60
The Garage is currently home to more than 60 student-founded startups, most of which are actively seeking product-market fit.

488
The Innovation and New Ventures Office (INVO) played an instrumental role in The Garage. INVO also helped file 488 patents in 2016.

Photo by Rob Calvey
A team of undergraduate researchers discusses their Design for America (DFA) project inside The Garage, Northwestern's 11,000-square-foot space dedicated to innovation and entrepreneurship. Founded in 2008 by Elizabeth Gerber, DFA is a network of student-led studios creating local and social impact through interdisciplinary teams. With support from the McCormick School of Engineering, DFA has expanded from a three-member Northwestern student group to a multi-university collaborative network housing thousands of members who perform innovative community service projects in fields like health, education, economics, and the environment. Along the way, student teams gain firsthand experience applying the engineering and design skills learned in the classroom toward crafting a tangible solution to a problem.

Gerber believes DFA’s structure allows students to experience and overcome failure throughout their development process, which provides them with the resilience to tackle large-scale problems. “If you know how to search, how to problem-solve and how to relate, you’re going to be successful in this world,” she says.
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Contents

06 Editorial Note

07 Research News
Recent findings by Northwestern faculty

12 Nobel Prize
For Molecular Machines

14 Life Under the Spotlight
Performance studies finds meaning on stage

22 Instant Impact
How concussions hit kids

25 Brain Strain
Environmental forces shape cognition

26 Concrete Solutions
Nanotech innovation for better buildings

28 Centerpiece
News from our University Research Centers

32 Science Behind Art
Northwestern’s eye-opening collaboration with Chicago’s Art Institute

34 Faculty Profile
Seema Khan, Vania Apkarian on creative discovery

38 Ask an Expert
Do libraries matter in the age of Google?

41 Toxic Social Disparity
Waste and want go together, policy experts find

42 Building Better Teams with Data Science
Bioinformatics are changing healthcare delivery

46 Function of Fun
Faculty recall the purpose of play

48 Play on Words
Link between language and cognition drives research

52 Hitting Reset on Education
Video games and a rethink of classroom learning

54 Books
Economist Robert Gordon on America’s growth challenges

On the cover: Ramón Rivera-Servera, performance studies department chair, on stage in one of Northwestern’s theater spaces. His research includes exploring the dynamics of race, gender, and sexuality in the context of immigration. Read more on page 14.
Performance studies at Northwestern is a dynamic exploration of meaning — how it is constructed, how our actions embody our intentions, and how we shape and communicate identity both for individuals and groups. The project is intrinsically interdisciplinary, harnessing expertise from literature, cultural studies, technology, as well as performance theory.

Through performance practice, Northwestern scholars and students ask questions and discover answers. “Here, performance is both communicating your research question to a community but also demonstrating how performance itself as an embodied practice is a conduit for understanding and beginning to answer that question,” says Ramón Rivera-Servera, chair of Northwestern’s thriving performance studies program, in our cover feature.

Elsewhere in this edition of Northwestern Research Magazine, faculty share insights about play from various, sometimes unexpected, angles. These include considerations of how play contributes to children’s intellectual and social development (p. 48).

“We know that play is not just play; it represents early cognition, early communication, and early social relationships,” says Sarah Bauer, a developmental and behavioral pediatrician at the Ann & Robert H. Lurie Children’s Hospital of Chicago and the Center for Audiology, Language, and Learning. “These are the foundations for learning because they are the basis for language.”

When play gets too rough — resulting in sports-related concussions, for instance — Northwestern experts are finding new ways to prevent, diagnose, and treat the injuries (p. 22). Similarly, our faculty are exploring how to build the best healthcare team, composed of experts who “play well” together (p. 42). Our engineering faculty, meanwhile, are pursuing innovations in how materials and design can create buildings with the right amount of mechanical “play” to resist harsh environmental stresses (p. 26). Our University Research Centers — interdisciplinary hubs for discovery — are highlighted, too, (p. 28), including recent scholarship from Northwestern’s Institute for Policy Research that points out the importance of early childhood education (p. 29).

It’s not difficult to see the links between play and innovation, including novel approaches to solving challenges that matter for society. While Northwestern thought leaders possess deep disciplinary knowledge, they also understand that some of the most exciting discoveries occur at the boundaries between those disciplines. It is there that exploration can assume a particularly bold form; one that combines diverse kinds of thinking to generate pathbreaking results with enduring impact.

**EDITOR’S NOTE:** Play and Performance as Ways of Discovery

Performance studies at Northwestern is a dynamic exploration of meaning — how it is constructed, how our actions embody our intentions, and how we shape and communicate identity both for individuals and groups. The project is intrinsically interdisciplinary, harnessing expertise from literature, cultural studies, technology, as well as performance theory.

Through performance practice, Northwestern scholars and students ask questions and discover answers.

Didier Morelli performs his project White Men Making White Smoke: More or Less at the 2014 7a*11d International Performance Festival in Toronto. Morelli, a doctoral student in Performance Studies at Northwestern, takes an interdisciplinary approach to exploring conceptual art, spatial theory, and teaching within the arts.

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RESEARCH NEWS

PINPOINTING THE ORIGINS OF PROSTATE CANCER

Northwestern scientists have discovered a protein that acts as a marker for a population of cells with both regenerative and cancer-initiating potential in the prostate. “We identified the cell of origin for prostate cancer, which is very important in determining if it is an aggressive cancer or not — and maybe even the treatment response,” says Sarki Abdulkadir, the John T. Grayhack, MD, Professor of Urological Research. The scientists used lineage-tracing techniques (above) in mouse models to show how this protein, Bmi1, identifies a population of cells, which are resistant to castration that mimics hormonal therapy used in patients with prostate cancer. Next, Abdulkadir’s lab will study recurrent prostate cancer and conduct research to identify the same cells in human prostate cancer.

$3 Billion

Just two and a half years since Northwestern publicly launched its largest fundraising campaign ever, the University has raised more than $3 billion toward its $3.75 billion goal for “We Will. The Campaign for Northwestern.” The Campaign holds the promise of further, ambitious undertakings such as the expansion of a competitive, multidisciplinary computer science program; the construction of the Simpson Querrey Biomedical Research Center on the Chicago campus; and the fulfilment of the University’s new no-loan commitment, announced in March 2016.

IMPACT OF EARLY LEARNING

In a decade-long project that tracked the education outcomes of more than 1 million Florida children, David Figlio, Institute for Policy Research (IPR) director, has revealed what’s at stake for children who are not in preschool or else are enrolled in poor quality ones. Children who start behind in kindergarten stay behind — whether they come from well-off or poor families.

“If you aren’t reading at grade level in third grade, you’re unlikely to catch up,” says Figlio, an education economist.

Early education is an issue on lawmakers’ minds: Paul Ryan’s new antipoverty plan emphasizes ways to strengthen early childhood development.

Figlio’s remarks were part of “Ready for School, Ready for Life,” a forum in Washington, DC, where four IPR experts addressed key issues of early education, including cost effectiveness and quality.
FUSE STUDIOS DEBUT IN FIVE CPS SCHOOLS

Northwestern’s rapidly expanding FUSE program, an initiative that enables children to explore hands-on challenges in technology and design, is now offered at five Chicago Public Schools.

The new offering marks several firsts for FUSE, including yearlong programming for high schoolers and promotion within schools predominantly attended by low-income students. FUSE was developed by researchers and educators at Northwestern’s School of Education and Social Policy (SESP).

Originally designed as an informal, after-school program, FUSE is adapting to meet the needs of schools with fewer resources and less flexibility. Inside a FUSE Studio, middle- and high-school students experiment with science, technology, engineering, arts/design, and mathematics while developing important 21st century skills, such as creative problem solving and collaboration.

“We’re excited about making FUSE an in-school program and bringing it to under-resourced schools that don’t have a lot of options,” says Henry Mann, director of education and partnerships and a research analyst at SESP.

NU-Q PROFESSORS AWARDED UREP GRANTS

Two Northwestern University in Qatar (NU-Q) professors are launching a pair of research projects thanks to funding from the Qatar National Research Fund.

Hasan Mahmud, sociology, and Anto Mohsin, science and technology studies, received Undergraduate Research Experience Program (UREP) grants to study Qatar’s foreign aid to developing countries, as well as the nation’s culture of scientific inquiry.

The UREP grants foster and develop a culture of research as a method of enhancing undergraduate education.

“These grants reflect the creative work of our faculty and play an integral role in NU-Q’s development as a hub of research excellence and innovation in Education City,” says NU-Q Dean and CEO Everette E. Dennis. “NU-Q values and encourages scholarly activity and innovation, which allows our students to participate in undergraduate research that engages their intellectual curiosity.”

In the past 19 cycles of UREP funding, NU-Q has been awarded nine grants, which have offered students and faculty the opportunity to immerse themselves in innovative pedagogical methods.

200

When completed in 2018, the Simpson Querrey Biomedical Research Center — a 14-story science hub in Chicago — will allow for the recruitment of approximately 200 new tenure-track faculty.
BIOMATERIAL MAY BUILD BETTER BONES WITH 3–D PRINTING

A Northwestern research team has developed a 3–D printable ink that produces a synthetic bone implant, which rapidly induces bone regeneration and growth. This hyperelastic “bone” material, the shape of which can be easily customized, one day could be especially useful for the treatment of bone defects in children.

Bone implantation surgery is never easy, but it is especially painful and complicated for children. With adults and children, bone often is harvested from elsewhere in the body to replace the missing bone. This can lead to complications and pain. Metallic implants are sometimes used, but this is not a permanent fix for growing children.

“Adults have more options when it comes to implants,” says Ramille Shah, materials science and engineering and surgery: organ transplantation. “Pediatric patients do not. If you give them a permanent implant, you have to do more surgeries as they grow. They might face years of difficulty.”

Shah and her team aim to change the nature of bone implants, and they particularly want to help pediatric patients.

UNETHICAL AMNESIA?

Odds are that you can remember a friend or co-worker’s bad behavior much more clearly than you can recall your own misdeeds. New research from Maryam Kouchaki, management and organizations, may explain why.

None of us likes thinking poorly about ourselves, so as a defense mechanism we tend to have murky memories of when we acted poorly. This faulty recollection, the research shows, can lead to unethical behavior in the future, since we don’t have our own experiences at hand to act as a deterrent. Kouchaki calls the phenomenon “unethical amnesia.”

$649.7 million

Northwestern’s sponsored research awards grew to $649.7 million last fiscal year, the largest amount in the University’s history and a 5 percent increase over last year’s record-breaking $621 million. The 2015–16 fiscal year marks the seventh consecutive year that annual research grants and contracts exceeded a half-billion dollars. The increased volume of research funding in 2016 was largely attributable to a 9 percent increase at the Feinberg School of Medicine.
RESEARCH NEWS

“Drugs currently available for treating depression help most patients, but they stop working for some patients and don’t work from the get-go for others.”

— Dane Chetkovich, neurology and physiology, on a study he led that identified a new antidepressant drug target

PATRICK, WARTELLA TURN TO TECHNOLOGY FOR ‘THE TALK’

Northwestern studies show that, despite access to unprecedented amounts of information about puberty, reproduction, and menstruation, children and adolescents are no more informed today than they were in the 1980s and 1990s. It’s a problem that researchers think can be remedied through entertainment.

The Center on Media and Human Development (CMDH), directed by Ellen Wartella, chair of communication studies and the Sheikh Hamad bin Khalifa Al-Thani Professor of Communication, has been conducting formative research on educational video shorts to teach preadolescents about human reproduction. The videos, using songs and fun characters to explain biological processes, have been developed in collaboration with animator and producer Eric Patrick, radio/television/film and the former animator of Nickelodeon’s Blues Clues.

“By teaching kids the actual names of these processes, it’s very empowering,” Patrick says.

The CMDH continues to conduct formative research in support of the videos through focus groups with children aged 7 to 12. Preliminary findings demonstrate that children are very receptive to viewing the videos, despite the medium addressing what historically has been perceived as an uncomfortable topic. Many parents who embrace modern technology and evolving childrearing styles are still reluctant about introducing such topics with their children, Patrick says. These videos take the sting out of “the talk.”

WHY WE FALL PREY TO MISINFORMATION

Even when people know better, their brains often rely on inaccurate or misleading information to make decisions. But why are so many so easily influenced by false statements such as “vaccinations cause autism” or “30 million illegal immigrants live in the US?”

In a new published review, Northwestern psychologist David Rapp explains that people quickly integrate the inaccurate statements into memory because doing so is easier than critically evaluating and analyzing those details.

Later, the brain retrieves the incorrect information first because that process requires less work to recall the recently presented material, says Rapp, the Charles Deering McCormick Professor of Teaching Excellence at the School of Education and Social Policy and a professor of psychology. “If it’s available, people tend to think they can rely on it. But just because you can remember what someone said, doesn’t make it true.”

It’s even harder to avoid relying on misinformation when accurate and inaccurate information is mixed together, he adds.
RESEARCH NEWS

RESHAPING VIRUSES FOR DRUG DELIVERY

Viruses are masters of delivery. When humans become infected, viruses integrate with cells to insert their own genetic material inside. So as researchers look for new ways to deliver precision drugs, using viruses seems like an obvious choice.

“There is a lot of work to develop viral vectors into drug delivery agents,” says Danielle Tullman-Ercek, chemical and biological engineering. “What we don’t know is how the virus’ properties, like shape and size, affect this delivery process.”

Tullman-Ercek has created a new method to help researchers discover how much the virus’ size matters. By mutating a single amino acid in a bacterial virus, Tullman-Ercek’s team drastically changed the size of its protein coating, or capsid.

“To date, there has not really been a way to compare what happens with different sizes and shapes of the same virus,” says Tullman-Ercek. “Size matters for a lot of drug delivery purposes because it changes which cells are accessible and how much information can be housed inside the virus.”

PRIMED FOR A RISKY DECISION?

Are you in the right emotional state to make a risky decision? Check your instant messages to find out.

That’s the lesson from research by Brian Uzzi, the Richard L. Thomas Professor of Leadership and Organizational Change, which analyzed millions of instant messages from professional traders to see if people’s electronic communications could offer clues about their emotional state. He found that the best trading decisions, and highest profits, happened when traders showed a moderate level of emotion in their instant messages.

Beyond simply improving trades, this finding could help anyone tasked with making risk-related decisions, from air traffic controllers to humanitarian aid groups.

WHY WHITE COLLAR INCOME INEQUALITY IS GROWING

Economic explanations for the growing wage gap have traditionally blamed either tax policy or the supply and demand for labor. But new research from Thomas Hubbard, the Elinor and H. Wendell Hobbs Professor of Management, suggests there is a third culprit, at least among white-collar workers: organizational efficiencies.

The research examined law firms, where a clear hierarchy exists between partners and associates. It found that technology, such as the legal search engine Lexis, allows partners to delegate routine parts of their jobs to associates. Previously, partners held so much knowledge in their heads that delegating was difficult. The ability to delegate frees partners up to see more clients, thus billing and earning more.
Nobel for Molecular Machines

SIR FRASER STODDART — CHEMISTRY

On October 5, 2016, Sir Fraser Stoddart, Board of Trustees Professor of Chemistry, was awarded the Nobel Prize in Chemistry. He shares the Prize with two longstanding collaborators for his seminal work on “molecular machines” — molecules that are 1,000 times thinner than a human hair and equipped with motors that allow them to move and perform tasks.

Illustration by Julie Cowan
“I share this recognition with my students, postdoctoral fellows, and colleagues. Northwestern is a special place, where everyone does science in a collaborative way. It happens seamlessly here.”
— Sir Fraser Stoddart, Board of Trustees Professor of Chemistry

“It is well known that we hunt in packs at Northwestern. If you don’t have the expertise, you can find it, and people step forward without being asked.” — Sir Fraser Stoddart

“I am sure I speak for all my colleagues in chemistry and across Weinberg College in congratulating Fraser on this great honor. His pioneering work inspires us all.” — Adrian Randolph, Dean of the Weinberg College of Arts and Sciences

“Fraser leads by example with regards to his unwavering integrity and passion for his work. Fraser has been unwavering in his advice and support, and he was a huge part of attracting me to Northwestern.” — William Dichtel, one of Stoddart’s mentees and the Robert L. Letsinger Professor of Chemistry

“This is a tremendous honor for Professor Stoddart and Northwestern University. Fraser is a pioneer in the fields of chemistry and integrated nanosystems and a member of an outstanding chemistry department. The University is proud of his many accomplishments.” — Morton Schapiro Northwestern President
Northwestern’s graduate performance studies program combines research rigor with expressive excellence to reveal dramatic new insights into society, literature, and culture.

To most, theater is a room. There are seats for the audience and a stage for the actors. There are sets and lights. A stage manager to handle logistics. A director to oversee it all.

And when opening night arrives, the lights go down, the curtain comes up, and the performers enact a tale meant to entertain and maybe even inform.

But, as some guy named Bill once said, the play’s the thing.

More broadly, it’s about the material behind that script or composition, as well as the process enabling it. That process can include journeys into underserved communities and into the very idea of performance itself: how actors see and hear, perceive and interpret, produce meaning and insight.

This dramatic excursion is the purpose of performance studies, says Ramón Rivera-Servera, chair of that department at Northwestern and director of graduate studies for the School of Communication.
Life Under the Spotlight

Ramón Rivera-Servera

Photo by Eileen Molony
“It develops and encompasses practices like theater and concert dance and other such activities,” says Rivera-Servera, “but it expands the framework for understanding all kinds of embodied communicative practices.”

The pursuit goes even deeper at Northwestern. Here, performance is used as a vehicle for scholarly work and research to study the humanities, especially in terms of philosophy, culture, and society. Even the law is subject to analysis as performance, an approach taken by assistant professor Joshua Chambers-Letson in his book A Race So Different: Performance and Law in Asian America, winner of the Outstanding Book Award from the Association for Theatre in Higher Education. The research aspect involves using “ethnographic methodologies to understand a phenomenon in a particular context,” says Rivera-Servera, whose award-winning ethnographic work addresses the role of movement, gesture, and dance as communication.

Using these methods, and working across disciplines with other Northwestern departments and programs, students and faculty examine race, gender, sexuality, and identity. “In performance studies, we’re interested in how those categories are sustained in practices of communication that involve creative engagement with embodiment and self-presentation,” says Rivera-Servera.
Such scholarship has led the department to research that provides key insights and new perspectives on many topics, including:

- **Kamran Afary’s** 2007 exploration of performance in activism during the 1992 Los Angeles riots
- **Mark West’s** 2009 look into the intersection of law and performance in advocating for the rights of Dalit (untouchable) castes in rural South Asia
- **Victoria Fortuna’s** 2013 examination of the role of dance in confronting state violence in Buenos Aires

Performance also influences research, says **E. Patrick Johnson**, the Carlos Montezuma Professor of African American Studies and Performance Studies, chair of African American studies, and founder of the Black Arts Initiative. Performance offers researchers the chance to reach a larger audience — one outside academia — and to share their findings with a less informed public.

Johnson’s 2008 book *Sweet Tea: Black Gay Men of the South* documents the oral histories of more than 70 men. While writing the book, Johnson found the written word — from word-count restrictions to editorial predilections — somewhat limiting. “In the South, there’s a lot of colorful, musical language,” he says. “You lose some of that on the page.”

A year after the book’s publication, Johnson — a renowned performance artist — developed *Sweet Tea* into a one-man show, embodying more than a dozen of his subjects. “What performance does is enliven the musicality of the narrators’ speech, as well as their vocal tics,” says Johnson. “It creates a different kind of register.”

**Collaboration and Cocreation**

Students entering the department’s graduate program examine both research and performance from the moment they enter the newly refurbished Annie May Swift Hall along the Evanston lakefront. In fact, doctoral students spend their first year focusing on those two topics.

In required courses on fieldwork research methods, students learn how to enter a community and establish “a collaborative dialogue,” says Rivera-Servera. Developed in part by the late **Dwight Conquergood**, a renowned ethnographer and Northwestern performance studies professor who died in 2004, this “coperformance witnessing” favors partnering with communities — sometimes to the point
of immersion — to conduct ethnographic research. His approaches were further codified into a methodology by professor D. Soyini Madison, a former student of Conquergood’s, whose Critical Ethnography: Method, Ethics, and Performance has become the best-selling textbook for this approach to research.

“Performance ethnography is an immersive process,” says Shayna Silverstein, performance studies. “Engaging with embodied practices is like learning a language, and the way one learns the nuances and subtleties of a new language is by going to the place where it’s spoken.”

Silverstein’s most recent research explores the politics and aesthetics of sound and movement in the contemporary Middle East, focusing on Syrian popular culture. To conduct this work, Silverstein traveled to Syria in 2004, living there for extended periods while she integrated herself into local music and dance scenes and built relationships with interlocutors — “a formal term for all the many, many relationships one establishes in the field,” she explains. These include colleagues, collaborators, and acquaintances.
This pattern continued until relations between the United States and Syria soured and Silverstein was denied reentry into the country. She says that the outbreak of civil war in 2011 “made it impossible to continue to do fieldwork in situ in Syria.”

Through Skype, social media, and other methods, Silverstein maintained relationships with her Syrian colleagues and collaborators. Her fieldwork, both in and out of Syria, has led to several published papers and the forthcoming book, *Performing Dabke: Popular Culture and Identity in Contemporary Syria.*

Archival research also plays a substantial role in information gathering, providing the context and broader scope needed to inform the researcher’s understanding. For third-year doctoral student Didier Morelli, this kind of research has become pivotal to his dissertation on the intersection of performance art and architecture in Los Angeles and New York between 1970 and 1985. During that period, says Morrelli, performance artists left the relative comfort and safety of galleries and studio spaces for public structures to produce “acts of kinesthetic protest.”

“When I came into the program, I was interested in more abstract theoretical and art-historical understandings of these protests,” says Morelli. With the guidance of his adviser and peers, he has delved into archival records and other documentation.

“I am now looking at urban histories, political economies, and the ways in which cities were developing at the time, including the basic economics of urban infrastructure and how these have shaped artistic practices,” says Morelli. “The project is always evolving and moving towards new narratives.”

**Finding ‘Elusive’ Meaning**

Along with teaching students how to conduct research, the program enables first-year graduate students to engage deeply with performance, from its history and development to its theory and composition. Performance is not merely about telling a tale; it involves harnessing all the supporting parts and presenting the powerful whole to an audience.

“That’s a lot harder than you might think,” says Mary Zimmerman, the Jaharis Family Foundation Chair in Performance Studies and an artistic associate at Chicago’s Goodman Theatre. “You must look at a work of art and all the signs and symbols in it, both literally and figuratively, and say what you saw.”

The academic approach allows students to dissect performances, from studying various genres and methods to evaluating each other in a classroom setting. That kind of intense, peer-based analysis teaches students how to think about performance as moments, gestures, elements, and dialogue, with each part building and informing the others.

Through that process, students uncover perhaps the most elusive result in creative work: meaning. “How is meaning being produced in this performance? How would it have been different if the creators had done this or that differently? What different meaning is produced by the relationship between all the elements of the performance?” asks Zimmerman. “That, to me, is endlessly fascinating.”

This work folds into Zimmerman’s own high-profile theatrical pursuits. An acclaimed adaptor and director, she won a Tony Award for her *Metamorphoses* as well as a MacArthur “Genius Grant.” A number of Zimmerman’s stage works are, in fact, adaptations of literary works, situated “exactly at that intersection of literature and performance” that Zimmerman says she prefers.

When working on an adaptation, she uses a hybrid process — writing out scenes the night before, then rehearsing with actors, letting their performances inspire her. The approach developed during her days as a graduate student in Northwestern’s performance studies department, working with faculty members such as the late Jungian psychoanalyst Leland Roloff, two-time Tony Award winner and professor emeritus Frank Galati, and three-time Jeff Award winner and associate professor Paul Edwards. Roloff, who taught Performance Art — a class Zimmerman now teaches — challenged students to use image and symbolism to interpret literature.

“He had us stage things like a myth in one image using only light,” she recalls.

Meanwhile, Galati and Edwards focused on faithful adaptation, keeping performances as close to the source material as possible. “In a lot of my work, the narrative voice is present, but there’s also this theatrical element...
that’s purely visual,” she says. “None of them did exactly what I do, but the array of them led me to what I do.”

**Embodying 'Complex, Contradictory Voices'**

Once mandatory requirements are completed, first-year graduate students develop a capstone project: a 20-minute solo show that melds the research methodologies they’ve learned with their performance work to announce their doctoral research question. “Here, performance is both communicating your research question to a community but also demonstrating how performance itself as an embodied practice is a conduit for understanding and beginning to answer that question,” says Rivera-Servera.

For Patricia Nguyen, the recital allowed her to stage some of the fieldwork she had completed in Vietnam on a Fulbright Scholarship. The daughter of Vietnamese refugees, Nguyen worked in theater and human rights prior to entering the graduate program and used her first year to crystallize her research and experiences into what evolved as her dissertation and her performance practice.

Her research question will connect disparate historical periods in Vietnam’s national narrative from the 1950s to 2010s by spotlighting the oral histories of Vietnamese and Vietnamese Americans who have been directly affected by communist state policies of national reunification and development through reeducation camps and forced migration.

“I began to untangle the messiness of fieldwork in a country my father is exiled from and explore how my positionality impacts the kind of access or denial of access to memories and stories I am able to gather from different sides of the war,” says Nguyen, now a fourth-year doctoral student. “The recital allowed me to situate my research question in terms of thinking about the racialized, gendered, and classed dynamics of the politics of return and to understand how to navigate opposing sides of the same war as a researcher whose history is deeply tied to the country of research.”

Once students have developed a research question, they spend the next year answering it, whether through fieldwork or archival research. Consequently, many second-year courses focus on theory, exploring how bodies can process all this incoming data. The coursework provides the skills, contexts, and knowledge students will need to answer their research questions.

Second-year students also dive into pedagogy, examining how the classroom itself is a performance space where they learn to be effective teachers of the materials.
they’re developing for their dissertations as well as of the performance methodologies they employ.

Whether they go into teaching is up to them, says Rivera-Servera. Some Northwestern alumni have gone on to found major theater companies. Others have found their calling as ethnographers. “Performance studies is not just about writing the book or article,” he says.

But many do go on to teach. After graduating from the doctoral program in 1999, Derek Goldman taught for six years at the University of North Carolina at Chapel Hill. In 2005 Goldman joined the faculty at Georgetown University as a professor of theater and performance studies.

Georgetown proved to be a good fit. A mentee of both Conquergood and Galati, Goldman had a deep respect for underrepresented communities and, he says, for “what Wallace Bacon used to call ‘a Sense of the Other.’” With its focus on foreign service and international politics, Georgetown led Goldman to explore global theater.

In 2012 he cofounded Georgetown’s Laboratory for Global Performance and Politics. Housed in the School of Foreign Service, the lab focuses on cultural diplomacy and exchange, using “the power of performance to create empathy or humanize what are often seen as difficult political situations.”

Case in point: slavery. The lab is currently working on a project centering around Georgetown’s institutional relationship to the practice — the Jesuits who originally ran the school sold 272 slaves in 1838 to keep Georgetown from closing — and resultant reverberations since the project was announced in April.

Northwestern helped prepare Goldman for “situations where performance is a method for embodying complex, often contradictory voices,” he says, “not just imparting a message, but a space that can contain tensions, conflicts, subtleties, competing narratives, and histories, and to do so respectfully in the deepest sense of the word.”

The Digital Stage

Today, researchers are exploring how the digital world — social media, streaming technologies, globally expanding wireless capabilities — plays into research and performance. From hacktivists causing mayhem on government servers to viral communications in social media, the digital realm has become a performance platform as real as any stage.

“Issues of embodiment are at play, even though there are no biological bodies on the screen,” says Marcela A. Fuentes, performance studies. “What I see is how people structure stories, how movements work with different temporalities, what keywords do they use, and what campaigns do they create. That’s purely performance.”

Fuentes, who researches the relationship between performance and digital technology in protest art, believes that as digital technology advances, the range and scope of what is considered performance will expand. Currently in Argentina conducting field research on the online and offline activist tactics used by the collective NiUnaMenos (NotOneLess) against gender violence, Fuentes recently taught a class in Buenos Aires where graduate students experimented with using forms of social media in compositional performance processes. This research will be included in her forthcoming book In the Event of Performance: Networks, Bodies, and Political Action in the Americas, expected in 2017.

“I want to think about creative ways of tinkering with technologies for the stage, but also within themselves,” she says, “exploring different ways of collaborating or creating stories that make us more human.” — Glenn Jeffers
Researchers work to reveal short- and long-term effects of concussions in young athletes

In a split second, the 13-year-old figure skater knew something was wrong.

Failing to complete a difficult double axel, she sat on the ice overcome by a headache, nausea, dizziness, and blurred vision, the result of a serious blow to the back of her head.

Five days later, the seventh-grader was still coping with symptoms when she arrived at the office of Cynthia LaBella, a pediatric researcher and the medical director of the Institute for Sports Medicine at the Ann & Robert H. Lurie Children’s Hospital of Chicago.

An estimated 30 to 40 million children participate in organized sports every year, according to the Centers for Disease Control. While the overall sports-injury rate among young kids is lower compared to adolescents and adults, concussion rates tend to be higher and children often take longer to recover because their brains are still developing. Unfortunately, very little research has been done to determine the short- and long-term effects of concussions on this youngest group of athletes.

Although there’s been a groundswell of interest in concussions in collegiate and professional football players, “they represent such a small subset of the at-risk population,” LaBella says. “You can’t extrapolate data from NFL players to 10-year-olds playing soccer.”

LaBella’s larger research focus is on identifying risk factors for injuries in youth sports and investigating strategies to prevent them. Her earlier work demonstrated that a 15-minute, coach-led warm-up with neuromuscular exercises could significantly reduce knee and ankle injuries in female soccer and basketball players at Chicago public high schools.

She’s also investigated the injury risk associated with early sports specialization — playing a single sport year-round. A collaborative study with Neeru Jayanthi from Loyola University showed that specialization was an independent risk factor for overall injuries and for injuries due to overuse.

LaBella’s ongoing concussion investigation seeks to identify age-appropriate clinical evaluation tools and treatment and prevention strategies for young children and teens.
“The goal is to fill in this research gap,” she says. “One question I hear all the time from parents is, what does this concussion mean for my child’s future? Right now we don’t have enough data to predict who may be at risk for long-term difficulties post-concussion.”

As a pediatric sports medicine specialist, LaBella identified an opportunity in the growing number of young patients she was seeing with concussions. For the past two years, every concussion patient seen by Lurie Children’s sports medicine physicians has been invited to participate in a longitudinal study that LaBella plans to extend for years to come. To date, nearly 400 patients have been enrolled, and data is collected every six months about their symptoms, sports participation, emotional wellbeing, academic performance, lifestyle changes, and any subsequent concussions.

Because concussions are currently a clinical diagnosis — based on patient history and a physical examination by a healthcare provider, rather than by a diagnostic test — how doctors assess patients is of great importance.

“In the simplest sense, a concussion represents a type of brain injury that affects how the brain functions,” LaBella says. “But how this manifests is highly individual. No two brains are the same, so no two concussions are the same. And the still-developing brain is much different than the mature brain, so one of the things we need to do is validate a set of age-appropriate testing and treatment measures for younger patients.”

Initial information from people who have suffered a head injury is typically obtained from a symptom checklist filled out by the patient. Physicians then administer tests of cognitive function, visual skills, and balance.

“One of the challenges in designing age-appropriate testing is to be able to diagnose 12-year-olds who aren’t necessarily worried about their health — they just want to get back to playing,” LaBella says. “When a patient who doesn’t report any symptoms fails a balance or visual skills test, we know their brain is still recovering, so we have them continue to rest from contact sports until these test results have returned to baseline.”

**BIOMARKER FOUND**

Groundbreaking research by Labella and Nina Kraus, the Hugh Knowles Professor in the School of Communication, recently identified a biological marker in the auditory system that could take the ambiguity and controversy out of diagnosing concussions and tracking recovery.

By observing research subjects’ brain activity as they were exposed to auditory stimuli, the research team discovered a distinct pattern in the auditory response of children who suffered concussions compared to children who had not.

“This is something patients cannot misreport, you cannot fake it or will your brain to perform better or worse,” says Kraus, who describes the initial findings as a major first step in developing a tool to better diagnose concussions. — Roger Anderson
Susceptibility to certain diseases and developmental problems is shaped in part by environmental exposures that occur in utero. Yet experts still know little about the underlying mechanisms that drive this process.

Laurie Wakschlag, medical social sciences vice chair for scientific and faculty development, is investigating how prenatal exposure to stress or carcinogens can increase a child’s likelihood of experiencing early neurodevelopmental problems or disease later in life. Wakschlag, a clinical and developmental psychologist, and her colleagues at Northwestern’s Innovations in Developmental Sciences collective aim to minimize the effects of adverse exposures and to optimize health and longevity.

“We want to move from calculating correlation to testing causation,” says Wakschlag. “Our ultimate goal is to translate discovery into interventions that can prevent many chronic diseases.”

Wakschlag has also researched the effects of adverse prenatal environments on behavior. Her group found, for example, that a pregnant woman’s smoking increased antisocial behavior in her adolescent offspring with specific genetic variations, which influenced vulnerability to detrimental environmental effects. More recently, she joined forces with developmental methodologists, neuroscientists, and developmental prevention experts from the School of Communication to monitor atypical patterns of infant brain growth and to identify markers of abnormal irritability in infants.

In several studies, Wakschlag and her collaborators have focused on the effects of prenatal exposure to stress. Among their discoveries are stress-induced abnormalities in the part of a child’s brain associated with self-control. Through a partnership with the Stanley Manne Children's Research Institute at the Ann & Robert H. Lurie Children’s Hospital of Chicago, Wakschlag will work with experts from maternal fetal medicine, prevention, and health information and use maternal health-sensing technology to deliver personalized intervention to pregnant mothers experiencing stress. The team will follow infants throughout their first year of life to track the neurodevelopmental effects of the intervention.

“We designed this study using cutting-edge tools from multiple disciplines with the goal of improving the prenatal environment and promoting healthy neurodevelopment even before children are born,” says Wakschlag. “If successful, we will work with clinical and population health experts to translate our findings into scalable applications.” — Monika Wnuk
CONCRETE SOLUTIONS

McCormick School of Engineering explores using nanotechnology to create better building materials

When it comes to building a skyscraper, the main ingredient has remained the same for nearly 50 years: reinforced concrete. A water, cement, and aggregate mixture poured over steel reinforcement bars, the composite material creates a sturdy, robust foundation for structures.

But tell that to an office worker on the 50th floor when the wind is gusting.

“We’re talking buildings that are thousands of feet tall. And when they’re that tall, they actually move a substantial amount,” says David Corr, the Charles Deering McCormick University
Distinguished Clinical Professor of Civil and Environmental Engineering. “It could be up to a foot in high winds. Sometimes a person on a high floor can even become seasick.”

Combating that sway — which can range from the motion sickness–inducing variety to that caused by earthquakes and other environmental hazards — has been the focus of research being conducted by Corr and Gianluca Cusatis, civil and environmental engineering. Both researchers are looking to improve on two key characteristics of building materials: strength and ductility.

Finding the ‘Magic Recipe’
Strength, Cusatis says, refers to the amount of weight a structure can bear. Ductility measures a solid material’s ability to stretch, which helps dissipate the energy of, say, earthquakes. Cusatis is developing an ultra-high-performance concrete that requires less water and material. But while the new mixture is typically three to five times stronger than normal concrete, it lacks ductility, Cusatis says. “These very-high-strength materials tend to be more brittle, like glass.”

The goal now is to add in enough fiber reinforcement — perhaps steel or polyvinyl alcohol, a high-strength plastic — to make the concrete ductile without a loss of strength. “If I add the plastic fibers, I do have quite a bit of increase in ductility, but then the strength might decrease,” he says.

SOLUTIONS

McCormick School of Engineering explores using nanotechnology to create better building materials “It really is about optimization. You want to find that magic recipe so that you can have the best possible properties all together.”

Thinking Small to Build Big
Corr is developing a concrete mixture that includes carbon nanotubes, cylindrical molecules that are incredibly strong. The nanotubes stiffen the concrete mixture, increasing the rigidity of a building’s structural frame at a relatively low cost. “That improvement to concrete will reduce the motion in tall buildings and make the occupants more comfortable,” says Corr.

But first Corr has to scale the development to a level that is applicable for building purposes while also keeping the nanotube molecules from clumping together. “When materials are that small, they tend to stick together,” he says. “You have to separate them before you can use them.”

The nanotubes are dispersed in a solution, which is then mixed with chemicals called superplasticizers to keep the molecules from sticking together again. Ultrasonic mixers are then used to disperse the nanotubes into the concrete mixture. Once this process has been perfected, the technology will move toward commercial application.

“We’re making our case that these materials do what we say they do and that the dispersion technology is within the grasp of an industrial partner,” Corr says. — Glenn Jeffers
Northwestern’s 54 University Research Centers and institutes are home to a range of exciting, transdisciplinary discovery that harnesses the diverse expertise of our scientists and scholars. These advances — a few of which are highlighted here — are transforming entire research domains and producing profound social impact.

This pair of images by Feinberg graduate student Kelly Jarvis depicts a human heart from the front (at left) and back. This special imaging technique — 4-D flow MRI — captures the heart’s blood flow at a single moment. The blood colored red is oxygen rich, flowing to the rest of the body, while the blood colored blue is returning to be re-oxygenated by the lungs. With this image, researchers can measure the flow’s speed and patterns: yellow and orange streaks move faster than dark red, and pale blue moves faster than dark blue. The image earned Jarvis top honors in Science in Society’s annual scientific image contest.
BUFFETT INSTITUTE EXPANDS WITH NEW RESEARCH GROUPS

The Buffett Institute continues to expand its research portfolio thanks to Roberta Buffett Elliott’s transformative $100 million gift to Northwestern in 2015.

Building on the University’s existing research strengths in fields such as law, engineering, business, energy and the environment, and the social sciences, the **Global Climate Change Governance** research group will examine the most pressing questions in climate change governance, including climate change mitigation and adaptation, and geoengineering. By strengthening existing research efforts in a collaborative, interdisciplinary setting, the group intends to establish Northwestern at the forefront of climate change policy analysis and debate.

The **Global Medical Cultures and Law** research group will examine the globalization of biomedicine and the recent rise of traditional medicine through an interdisciplinary lens. Until now, few scholars have attempted to study these factors together or to unravel their connections on an international scale and assess their impact on global health programs.

A research team led by John A. Rodgers, the Louis Simpson and Kimberly Querrey Professor of Materials Science and Engineering, and Yonggang Huang, the Walter P. Murphy Professor of Civil and Environmental Engineering, has developed a first-of-its-kind soft, flexible microfluidic device (pictured) that easily adheres to the skin. A little larger than a quarter, the simple, low-cost device analyzes key biomarkers in sweat to help a person decide quickly if any adjustments, such as drinking more water or replenishing electrolytes, need to be made or if something is medically awry.
UNDERGRADUATE’S RESEARCH SHOWS ECOLOGICAL BENEFITS OF CITY PROGRAM

When Chicago launched a program to sell vacant lots on the city’s South and West sides for just $1, no one quite knew what to expect. For Allison Rose Grenen, a Northwestern senior and environmental science major, that uncertainty made applying her expertise to study the Large Lots program all the more exciting.

Last summer, Grenen conducted in-person surveys of vacant lots in Chicago’s Greater Englewood neighborhood where she analyzed various factors of lawn maintenance, including turf, shrubbery, and fencing. Her work was funded by a Northwestern Undergraduate Research Grant with future study aided by the Institute for Sustainability and Energy at Northwestern, one of more than 50 University Research Centers.

Grenen assessed each lot for the presence of two ecologically significant plants — white clover (*trifolium repens*) and plantain (*plantago major*).

“You’ll only find these plants on healthy lawns that have been recently mowed,” she says. “White clover won’t tolerate drought or soils that are too alkaline or acidic and plantains are short plants, so you wouldn’t be able to see them on an overgrown, high lawn.”

Grenen found that 17 percent of the lots had white clover coverage and 54 percent had plantain coverage, numbers that surprised her.

“I expected the lots to get more care, but I didn’t think there would be so much change in just a couple of years,” she says.

REDESIGNED RIBOSOME

Michael Jewett, chemical and biological engineering and an International Institute for Nanotechnology affiliate, is leading a multi-university team focused on engineering and repurposing the ribosome (pictured) — the core catalyst in cells that are responsible for life. The effort aims to make new kinds of polymers for flow batteries. By Using biological catalysts, the team aims to produce materials for sustainable, rechargeable batteries that are currently impossible to make chemically.
GETTING FATHERS TO PLAY LARGER ROLES IN CHILDRearing

Though mothers still shoulder the bulk of childcare, a recent clinical report from the American Academy of Pediatrics shows that fathers are more involved in their children’s lives now more than ever.

The report, co-lead by Craig Garfield, pediatrics, medical social sciences, regroups a wealth of data from qualitative and quantitative studies produced since 2004.

The number of single dads raising children has increased 60 percent in the past 10 years, and the time fathers spent caring for their children more than doubled between 1965 and 2011.

“Despite the pressures at work and from society, encouraging fathers to become involved early on with their children can make a big difference in their comfort level and confidence in caring for their children as they grow,” says Garfield.

The report details specific ways that fathers influence their children’s health and development. For example, a father’s play tends to be more vigorous, and this rougher play might challenge children to explore and learn how to take safe risks. Additionally, dads are more likely to introduce new words when they talk with a young child, speeding language development.

— Guillermo Ameer, biomedical engineering and a member of the International Institute for Nanotechnology. He and his team have developed a novel material called a “regenerative bandage” that heals diabetic wounds four times faster than a standard bandage and without side effects.
RESEARCH AT THE CROSSROADS OF ART

NU-ACCESS PARTNERSHIP REVEALS COLLABORATIVE BEAUTY OF ART, SCIENCE
When Francesca Casadio was appointed as the first full-time conservation scientist at the Art Institute of Chicago in 2003, she had an ambitious vision: advance scientific preservation techniques to support the museum’s encyclopedic collection. But more than that, she wanted to build a robust, enduring institutional partnership that promoted research at the crossroads of art and science. Casadio identified Northwestern as a natural ally based on the University’s reputation for vibrant cross-disciplinary research, state-of-the-art instrumentation, and expert faculty across scientific fields.

In 2004, the two institutions began a collaboration backed by the A. W. Mellon Foundation. Over the next eight years, the partnership produced numerous discoveries that offered insight into the rich biographies of cultural artifacts and refined noninvasive exploratory techniques used for sampling and replication in conservation science. But Casadio and Kathy Faber, (formerly materials science and engineering, now at Caltech), believed more could be achieved with additional investment.

In 2012, the University secured a six-year, $2.5 million grant from the Mellon Foundation to invest and expand the institutional partnership by launching the Northwestern University/Art Institute of Chicago Center for Scientific Studies in the Arts (NU-ACCESS). This crucial support helped enable Northwestern to recruit Marc Walton, a senior scientist from the J. Paul Getty Museum antiquities collection, to catalyze collaborative efforts between McCormick School of Engineering scientists and Art Institute conservators.

“We have been very busy the past four years,” says Casadio, co-director of the initiative. “NU-ACCESS has produced more than 40 publications, 15 presentations, numerous symposia convening experts across the field, as well as several student-focused efforts, including a recent tour of the museum’s conservation efforts for a group of Chicago sixth-graders to showcase the interconnectedness of art and science.”

Respected by top academic institutions across the country, NU-ACCESS has become a leading model for collaborative scientific research in the arts and a resource for art historians, archaeologists, conservation scientists, conservators, and curators for object-based research. Casadio attributes the collaboration’s unique success to Northwestern’s institutional support, the enthusiasm of its scientists, and availability of advanced instrumentation—including use of beamlines at Argonne National Laboratory, an arrangement made possible thanks to an existing Argonne-Northwestern relationship.

“At NU-ACCESS, interdisciplinarity is in our DNA,” says Casadio. “When art and science converge, the interplay of the object and subject comes alive to reveal important historical questions of methodology, materials, and meaning. Although different lines of inquiry emerge from the humanities and hard sciences, we also must search for a common language for effective collaboration.”

To encourage that kind of communication, NU-ACCESS hosted a December workshop for McCormick students and students from the Weinberg College of the Arts and Sciences with the aim of exploring questions that emerge from different disciplines about a given object.

In 2017, Casadio and codirector Monica Olvera de la Cruz, the Lawyer Taylor Professor of Materials Science and Engineering, will partner with Northwestern’s Buffett Institute for Global Studies to host a domain dinner to encourage further cross-disciplinary cultural heritage research by matching experts in the humanities with peers in the hard sciences. — Kate Banner
The bookshelves in their North Side Chicago home are packed with 5,000 volumes, ranging from Arabic and Armenian literature to most of the classics in English. The art on the walls is a road map to their global travels; two masks from Costa Rica sit by the front door while opposite is a watercolor of a Tibetan monastery. There are pieces by Aboriginal, Pakistani, Armenian, and Bangladeshi artists, as well as several Midwest landscapes.

“Ask how many countries we haven’t been to,” says A. Vania Apkarian, smiling, when quizzed about where he and his spouse, Seema Khan, have traveled. “We think of the world as our home. I don’t believe in the boundaries of this planet.” Besides, he says, “being from Syria and Pakistan ensures you have friends and relatives all over the world.”

The two Northwestern University Feinberg School of Medicine faculty members met nearly three decades ago at a dinner party in Syracuse, New York, and bonded over a mutual interest in US politics. “We were on the same side of
a political argument,” explains Khan, who at the time was finishing a surgical oncology fellowship at Roswell Park Cancer Institute in Buffalo. Apkarian was completing his physiology doctorate at the State University of New York Upstate Medical University.

Born and raised in Pakistan, Khan came to the United States for better postgraduate opportunities after completing medical school in Karachi. Apkarian arrived at age 18, via Armenia, Syria, and Lebanon, to attend the University of Southern California. Married since 1989 and based at Northwestern for the past 16 years, the couple shares a love of science, art, and travel. “Literature and art inspire us in a creative way,” says Apkarian, a professor of physiology, anesthesiology, and physical medicine and rehabilitation. “One needs the freedom of creativity to do fun science like this.”

While Kahn focuses her clinical practice and research on breast cancer prevention and treatment, Apkarian’s lab at Feinberg’s downtown Chicago campus concentrates on chronic pain and its relationship to structural changes in the brain.

“The major push nowadays is to understand the risk factors of chronic pain, and what we’ve uncovered is that the main risk factors are changes in brain structure and function, rather than the injury,” explains Apkarian. “Of course the injury is an important factor, but it’s the brain properties that determine who develops chronic pain and who doesn’t.”

Apkarian recently applied for a National Institutes of Health grant to create what he hopes will become the first national center on chronic pain and drug abuse, to be located at Northwestern. “There’s a massive epidemic of opiate abuse and mortality, and absolutely a large portion of that comes from opiate and morphine treatment of chronic pain patients,” he explains. “Yet there’s very little science on how opiate treatment works for chronic pain. That’s what this center is all about — how treatment and chronic pain influence each other.”

Across the street from Apkarian’s office and lab is his wife’s practice at the Robert H. Lurie Comprehensive Cancer Center. A surgeon who divides her time between treating patients and conducting research, Khan holds the title of Bluhm Family Professor of Cancer Research and specializes in breast cancer risk and prevention. She is also head of the Northwestern Cancer Prevention Consortium, which performs early-stage cancer prevention clinical trials.

Khan is especially focused on two objectives: finding better ways to identify those at high risk for breast cancer (and in turn subjecting fewer patients to cancer treatment unnecessarily) and developing treatments that might alleviate the pain of breast cancer patients. A recent study that Apkarian conducted suggests that a small group of women who had undergone chemotherapy for breast cancer were able to reduce their pain by taking drugs that act on the brain’s opioid system, even though these drugs are typically used to treat cancer patients who have no breast cancer. “We need to study that much more,” he says.

“THE MAJOR PUSH IS TO UNDERSTAND THE RISK FACTORS OF CHRONIC PAIN, AND WHAT WE’VE UNCOVERED IS THAT THE MAIN FACTORS ARE CHANGES IN BRAIN STRUCTURE AND FUNCTION, RATHER THAN THE INJURY.”
research at Kenyon College — they spend more time together in their art- and book-filled home in Chicago’s Old Town neighborhood.

“We talk quite a lot about work because I can help with the design, recruitment, and analysis of the human trials he’s doing,” says Khan. “He’s very forward-thinking and uses social media and other formats I wouldn’t think of. I show him data and he’s good at statistics and gives me advice.”

“My wife’s work has influenced me in many ways,” adds Apkarian.

The beauty of science, he says, is that scientists can influence society at large. “My wife helps people every day, while my work is much more theoretical. But I am doing the basic science with the optimistic viewpoint that we will make the planet suffer less pain at some time. I don’t know if that will happen in my lifetime, but I’d like to see that.” — Anne E. Stein

treatment) and improving prevention strategies by reducing the toxic side effects of common cancer-fighting medications. She and colleagues have found that when the breast cancer drug tamoxifen is applied as a gel to the breast rather than taken as a pill, it does less harm to other parts of the body and avoids the risk of blood clots. Endoxifen, another form of tamoxifen, is even more promising, says Khan, who plans to test an endoxifen gel in a year or so.

“The National Cancer Institute has grown very interested in transdermal drugs for cancer prevention, so it’s really taking off,” she says. “Transdermal delivery will be a major advance in cancer prevention if it pans out.”

Khan’s current research stems from a paper on breast pain that she and her husband published together in the 1990s. They modified a pain questionnaire for the paper and were subsequently contacted by a company developing a tamoxifen gel for breast pain management. Khan thought the gel could work for breast cancer prevention while causing fewer adverse side effects, and persuaded the company to sponsor a study, leading to her transdermal drug studies today.

Now that Apkarian and Khan are empty nesters — their daughter lives and works for nongovernmental organizations in Armenia, while their son studies writing at Kenyon College — they spend more time together in their art- and book-filled home in Chicago’s Old Town neighborhood.

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Libraries are the original “core” or “shared” facility, bringing together vast amounts of information in a well-organized, integrated framework. But in the Internet era, with humanity’s collective knowledge seemingly just a few keystrokes away, do libraries still perform their traditional functions — and have they adapted and evolved to meet the needs of modern audiences?

Sarah Pritchard, Dean of Libraries and Charles Deering McCormick Librarian, offers her insights with Northwestern Research Magazine.

NRM: Today there is more digital information than ever and lots of it appears on websites that are called libraries. How do we define what a library is now?

SP: The library is a suite of services. Collections, technologies, cataloging, instruction — even the buildings — are dynamic components of a planned service, not a passive, static box. A library is an intentional aggregation organized for a purpose, whether the materials are paper or digital, fabric, film, wood, or stone (all of which Northwestern University Libraries collect).

The library is not some impersonal entity. Librarians and library staff are deploying resources both local and remote. They set up facilities and technologies, they advise on information management options, and they deliver the information wherever the user is and in the ways most effective for the task.
Librarians are expert consultants with expertise in how information or creative work gets produced, the characteristics and information needs of different users, and how to design the best interfaces to connect those users with information. That interface may be the library’s most visible feature: originally a shelf with books in a certain order, it became a card catalog and then a digital database. More recently it includes text-mining tools. Libraries also are the locus for mediating production quality, acquisition costs, academic legitimacy, and intellectual property rights.

“Google doesn’t tell you what you’re not getting. Much of the world’s information isn’t available on the Internet.”
— Sarah Pritchard, Dean of Libraries and the Charles Deering McCormick Librarian

**NRM:** But with enhanced online search ability, some may feel they never need to go into a library.

**SP:** That misconception is understandable, as libraries and commercial enterprises have made many strides in digitizing new and retrospective works. Even so, much of the world’s information isn’t available on the Internet. Paper production of books and documents is still prevalent in many countries. Then there’s the matter of digital information that can’t be fully searched on the Internet because it’s incompletely encoded or not free. High-quality information is often available only via subscription; new “open access” repositories are growing but are not a substitute for libraries. Google doesn’t tell you what you’re not getting, so people need to evaluate the quality and completeness of what they see on their screens. And a library that is purchasing large arrays of material can yet and organize digital information to meet the particular interests of a university.

**NRM:** What’s the value of the library’s physical space today?

**SP:** The buildings are as important as ever, if in different ways. Patrons do use them as study spaces, but what’s equally vital is that they are centers for staff experts, research instruction, technology labs, rare collections, and high-use student services. Digital information services require a lot of space; planetary scanners, book scanners, video and graphics production, GIS plotters, media conversion labs, and accompanying peripherals and consultation space require considerable square footage. Increasingly, the expectation is for digital up-time — and the human support that keeps it that way — to be 24/7. It’s a challenge to design spaces that integrate the physical and the digital. Advanced technology, security, high-quality audio, and group study have to work together when you house rare and important collections, such as the John Cage collection, an archive of the composer’s life.

**NRM:** If the library is still a building with books, where’s the digital library?

**SP:** This environment still includes print media and physical spaces, but those are leveraged and extended through digital infrastructure. That infrastructure includes interoperable digital content, online business operations, digital communication, software tools for analyzing and visualizing information, digital platforms for collaboration and dissemination, and immersive virtual worlds of which we are just seeing the early stages.

**NRM:** How do big libraries differentiate themselves these days?

**SP:** Each library focuses on special strengths and local needs. Two seemingly paradoxical trends converge in digital information: the global and local. Globally, mass stores of digitized information are expanding, and their size and ubiquity is what frees libraries locally to develop customized services and unique research resources, whatever the format.

Academic libraries are expanding their roles to support information creation and use: electronic publishing, advice about copyright and scholarly communication, data management, digital archiving, development of metadata for digital assets, and digital humanities consultation and tools. These services go beyond just the materials in our own collection and extend to collaborate with faculty, students, and others to support a global information environment. — Matt Golosinski
New cases of lead contamination around the United States are reintroducing Americans to the negative health effects associated with living near toxic soil, air, or water. A group of Northwestern researchers recently discovered that such contamination also has unwanted cognitive effects, some of which begin before birth.

“People tend to think that environmental factors start playing a role in children’s lives once they’re born, but more commonly we’re finding that the air mom breathes and the water she drinks are also affecting her child in utero,” says economist David Figlio, education and social policy, who directs Northwestern’s Institute for Policy Research.

His research, in collaboration with recent Northwestern PhD graduate Claudia Persico (now a professor of education at the University of Wisconsin-Madison), examined Florida siblings living within two miles of Superfund sites — locations polluted with hazardous materials that require long-term cleanup. One sibling was conceived prior to or during the cleanup, while the other was conceived after cleanup was completed.

By comparing siblings, the team eliminated external factors that could have affected results, such as parenting quality, home environment, or relocation away from the toxic site. This approach allowed the team to assume that the only variable between the siblings’ conceptions was the cleanup of the Superfund site.

“We threw all of our ammunition at this problem to be sure that toxic waste is the thing affecting cognitive development, not any other variable,” Figlio says. “And we are able to point to a critical period in a child’s life when this is happening.”

The team found that siblings conceived before or during the cleanup were more likely to repeat a grade, have lower test scores, or be suspended from school. They also discovered that children conceived by mothers living within one mile of a Superfund site before it was cleaned were 10 percent more likely to be diagnosed with a cognitive disability. Once the site was cleaned, test scores dramatically improved and rates of new disability were cut in half.

Since 1980, the Environmental Protection Agency has identified more than 15,000 Superfund sites, and census data show that low-income families are more likely to live near these polluted locations. Understanding the link between proximity to Superfund sites and cognitive development, Figlio says, is important to drive momentum toward prioritizing site cleanup, but it also makes a good financial and policy argument.

“Even if we don’t consider the human capital of these kids,” Figlio says, “a typical Superfund cleanup will pay for itself in 38 years in terms of reduced special education costs alone.” — Monika Wnuk
BUILDING BETTER TEAMS WITH DATA SCIENCE
Bioinformatics experts are changing the way we think about healthcare delivery

“Hospitals by nature are intensely busy places with a lot of moving parts,” says Nicholas Soulakis, preventive medicine: health and biomedical informatics. “They work really well, but there is a lot going on.”

Some of that complexity can be seen in Northwestern Medicine’s Enterprise Data Warehouse (NMEDW), a collection of electronic health record (EHR) data from more than 6 million people.

“What we’re trying to do,” says Soulakis, “is use this vast dataset to identify improvements in the way care is delivered.”

After starting his career tracking infectious diseases in New York, Soulakis arrived at Northwestern in 2014 to investigate the intricacies of patient care. On the same floor as his downtown Chicago office and the NMEDW are members of the Northwestern University Clinical and Translational Sciences Institute — including its director, Donald Lloyd-Jones, chair of preventive medicine.

Down the street are cardiologists Clyde Yancy, who has published nearly 400 papers and was recently inducted into the National Academy of Medicine, and Robert Bonow, one of the world’s most highly cited researchers.

“Our access to these world-class physician-scientists is incredible, and they’ve been quick to support our work,” says Soulakis, a public health scientist whose research lies at the intersection of epidemiology and informatics. “Our endgame is to identify ways to improve healthcare delivery, which will in turn promote patient well-being.”

During the past two and a half years, Soulakis has continued to illuminate the local healthcare experience, discovering that at Chicago’s Northwestern Memorial Hospital any number of about 8,000 employees may contribute to a given patient’s digital trail.

From a research perspective, no one is looking at any one trail, but rather at how those trails intersect. “Day-to-day healthcare generates a lot of data,” says Soulakis, “and it’s up to informatics experts to identify places where that data reveals interesting features. Advanced data science techniques allow us to crystalize those moments when
providers work together in a new way, producing an unexpectedly good outcome. It’s like capturing one perfect snowflake but then systematically recreating it, turning it into a teamwork model.”

**Healthcare Fragmentation**

Distilling the information is an often difficult and time-consuming process. But when done properly, it can reveal the very trends in healthcare delivery that Soulakis hopes to illuminate.

He relies heavily on the NMEDW, which contains EHR data from more than 6 million people. A joint project between the Feinberg School of Medicine and Northwestern Memorial HealthCare, the NMEDW supports analytics for both clinical research and healthcare operations. This shared platform allows researchers to convert findings quickly into healthcare operations, increasing the potential for new discoveries to improve patient care sooner.

Using EHR data, Soulakis and Gayle Kricke, a fourth-year student in Northwestern’s Health Sciences Integrated PhD Program, recently showed that 35 percent of cardiac patient discharge activities were completed by unexpected individuals, including employees from 12 categories not identified as part of the established hospital workflow.

“When an unexpected provider is involved in care, we either need to fix our process or fix our mental model of how that process works,” says Kricke. “We must ask, is it okay that unexpected providers delivered care? If so, then we need to make sure the care team’s members understand those providers’ involvement and thus their need to be part of the team.”

Soulakis earlier discovered that, on average, 112 hospital employees interact with a cardiovascular patient’s electronic chart during a seven-day hospital stay.

“Nurses and doctors document care throughout the day, so in the natural course of their work they are throwing off digital trails that can be extremely useful,” he says. “Leveraging electronic health record data this way is an improvement on manually trying to determine an individuals’ healthcare team. It’s very difficult to get the full picture, because the team members are never all standing around the patient bed at the same time.”

**Going Beyond EHRs**

Lu Wang, a fourth-year PhD candidate in operations management at the Kellogg School of Management, recently helped Soulakis explore healthcare teams from a different angle.

Wang spent two months shadowing “hospitalists” — physicians who provide care for hospital inpatients — to capture real-time information about their daily workflow. Among the findings was that hospitalists’ productivity is strongly influenced by the team they’re working with.

“Interestingly, we juxtaposed the physical team — the caregivers with whom the hospitalist physically interacts regarding a patient — and the digital team — all of the caregivers who made an edit to that patient’s EHR,” says Wang. “What we found was that the size and day-to-day consistency of the digital team’s makeup is as important as the physical team’s with regard to hospitalist productivity.”
This research highlights how using EHRs to facilitate improved healthcare comes at a cost: the almost invisible load of digital information greatly impinges on caregivers’ time.

“Quantifying the physical and digital interaction is an important factor in understanding how we enhance workflow,” says Soulakis. “There’s good reason for major funding initiatives to focus on precision medicine and genomics, but if we can improve the delivery of care, we can also improve health on a broader scale.”

**Increasing Positive Outcomes**

Building better healthcare teams requires researchers to dissect existing networks.

**Matthew Carson**, preventive medicine: health and biomedical informatics, worked with Soulakis to develop the Shared Positive Outcome Ratio (SPOR), a novel metric used to evaluate pairs of healthcare providers who collaborate on patient care.

“In terms of patient satisfaction, we found that it’s possible to identify extreme high- and low-scoring relationships over a set of shared patient encounters,” says Carson. “In addition, a majority of providers are involved in both high- and low-scoring relationships, suggesting that collaboration is also highly variable on an individual level.”

Tapping into emergency department EHRs over a three-year period, researchers used SPOR to identify 295 of 5,615 paired relationships that resulted in significantly higher patient satisfaction rates, further identifying 29 top performers within the department. Those results helped validate the idea of evaluating a collaborative network to characterize interactions among healthcare providers in a hospital setting.

SPOR essentially assigns each individual a score representing that person’s strength as a teammate.

“These advanced analytics, like the SPOR, are not just another report card. Your SPOR is relative to the performance of the organization,” says Soulakis. “If everyone is great, you may just be a little less great.” Heart failure patients at Northwestern Memorial Hospital, for example, receive some of the best care in the world, so a low SPOR is still excellent.

The research team also looked at lower scores for opportunities to improve provider communication strategies, training needs, and structural barriers. Soulakis believes that low SPORs likely reveal systemic issues rather than individual practice concerns.

“It’s still a ways off, but someday we envision all patients getting the best team for their exact circumstances,” he says. “SPOR takes the current retrospective approach to evaluating healthcare teams and turns it into a prospective approach that increases the likelihood of patients having a positive experience.” — Roger Anderson

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**Northwestern Leads New EHR Consortium**

The National Institutes of Health has awarded a $6.3 million grant to accelerate the use of patient-reported outcomes in research and clinical care. The grant is directed to a Northwestern-led coalition of nine universities.

“We are very excited to see this multi-institutional project take off,” says Donald Lloyd-Jones, director of the Northwestern University Clinical and Translational Sciences Institute. “This approach to direct, efficient acquisition and integration of patient-reported information represents the future of patient care and medical research, and this project paves the way to that future.”

The project will integrate a patient’s electronic health record with a computerized survey tool that adapts to each patient’s unique answers. By asking only the most relevant questions, researchers hope to make surveys up to 10 times shorter.

Patient-reported outcome surveys ask patients questions about their physical, mental, and social health. By comparing an individual’s medical information and survey responses, healthcare providers and researchers can see how clinical care is affecting patient health. Studies have shown that these surveys are one of the best ways to increase research impact.
Both Jean Piaget and Maria Montessori held the view that “play is the work of the child.” Likewise, Carl Jung saw play, rather than reason, as central to innovation. So how does play shape our lives and spur creativity? We asked Northwestern faculty members to recall some of the ways that childhood play reflected their personalities and aspirations, while helping develop their intellectual and emotional capacities.

MICHELLE M. WRIGHT
African American studies and comparative literary studies

We lived overseas for most of my childhood, so my younger brother and I loved taking the US and foreign TV shows that we watched and recreating them with our Playmobil figures — mostly Japanese robot cartoons from the 1970s, like “Mazinga” and “Goldrake,” as well as “Space 1999” and stranger stuff like “The Dukes of Hazzard.” (Picture two African American kids doing their best white Southern accents.) My figures tended to mostly talk and talk and talk and talk. Not much action. So perhaps it’s no surprise that I became a professor of literary theory, which is so intensely language based.

GUILLERMO AMEER
biomedical engineering and surgery

As a child, I loved sports, specifically basketball. I think team sports help build character and excellent social skills for group dynamics. It can also help build leadership skills.

ED COLGATE
mechanical engineering

As a kid, I loved to make things. This apparently began when I was old enough to use scissors, and grew as I picked up hammers, saws, and chisels, followed by drill presses, lathes, and milling machines. (My dad had one of the better-outfitted basement shops around!) When I got to college I thought that I wanted to be a scientist, but the desire to make things kept bubbling up, and before long I found my way to mechanical engineering. It was the right move. I love that my Northwestern career affords me personally a chance to be creative — to make things — and it gives me a chance to share that passion with students.
NITASHA SHARMA  
African American studies; Asian American studies

Growing up in Hawaii, I was a body boarder. The Pacific waves are strong and the reefs are rough; I’d often get cut up by the coral when I missed a wave. But when I caught one — it was magic! This experience taught me both to go with the flow and be patient. When your wave comes, you have to be decisive: go for it and paddle, paddle, paddle. Or else don’t. And be sure not to get swept under or you will pay for it. Teaching and research insights are similar; know your opportunities and decisively take them (but with an open mind), or let them pass you by, but do so knowingly.

ZACHARY V. WRIGHT  
history and religious studies

Among the liabilities of being raised by 1960s cultural revolutionaries in the woods of New Hampshire (without electricity or television) was the development of an imagination disconnected from the normal cartoon characters that marked most schoolyard conversations. My siblings and I glided through forests, battled demons, talked to trees, and pretended we could turn invisible or walk on water. After spending time researching Sufism in West Africa, I was struck by the highly developed reflection on the potentialities of the human condition, a reflection that, for me, invoked the deep aspiration of youth’s blossoming soul.

DAVID NEIL RAPP  
psychology

One of my favorite activities as a child involved dumping out LEGO blocks onto my living room carpet and creating little settings in which characters (mostly superheroes) could go on adventures. I loved building environments for these stories. One line of my research involves understanding the ways in which people comprehend and produce narratives, as well as figuring out how to support people’s learning from stories. This aligns quite nicely with my engaged play as a kid.

ZACHARY V. WRIGHT  
history and religious studies

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PLAY ON WORDS
Most two year olds have a PhD in play.

They’ve graduated from crawling and finding their first words to imagining that a ball is an apple or an empty cup is full of tea.

Parents don’t often note the earliest signs of symbolic play, but they represent a milestone in typical cognitive development.

“By 24 months, kids can express some of the highest forms of play,” says Megan Roberts, the Jane Steiner Hoffman and Michael Hoffman Assistant Professor of Communication Sciences and Disorders. “We call it ‘pretending,’ but teaching kids that one thing can represent something else is often the link to language.”

The relationship between language development, cognition, and play allows Roberts and colleagues at the Northwestern University Center for Audiology, Speech, Language, and Learning to evaluate children who may have deficits in communication or cognitive ability.

“We use play-based measures as a way to assess where children are developmentally, but also as a context for intervention,” says Roberts, a speech-language pathologist and developmental therapist. “If we know a child can’t conceptualize a wooden block as anything other than a wooden block — a literal interpretation that many children on the autism spectrum struggle with — we can customize our approach.”

Roberts is leading a pair of play-based clinical trials at the Evanston-based center, which has been designed to interweave clinical expertise and pioneering research.

In one study, she is exploring if language and play skills can be simultaneously improved in children with autism to positively affect long-term outcomes. The second trial investigates parental characteristics that may inhibit the ability to play with and/or teach language to their child.
“It’s extremely important for us to empower and teach parents how to best interact with their children because parents are a child’s primary communication partner,” says Roberts.

The theoretical foundation for this research is that language and social communication develop on a platform of joint engagement with people and objects, and that those interactions happen within the context of daily life, which for a child involves a lot of play.

“We know that play is not just play; it represents early cognition, early communication, and early social relationships,” says Sarah Bauer, a developmental and behavioral pediatrician at the Ann & Robert H. Lurie Children’s Hospital of Chicago and the Center for Audiology, Language, and Learning. “These are the foundations for learning because they are the basis for language.”

Typically, play’s different layers go largely unnoticed, Bauer says. It’s when development seems “off” that patients are referred to the center where clinicians can conduct an in-depth evaluation, try to pinpoint where things may be going wrong, and pursue possible remedies.

Language Makes Us Human
Sandra Waxman, the Louis W. Menk Professor of Psychology and faculty fellow at the Institute for Policy Research, has been studying early language and cognitive development for more than 20 years.

“In comparison to other mammals, humans are the most helpless at birth. We’re highly dependent on those around us,” says Waxman, director of Northwestern’s Project on Child Development, a developmental psychology lab that studies how children think and learn. “The second half of this equation, however, is that our brains are tailored for acquiring new knowledge, and play is one of our greatest tools for learning.”

Waxman’s research, which focuses on language and cognitive development in infants and very young children, points to the benefits of social interaction in playing with preverbal children.

“The mind is so capacious as to allow for babies to entertain different concepts of the world around them,” she says. “Letting infants and children experiment and play allows them to guide their own discovery, enhancing cognitive and language development.”

And it turns out that it matters far less what a child plays with than the social context of that play.

“You don’t have to buy the perfect toy, because children learn the most from doing,” says Waxman. “A baby could play with plastic cups or silver spoons; it’s the direct hands-on experience that matters, coupled with the language and social support provided by others.”

Cultural Influence
How children play affects their understanding of the natural world, and also reflects their knowledge. Waxman has found.

Together with colleagues and collaborators at Northwestern and in the Menominee Indian Tribe of Wisconsin, Waxman’s team has compared children growing up in urban Chicago with those living rurally on the Menominee Reservation.
In a recent study, the team observed children playing with a woodland-scene diorama. Although city-dwelling majority-culture kids typically had access to many more toys than their Menominee peers, those living on the Menominee Reservation were just as capable — or more capable — when it came to their knowledge of the relations among plants and animals in the natural world.

“These children’s spontaneous play shed light on the powerful effect that children’s communities have on learning and play,” Waxman says. “The children from both communities knew a lot about individual objects in the diorama. But only the Menominee children revealed in their spontaneous play that they understood the ecological relationship among plants and animals. This is information that they learn within their communities.”

In another set of experiments, Waxman has compared how 24-month-old infants from the United States and China deploy their attention to objects and actions in dynamic scenes. Prior research had suggested that people in these two communities differ in their attention to objects versus events: people in the United States focused more on objects than events, while people in China showed the opposite tendency. Waxman wanted to identify the developmental origin of this cross-cultural difference.

In the experiment, infants watched a series of repeated scenes — a girl petting a dog, for example. Then, infants watched two new scenes. In one, the object was switched (the girl petting a pillow). In the other, the action was switched (the girl kissing a dog). Infants from China preferred looking at the scenes featuring a new action. In contrast, US infants preferred scenes featuring a new object.

“The results suggest that by the time they reach their second birthdays, infants may be on their way to becoming ‘native lookers,’” says Waxman. “We know that children have this powerful and innate capacity for cognition, which is boosted by listening to language. We are now beginning to understand that their surroundings may play a larger role in the manner in which they think about and digest information.”

**Play as Therapy**

At the Northwestern University Center for Audiology, Speech, Language, and Learning, Megan Roberts is among the most enthusiastic proponents of play-based intervention. During a recent autism assessment, Roberts observed a young child playing with a doll. When he stopped, picked up a ball, and pretended to feed it to the toy baby, she couldn’t help but smile.

“It meant that he understood symbolic play, which allows us to cater an intervention that further teaches about the symbol of words,” says Roberts. “Clinicians can be so focused on outcomes and not the process, but when it comes to children, they learn through the process of play.”

Northwestern researchers continue to strengthen the connection between the cognitive capabilities necessary for certain types of play and the ability to develop language. That link may be most apparent in a child who can complete two sequential tasks with a toy — a train stops at a station and then takes passengers to work — and then also string together two consecutive words, says Judy Roman, communication sciences and disorders.

“The sophistication mirrors each other,” says Roman, a board-certified childhood language specialist and lecturer at the School of Communication. “It’s not necessarily that one is driving the other, but they are connected.”

She notes that there is an art to picking the right toy for some kids. Play, by its nature, has to be freely chosen. Once a child is prescribed play, the task becomes work.

“One of the things that we have the privilege of doing as clinicians in an academic setting is teaching evidence-based practices to graduate students,” says Roman. “We’re not just advising them to preach play because it seems like a good idea; we’re sharing with them this robust level of research that shows how play can be used as a tool for social, cognitive, and language development.”

— Roger Anderson
Video game research inspires classroom model where failure is an option — but for good reason

Video games don't pass judgment.

When players fail, they're allowed to learn from mistakes, develop new strategies, and make another attempt at progress.

“The way children gain knowledge while playing video games and interacting with media is a stark contrast to the classroom setting, where failure is considered the worst outcome,” says Reed Stevens, learning sciences and an Institute for Policy Research associate. He should know: he's been studying how technology mediates thinking and learning for nearly 20 years.

“When I began this work, I didn't just want to study play; I wanted to distil our observations and explore how they might advise the creation of a nontraditional learning environment,” he says.

In 2011, Stevens cofounded FUSE, a set of interest-driven, hands-on learning modules that rely on media, technology, and the video game mentality of leveling up, or progressively facing more difficult challenges.
An informal, in-school, after-school, and weekend program, FUSE has been adopted by educators throughout the United States and as far away as Finland. In September, the program launched in five Chicago public schools, adding to the thousands of area middle and high school students who have benefited from the pedagogical innovation.

Each FUSE challenge engages teens in different science, technology, engineering, arts/design, and mathematics (STEAM) topics. The program features dozens of challenges that include 3-D printing objects, Android app development, ringtone development, building solar-powered toys, and more.

“I think of learning through play as fundamentally being about exploration,” says Stevens. “The reality is that schools don’t frequently excel at supporting exploration. There is a curriculum and it is followed. When schools give students permission and encouragement to explore, interesting things start to happen.”

With FUSE, students frequently become the teachers, sharing their expertise with peers, while the adults in the room act as coaches.

Stevens is an ethnographer — his research relies on observing individuals in natural environments — and his study of video game players involved recording the interactions of eight- to 12-year-olds while they played.

“This idea of a kid interacting with media, like a video game, in isolation is a caricature that just isn’t accurate. Typically, there is incredible socialness to playing,” says Stevens, adding that video games are not intrinsically detrimental. “No matter what you may think about an individual game’s content, one of the powerful takeaways is that these children are ‘learning to learn’ and learning to teach, which is an important part of life.”

Stevens’ research examines and compares cognitive activity in a range of settings — including classrooms, workplaces, and science museums and has also revealed many aspects of how kids play games. While some played according to the rules, competing for points and leveling up, others became interested in subverting the game, developing their own sets of goals before attempting to achieve them.

“This mimics what people do in real life. When we are working within constraints, we frequently push the boundaries,” says Stevens. “Children are really good at finding ways to learn, and they’re willing to rely on each other’s expertise to complete a challenge. This rich culture of peer learning is precisely what we wanted to capture with FUSE.”

— Roger Anderson
Stunted: America’s Growth Challenges

Economist Robert Gordon’s new book describes a (mostly) bleak future

Today’s innovations may seem impressive, but they pale by comparison with earlier breakthroughs. In fact, new advances are unlikely to have the same transformative impact as those of the past, according to eminent Northwestern economist Robert Gordon.

His latest book, The Rise and Fall of American Growth: The U.S. Standard of Living since the Civil War, highlights the conditions that led to a century of unparalleled economic growth between 1870 and 1970. That period of rapid and far-reaching advances — including electric lighting, motor vehicles, and air conditioning — uniquely laid the foundation for many of the technological and economical developments since, Gordon contends.

“We have plenty of innovation now, but it’s affecting the economy very slowly and in fringe areas, such as voice recognition or virtual reality,” says Gordon, Stanley G. Harris Professor in the Social Sciences and professor of economics. “We’re not experiencing the top-to-bottom revolution that we saw in those days.”

Gordon’s analysis hinges on his claim that growth seen during the century after the Civil War can never be repeated. Society’s transformation from a rural to urban setting happened just once. Similarly, advances such as air conditioning confer one-time benefits. Even the marvel of air travel has limits: Commercial airlines today achieve speeds no faster than in 1958, and planes have become even less comfortable.

“If you think of an office, by 1970 it was equipped with typewriters, clunky calculating machines, file cabinets, and paper,” Gordon says. “By the 1980s, we had computers with spreadsheets and word-processing software. With the 1990s arrived the Internet and e-commerce, but by 2005 the digital revolution’s main fruits had been harvested.”

“One simple way to think about this is that, in 1870, the house stood in isolation,” Gordon says. “But by 1940, that house was connected in five ways: electricity, gas, telephone, running water, and waste removal. We haven’t seen this kind of comprehensive change since.”

In his book, Gordon encourages an assessment of growth that goes beyond the conventional use of GDP, which doesn’t account for many signs of growth that humans care about and that contribute to an elevated standard of living. For example, in the century after the Civil War, life expectancy jumped from 45 to 72 years, infectious disease and infant mortality were significantly reduced, manual housework was largely replaced by electric appliances, and television brought images of the world into the living room.

Policy also accelerated progress for laborers through the introduction of the five-day workweek, restrictions on child labor, and government-supported retirement — all staples of American life today. Policy also supported growth through free high school education and labor unions. But today, Gordon argues, four “headwinds” are stalling progress. Rising inequality, stagnating education, an aging population, and the ballooning debt of college students and the federal government are all factors that stunt growth. Yet even with these obstacles, Gordon says he remains optimistic about employment.

“There’s not a quick fix for our nation’s stagnant growth, but one thing I’m not worried about are jobs,” he says. “We’ll have plenty of jobs in the service sector, in healthcare and education, and in many other industries where machines are unlikely to displace humans over the next few decades.” — Monika Wnuk
No Tea, No Shade Finds New Paths and Consolidates Existing Ones

In this follow-up to the groundbreaking *Black Queer Studies*, E. Patrick Johnson, African American studies and performance studies, curates a collection of 19 essays from the next generation of scholars, activists, and community leaders doing work on black gender and sexuality. *No Tea, No Shade* — an expression rooted in an attempt to speak with conviction and authenticity — builds on the foundations laid by the earlier volume, with contributors speaking new truths about the black queer experience while providing convincing evidence for black queer studies as a rigorous and vital area of study. Topics include the carceral state, gentrification, sex, gender nonconformity, social media, the relationship between black feminist studies and black trans studies, the black queer experience throughout the black diaspora, and queer music, film, dance, and theater. The text’s contributors push black queer studies in new and exciting directions, proving that the field is substantial and enduring, despite early critiques that this scholarship was a passing trend.

— Matt Golosinski

Digital Platform Brings Revolutionary Theatre to Life

Northwestern University Press has published Dassia N. Posner’s second book, *The Director’s Prism: E.T.A. Hoffmann and the Russian Theatrical Avant-Garde*. In this book, the theatre and Slavic languages and literatures expert investigates the revolutionary innovations of three Russian directors — Vsevolod Meyerhold, Alexander Tairov, and Sergei Eisenstein — through the lens of each one’s fascination with German Romantic fantasy writer E. T. A. Hoffmann. Many of the devices associated with avant-garde theatre — breaking the “fourth wall,” for instance — emerged from this intercultural exchange, she writes.

Posner’s book is accompanied by a web-based archive ([fulcrum.org/northwestern](http://fulcrum.org/northwestern)) the first to be featured on the new publishing platform Fulcrum, which provides a stage for multimedia materials and born-digital projects that can’t be accommodated in traditional monographs. Posner traveled to Russian, German, and US archives to extensively research the book and its online archive. She says that the digitally enriched source materials, such as theatrical designs, film clips, and playbills, illustrate the vivid and innovative approach to theatre-making that later was suppressed by Stalin. Additionally, the easy access and high quality of these digitized items brings a new dimension to the medium from which they originated.

“Performance is ephemeral and does not exist as a physical object, which makes it challenging to analyze as one would a painting or a dramatic text,” she says. “The materials in this online archive show that we can analyze historical performances by engaging deeply with the traces they leave behind.”
**Felix Hu** envisioned a career in big data. Then, *Data as Art* happened. A collaboration between Northwestern and the School of the Art Institute of Chicago (SAIC), the innovative course challenges students to translate complicated information into visual art or images for the masses. For Hu, who graduated in 2014, it also ignited a passion for tangible digital design and launched a journey that resulted in Osmo Coding, a recently released game that helps children learn the basic concepts of computer programming.

While taking *Data as Art* in, Hu and SAIC student Ariel Zekelman began exploring different tangible design products. They continued their search after completing the course, and contacted **Mike Horn**, electrical engineering and computer science, to inquire about ongoing projects.

Horn introduced the two to Strawbies, a project focused on developing a game to teach elementary school children the building blocks of coding. In September 2015, the trio ventured to Silicon Valley for a meeting with Tangible Play, a startup focused on educational games. Tangible Play’s leaders liked Strawbies so much they offered to buy it and to hire both Hu and Zekelman. Renamed Osmo Coding, the game, which blends digital and physical play, launched publicly in May 2016. “It was an absolute whirlwind,” says Hu, who continues releasing new content for Osmo Coding while helping Tangible Play conceptualize new games.

— Photo courtesy of Tangible Play and text courtesy of Northwestern Engineering