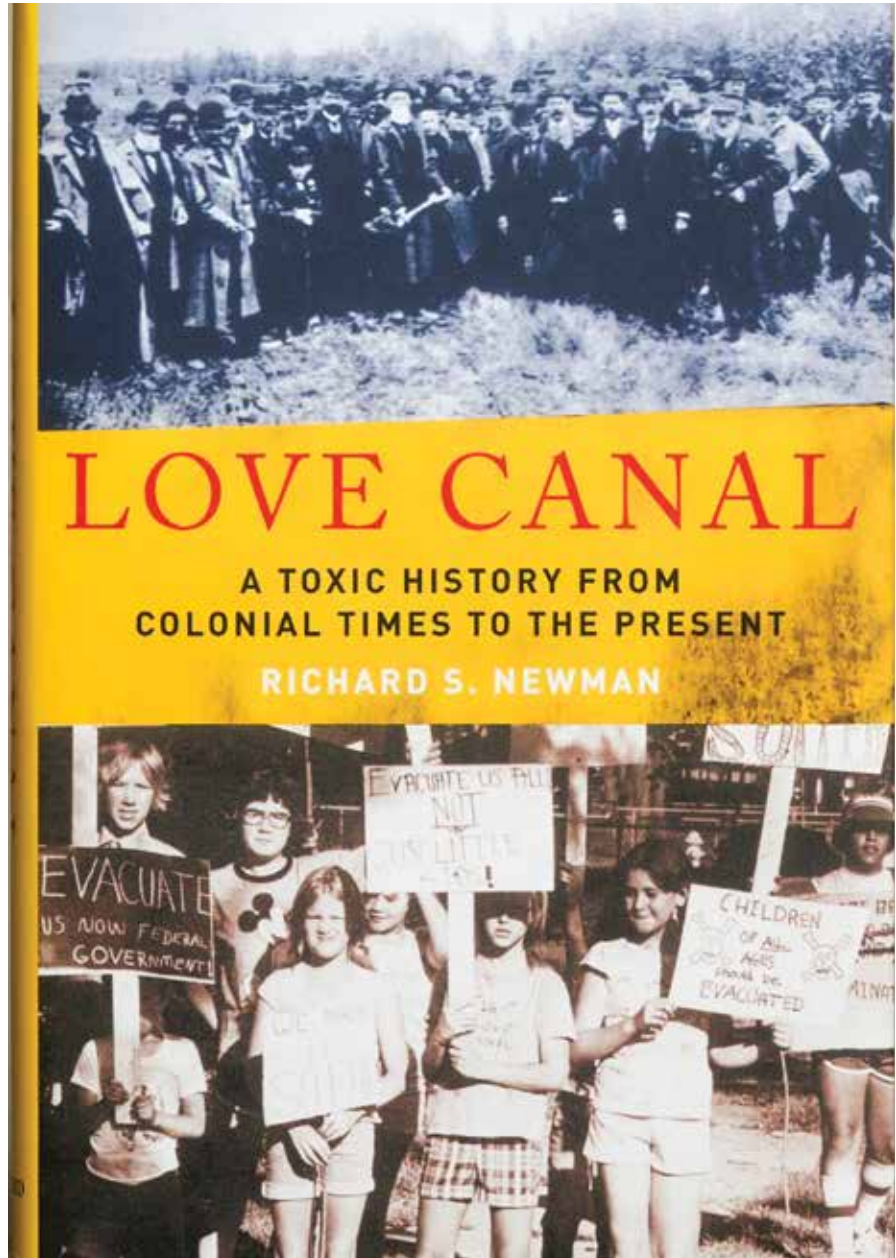
Many at the time believed they were living through a “sound revolution,” she said. “It was hard for them to separate radio from other new sound media, such as the gramophone or the public address system, which were beginning to colonize both public and private spaces.”

Listening to radio soon became the subject of fierce intellectual and political debates.

Scales said readers interested in European history, the mass media, and sound studies will appreciate her book, which was made possible through internal and external grants, including from the French Embassy in the United States, the Social Science Research Council, and the Western Society for French History.

The book was published by Cambridge University Press.

Scales received a sabbatical and grants from the National Endowment for the Humanities and the American Philosophical Society to allow her to spend part of 2018 in France to research another book project, *Polio’s Hidden History: Disability and Epidemic Disease in Twentieth-Century France*.



**Love Canal: A Toxic History from Colonial Times to the Present**, by Richard Newman.

When Richard Newman came to teach environmental history at RIT in 1998, nearly 20 years had passed since 250 homes were bulldozed on a 70-acre parcel in Niagara Falls, N.Y., known as Love Canal, one of the most toxic locations in the country.

Housewives there became activists after hundreds of people developed cancer and other medical ailments before the families were compensated to move away.

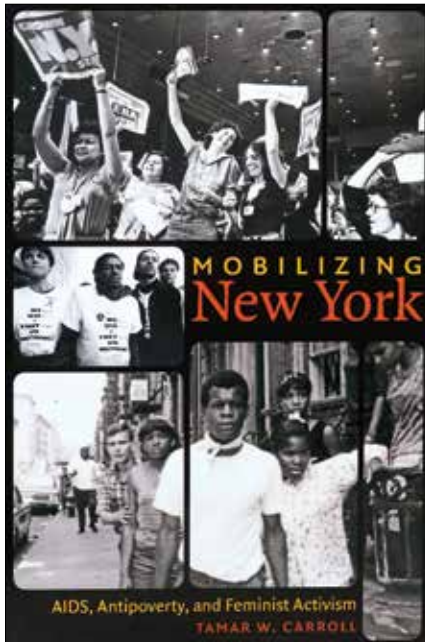
“I always thought Love Canal would be a fascinating case study for students,”

said Newman. So he brought his history classes to visit the area and had activists talk to his students. Newman spent years researching Love Canal and wrote a book, *Love Canal: A Toxic History from Colonial Times to the Present*, published by Oxford University Press. He received funding from the College of Liberal Arts to research Love Canal collections at Tufts University.

In the 1890s, entrepreneur William Love wanted to create a waterfall to produce hydroelectric power and carved

out a piece of land which became Love Canal. After that project was abandoned, Hooker Chemical Co., a leading employer in Niagara Falls, decided the canal would be a perfect place for a chemical dump. Baby boomers eventually built homes at the site, but more than 80 chemicals in the ground—which began to emit foul odors and made rocks smolder—caused medical problems in hundreds of residents.

Resident Lois Gibbs became president of the Love Canal Homeowners Association after two of her children became ill. She was a vocal and effective leader of the activism, which led to President Jimmy Carter designating Love Canal a national emergency and in 1980 the area being designated the first Superfund site.



**Mobilizing New York: AIDS, Antipoverty, and Feminist Activism,**  
by Tamar Carroll.

Attending graduate school, Tamar Carroll visited the Smith College Archives in Northampton, Mass., expecting to research and write about feminist Gloria Steinem. But first, the archivist shared papers about a Brooklyn-based feminist group named the National Congress of Neighborhood Women.

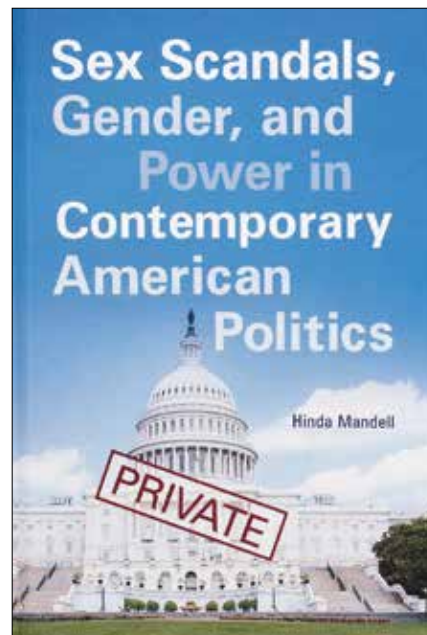
“I found it fascinating,” said Carroll, now an associate professor of history at RIT. “It was all unexpected, all of these

coalitions between groups that were supposed to be at odds with each other. To find white and black women collaborating, to find Catholic women who were supposed to be opposed to feminism was really interesting. I wanted to look at other examples of coalitions between unlikely allies.”

The culmination of Carroll’s research resulted in *Mobilizing New York: AIDS, Antipoverty, and Feminist Activism*, a book that focuses on three grassroots movements that empowered people for social change in New York City.

“I look at the ways they were trying to foster participatory democracy, grassroots activists partnering with professionals to achieve better results,” Carroll said. “These are stories of ordinary people who changed their world, and I hope readers will be inspired by their examples.”

Carroll received a Paul and Francena Miller Research Fellowship from the College of Liberal Arts, giving her a semester off from teaching. She also received funds from the college through the Faculty Development Grant and the Faculty Research Fund Award. Prior to coming to RIT, she received grants from the Lyndon Baines Johnson Foundation, the University of Minnesota, and the University of Michigan. The book is published by the University of North Carolina Press.



## **Sex Scandals, Gender, and Power in Contemporary American Politics,** by Hinda Mandell.

Political scandals—especially involving affairs of the heart—seem to dominate the news when they are discovered.

A book, *Sex Scandals, Gender, and Power in Contemporary American Politics*, examines how the scandals ruin reputations and the ability for politicians to do their jobs effectively, how they contribute to the mistrust of government, and how they are linked with power and morality.

“I’ve always been very interested in both the private and political dynamics with political wives whose husbands have had sex scandals,” said author Hinda Mandell, an associate professor in the School of Communication in the College of Liberal Arts. “I’m interested in how media covers these events. They take up so much news coverage. I view people as consuming these events.”

Former New York Gov. Eliot Spitzer, former South Carolina Gov. Mark Sanford, and former New York Congressman Anthony Weiner are among the men whose scandals are mentioned in the book, which was made possible with College of Liberal Arts Faculty Research Fund Grants and a Paul and Francena Miller Research Fellowship, which provided a semester away from teaching.

The book, published by Praeger, also attempts to make sense of the gender imbalance in the occurrence of political sex scandals—and why there never has been a major sex scandal with a female politician—and what that says about power in government and social expectations more broadly.

Mandell’s research included analysis of news articles, interviews with everyday people to see how they reacted to specific scandals, and interviews with two dozen members of the New York State Assembly, which has seen several sex scandals in recent years.

### **Other Books**

Find more at the RIT Press  
[www.rit.edu/press](http://www.rit.edu/press)

# Research Awards and Honors

RIT values the research contributions of its faculty, staff, and students. Below are some members of the RIT community who have received recent international, national, and university recognition.



**Mishkat Bhattacharya**

Research underway at RIT advances a new kind of sensing technology that captures data with better precision than currently possible and promises cheaper, smaller, and lighter sensor designs.

Mishkat Bhattacharya, a theoretical physicist at RIT, is investigating new precision quantum sensing solutions for the U.S. Department of the Navy's Office of Naval Research. The three-year study is supported by a \$550,000 grant and is a continuation of a previous award. Bhattacharya will test interactions between light and matter at the nanoscale and analyze measurements of weak electromagnetic fields and gravitational forces.



**Parsian Mohseni**

Researchers at RIT are expanding solar cell technology using nanowires to capture more of the sun's energy and transform it into usable electricity.

Comparable to ultra-thin blades of grass, nanowires added to today's conventional materials are capable of capturing more light and can be cost-effective solutions for adopting solar energy into the broader consumer market.

One of the larger global challenges today is meeting energy demands, and alternative energy solutions such as solar power are being sought. Using nanowires for solar cells has been an active field for nearly 10 years. Until now, few researchers have conclusively demonstrated how different

materials beyond silicon and nanowire arrays can be used to achieve increased solar energy.

An RIT research team is exploring an unconventional process to improve solar power conversion efficiencies to convert sunlight into useful electrical energy. Their work focuses on maximizing how much of the solar spectrum can be taken in using tandem junction solar cells based on III-V compounds—metallic and non-metallic elements on the Periodic Table to supplement silicon, said Parsian Mohseni, assistant professor of microsystems engineering in RIT's Kate Gleason College of Engineering and lead researcher.



**Scott Franklin**

RIT has been awarded \$1 million from a private philanthropy to increase diversity and inclusivity among undergraduate science majors and develop a strategy for supporting their success.

The Howard Hughes Medical Institute's Inclusive Excellence Initiative is a five-year science education grant to develop future scientists reflecting the nation's diversity. RIT is one of 24 institutions selected to develop strategies for expanding access to science education to all students.

These initiatives will serve as national models for other institutions.

RIT will use the award to increase infrastructure, resources, and expertise to involve and retain deaf/hard-of-hearing, female, African-American, Latino/a-American and Native American students in RIT's schools of Physics and Astronomy, Life Sciences and Chemistry, and Materials Science in the College

of Science.

"Over the five-year project, we seek to engage 70 percent of all faculty, including new hires and a majority of students in project activities," said Scott Franklin, director of the Inclusive Excellence program at RIT and the Center for Advancing STEM Teaching, Learning and Evaluation. "Our goal is to increase representation and inclusivity in the College of Science, strengthening the community and improving the retention of all students."



**Blanca Lapizco-Encinas**

Blanca Lapizco-Encinas was awarded \$299,611 from the National Science Foundation for "Development of dielectrophoresis chromatography employing asymmetric insulating structures and electric fields."

The associate professor of biomedical engineering will develop a process to separate biological cells and biomolecules through chromatographic theory to characterize dielectrophoretic separation. This is a continuation of work by Lapizco-Encinas in the area of microfluidics and lab-on-chip medical devices—highly sophisticated laboratories on microchips.

Current work focuses on how the characteristics of particles affect the "particle retention" in the team's insulator-based dielectrophoresis systems.

Lapizco-Encinas leads the Microscale BioSeparations Laboratory in RIT's Kate Gleason College of Engineering, developing techniques in microfluidics to separate cells so that scientists and clinicians can better analyze diseases.