CenterPiece

Research Scholarship, Collaboration, and Outreach at Northwestern University

FALL 2012

IN THIS ISSUE

NORTHWESTERN
UNIVERSITY

When Dr. Seuss wrote his popular book, *Oh, the Places You'll Go!*, he most likely wasn't thinking about university research. But his title well describes the contents of this issue of *CenterPiece*. Northwestern researchers explore actual and virtual worlds through their research, giving them—and sharing with us—an appreciation of art, a better understanding of disease, and the ability to use today's technologies creatively. As these articles demonstrate, their ideas and their tools enable the power of research to take us from the world's highest mountains to its smallest nanoparticles.

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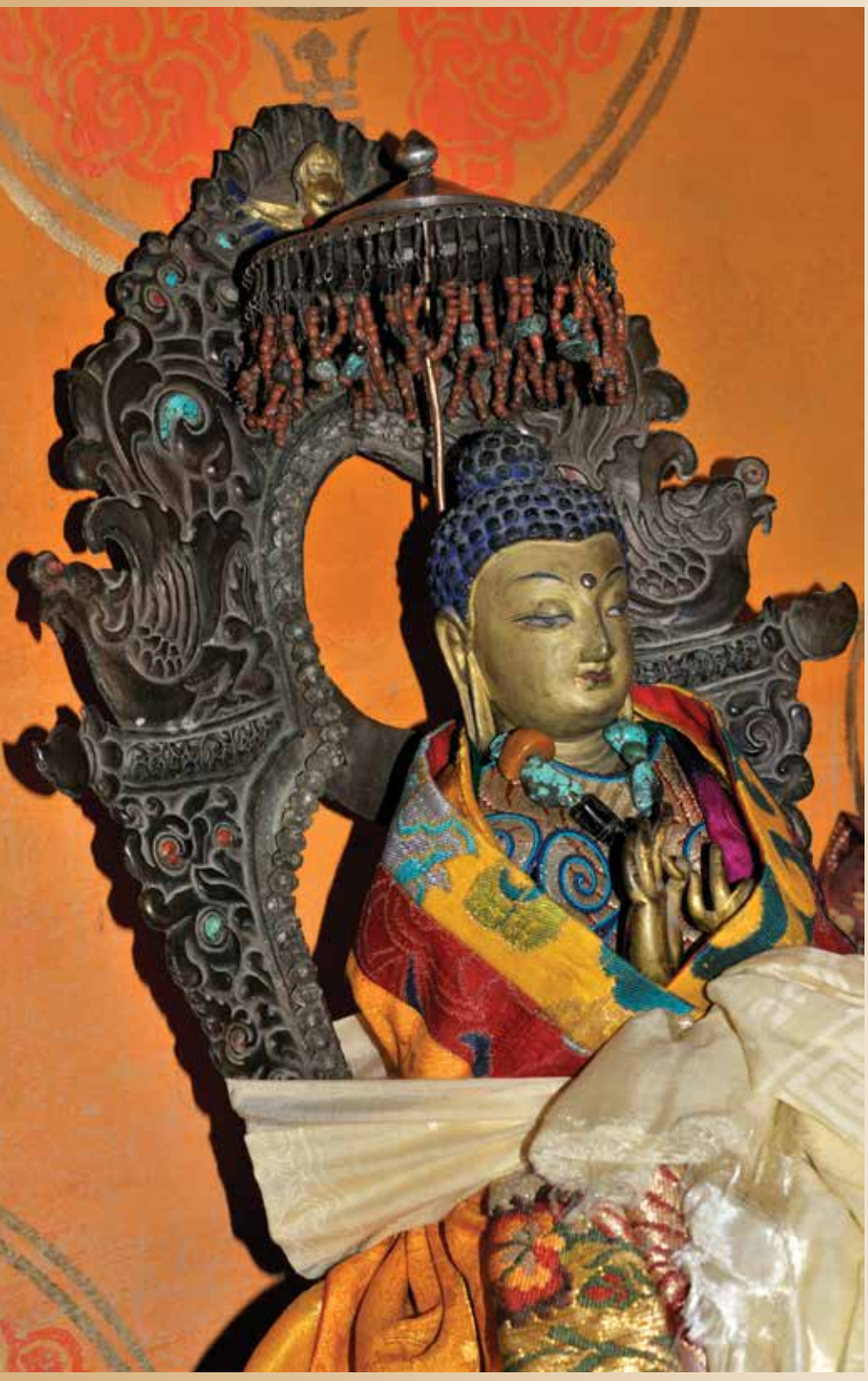
COVER – **Trekking Against Time**: To reach the remote Indian village of Relagong, Rob Linrothe, art history, hikes at an elevation of 17,000 feet or higher across the Himalayan Mountains. Three stupas (Buddhist relic monuments that commemorate sacred space or events) are shown in the foreground. Photo by Rob Linrothe.

Trekking Against Time:
The Race to Document Buddhist Art



To reach the remote Indian village of Relagong, Rob Linrothe, art history, hikes at an elevation of 17,000 feet or higher across the Himalayan mountain range. Linrothe heads not for peaks but for gaps in the range, looking for the lowest points on the horizon. He treks along faint trails during daytime, and sets up camp when the sun slips behind the mountains. After 10 long days of hiking, Linrothe reaches his destination.

Linrothe spends every summer trekking the Himalayas but had not been to Relagong before. He recently received a tip that a little-known 17th-century Buddhist painting adorns the village shrine. He wants to study the inscriptions on the piece and document it in its location.

"These villages are extremely rich in art and culture," Linrothe says. "But they are so remote that they are little studied. A lot of the art has not been fully explored."

The village of Karsha in the Zangskar Valley serves as Linrothe's home base. Every summer, he flies from Chicago to New Delhi, then within India from New Delhi to either Srinagar or Leh. Then he takes a Jeep or walks for 10 days into Zangskar where he stays with friends in Karsha. After a few days, he hikes to other villages, then returns to Karsha for a rest before trekking out again. Most of his treks have lasted 30 to 45 days. This year he did four 10-day treks.

DISAPPEARING ART

A specialist in early and recent Tibetan Buddhist art, Linrothe has dedicated his life to documenting these works before they disappear. Development, climate change, and art collectors all pose threats.

Rob Linrothe (back, center) often stays with friends during his visits to the Himalayas. Here he stands with his close friend Karsha Lonpo (in the red hat), two of Lonpo's daughters and his grandchildren during a visit to the Zangskar Valley last summer.

As the region develops and roads are built, villagers send their children elsewhere for better schooling. While Linrothe admires this, he says it causes "the culture to erode from within." Children grow up and seldom want to move back to their remote villages. As the population declines, few are left to take care of the buildings and art. "Children come back from school 10 or 15 years later and don't like it," Linrothe explains. "It's rough to live without electricity in the middle of nowhere, so they want to move back to urban India or somewhere West. I'm not blaming them for this; it's just a fact."

In terms of climate, Zangskar is a high-altitude semi-desert on the northern flank of the Himalayan range. Until recent years the mountains acted as a barrier, protecting Zangskar from Indian monsoons. As the climate grows warmer, however, the warmer air allows the monsoon clouds to travel higher and ascend the mountaintops. After crossing the peaks, the clouds burst.

"It's not the kind of rain that's good for agriculture," Linrothe says. "These storms are terribly destructive. About two years ago a storm killed dozens of people and destroyed part of the town of Leh in the nearby Ladakh region." Since little rain previously occurred, the Zangskar buildings are flat-roofed and not built to withstand rain. The pummeling storms cause roofs to leak and murals to be destroyed.

"The third factor that motivates me to document the art is that more and more art collectors from Asia, Europe, and America have been extracting material," Linrothe says. "In Buddhism it's immoral to buy and sell these things. It's like selling God. But people who are desperately poor will fall for it if the Western art market offers them the opportunity to sell objects clandestinely."

According to Linrothe, art collectors or their representatives often take advantage of the poverty of poorer areas. They pay very little for the artworks then sell them for tens of thousands of dollars back home. Yet the pieces lose value when extracted from their original homes. "Most of the pieces are made in sets," he says. "If you take just one, then it's an orphan. It cannot tell us as much as it could in its own environment."

VALUABLE CONNECTIONS

The ruthless art market causes many villagers to be skeptical of Westerners. Linrothe has been visiting since 1990, however, and many know him by now. During his travels he has made several close friends with whom he keeps in touch all year. Sometimes his friends accompany him on his walking journeys within Zangskar. Because they help him find and gain access to hidden artworks, Linrothe credits them with most of his rare art findings. This network of connections is crucial; because the pieces are undocumented, most of their whereabouts are known purely by word of mouth.

A few years ago as a visiting scholar at the Getty Research Institute in Los Angeles, Linrothe found a book of photographs dated from 1908 that included a picture shot by French travelers of a 10th-century sculpture of the Buddha. The sculpture was said to be located in Muni Gompa, a monastery in the Zangskar Valley. He'd been to Muni Gompa before and never seen it.

"I asked my friend about it, and he said it wasn't from Muni," Linrothe says. "It was from the Bardan monastery. He recognized it as a special sculpture that is only shown during Tibetan New Year's celebrations."

All images in this article by Rob Linrothe.

Top left: An exterior photo of a monastery in Zangskar. **Above:** A section from a 500-page Buddhist manuscript that Linrothe studies. The manuscript has been with the same family ever since it was commissioned in the 17th century. **Middle left**: A yak grazes in a valley against the backdrop of the Himalayan mountain range. **Bottom left**: Prehistorical petroglyphs, carved into rocks alongside a Himalayan path, show men hunting ibex with bows.

During Linrothe's most recent visit this summer, he, his friend, and his friend's son traveled to Bardan in search of the sculpture. When they arrived, the monastery had just appointed a new manager. This event was deemed a special occasion, so Linrothe was able to view and photograph the piece. Based on the details of the sculpture, he confirmed it was the same one shown in the photo album at the Getty (see photograph on page 2).

ANCIENT FINDINGS

Though Linrothe follows tips and clues, he also stumbles upon pieces that he does not expect. While hiking through the Himalayas, he occasionally spots prehistoric rock carvings called petroglyphs. The carvings show hunter-gatherers alongside native animals, such as yaks, ibex, and mountain goats. Several date as far back as 2,000 B.C. Linrothe says these, too, are in danger of being destroyed by development, but many at the higher altitudes remain untouched.

"They are just found in the middle of nowhere," Linrothe says. "You can't see them if you are whizzing by in a car. I find them by walking on and off the path."

And Linrothe will continue to spend his summers wandering through the Himalayan Mountains and sleeping in tents under the stars. He has yet to return from a trip where he didn't find something worth documenting.

Linrothe's research is the subject of his forthcoming book *At Shambhala Gate: Toward an Art History of Zangskar*. — *Amanda Morris*

MASTERING MAYA: INNOVATIVE COSTUME DESIGN

Chances are that you haven't met Maya, but you probably know her work.

She created the mystical, smoky ghosts in the Harry Potter movies. She rendered the post-apocalyptic landscape in *Rise of the Planet of the Apes*. She produced the lifelike, copper hair that flows from *Shrek's* Princess Fiona. And she created the bioluminescent universe in *Avatar*.

While the resumé seems impressive, Maya is not a person. Named for the Hindu concept of illusion, Maya is a 3-D computer graphics program used for visual effects, video game development, and animated films. And now Ana Kuzmanic, theater, is using Maya in a most unusual way.

"When I first encountered Maya, I noticed there were a lot of theatrical elements in the program," says Kuzmanic who teaches costume design. "I wanted to learn how to use the software but gear it to my own interests."

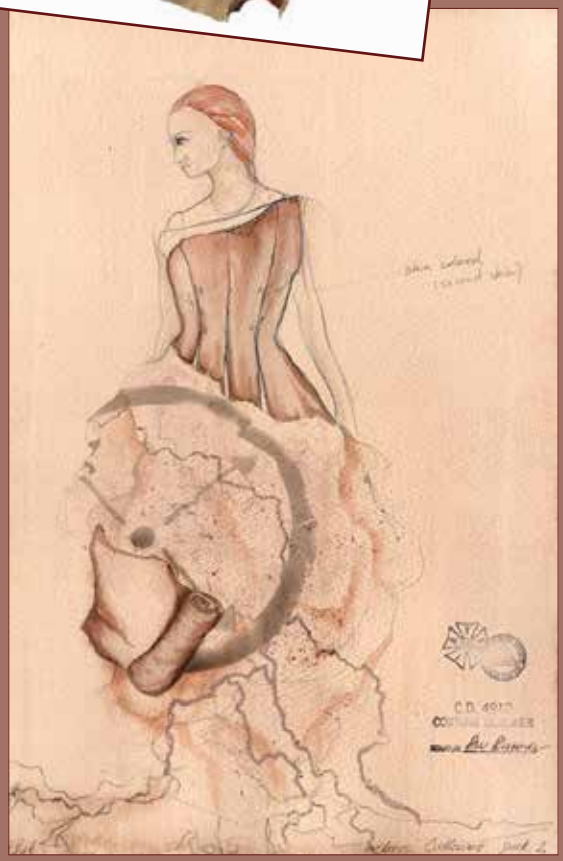
Supported by the School of Communication, Kuzmanic enrolled in courses for the animation software at the School of the Art Institute in Chicago. While other students in the class created video games and cartoons, Kuzmanic developed theater costumes that came alive on the computer screen and awed her peers.

"I don't know of anybody using Maya specifically for costume design," she says. "In class, so many people said 'Wow, I've never seen anyone do that before.'"

Kuzmanic first began experimenting with a series of costumes that she calls "dissolving dresses." She combined Maya with Real Flow—a program used for animated liquid—to create a dress that looks as though it's made of splattered paint suspended in space. The light

All images in this article by Ana Kuzmanic except where noted.

"Everything starts with research," Kuzmanic says. "Before that, I have no idea how it will turn out." When Kuzmanic begins her design process, she starts by making collages that "generate the feeling" of what she hopes to create. The above collages of inspirational research and preliminary drawings were used for her costume designs for the play *Willful*, which debuted last summer at the Oregon Shakespeare Festival. Following inspiration from the collages, she sketches each costume from various angles. Then she imports her sketches into a computer program called Corel Painter and paints each sketch (shown on the right) with the chosen color palette. While the computer program allows her to work faster, Kuzmanic notes that the most important part of the process is the original idea. "I want students to be aware of how their ideas develop," she says. "The programs cannot give you ideas, they can only develop them further."



reflecting off the dress, the reflection on the floor, and the glossy background are all effects from Maya.

Maya users can make whole worlds and characters emerge from a blank field. While computers are useful for creating clean and symmetrical illustrations, Maya also excels in making flowing, organic shapes and rich textures. Every piece is created either with polygons, made up of straight lines and angles, or NURBs (non-uniform rational b-spline), which is mathematical jargon for rounded objects and curves. From there the user can add texture, color, and lighting, and view the figure from various angles.

"I instantly made a connection to theatrical design," Kuzmanic says. "In Maya, there are endless banks of textures, colors, and surfaces that you can apply to objects. In costume design, it's all about dealing with a form and then adding texture and color."

Because the program works in three dimensions, it's easier for Kuzmanic to visualize her costumes before constructing them for the theater. When working with pen and paper, she sketches her designs from several angles and then paints them to experiment with colors. Using Maya, Kuzmanic can accomplish this much faster and easier.

"I've designed costumes that were very outlandish, so it's important to think about construction," she says. "I have to think about how to make the costume a reality without impairing the actor. The 3-D element allows me to see the design from all sides and know what's possible before it goes into production."

For the Oregon Shakespeare Festival last summer, Kuzmanic designed costumes for the play *Willful* the old-fashioned way. Directed by Michael Rohd, theater, *Willful* was an experimental play about the nature of stories—how we tell them, how we understand them, and how we create them to make sense of our lives. As the script was being developed, Kuzmanic had the idea of three characters wearing costumes that looked like ancient books to give a sense that they were conveying knowledge.

She started with visual research, collecting ideas and inspiration. She made collages from magazine clippings that conveyed particular emotions or contained appealing lighting or shapes that reflected the play. Then she experimented with colors to correspond with the images in her collage. Next she made a series of sketches on textured paper to further develop her ideas. Kuzmanic ended with elaborately sculpted costumes made of leather, Tyvek®, linen, and jute. The Office for Research funded the construction of many of Kuzmaric's costumes.

Max Gojakovic

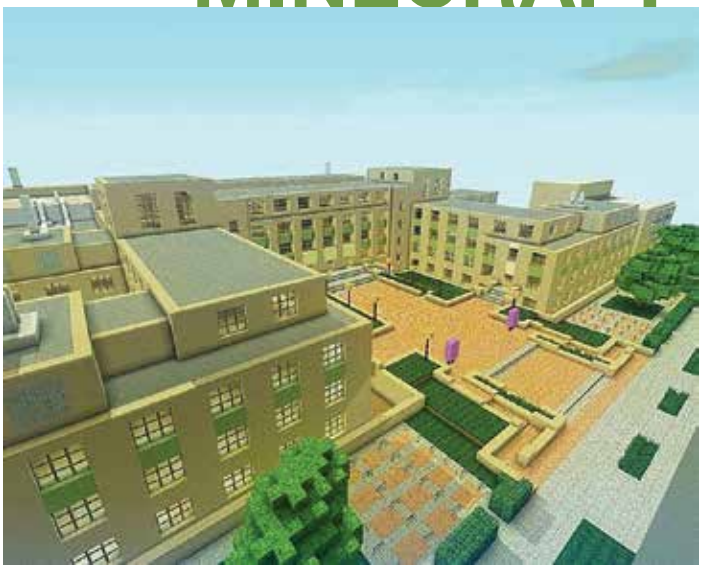
Ana Kuzmanic

Although Kuzmanic did not use Maya for the costume design in *Willful*, her Maya training deeply influenced her work. "Maya is like learning a new language," she says. "And this new language enabled me to say things that I couldn't say before."

Inspiration and the development of ideas will always be the most important part of the design process. While Maya can only further the development of those ideas, Kuzmanic believes that theater costume and set designers could learn important skills from 3-D animation. She currently is working with the theater department to offer an introductory class on Maya taught from the theater perspective. —*Amanda Morris*

Two actors from the play *Willful* wear costumes made of leather, Tyvek®, linen, and jute. Kuzmanic wanted them to look like ancient books.

STUDENT BUILDS CAMPUS WITH MINECRAFT



Rothman's design in Minecraft shows the exterior of the Technological Institute on the Evanston campus.

On display in the lobby of Tech, there is a miniature model of Northwestern's Evanston campus, so detailed that it includes Alice Millar Chapel's stained glass windows and the Rebecca Crown Center's clock tower. Each sidewalk, courtyard, and fence is placed accurately and precisely. It's hard to believe the model was designed with a computer game.

Created by Ben Rothman, an undergraduate in computer science and applied mathematics, the scale model was created with Minecraft, a computer game that allows players to build constructions with textured cubes in a three-dimensional world. Using Minecraft, gamers typically place blocks to build fantastical worlds with majestic castles, futuristic spaceships, or enchanted forests. But Rothman was inspired to build something more practical—his dorm.

"I recreated Slivka Hall and then thought it looked lonely," Rothman says. "I needed to make the dorm across from it. And then I needed to make the building next to that. I didn't know how far it would go."

By the time Rothman completed Northwestern's north campus in its entirety, McCormick Dean Julio M. Ottino heard about the project. Having recently co-authored an article for *The Wall Street Journal* about the emerging technology of 3-D printing, Ottino asked Rothman about the possibility of building and printing the whole campus.

Recruiting fellow undergraduate Alex Chandel to help him finish the model, Rothman used a satellite image of campus, provided by Northwestern, and laid it beneath his Minecraft map. This ensured that every building, staircase, and water fountain was placed accurately and to scale.

"I had to redo Hogan Hall three times," Rothman says. "But the hardest was the Block Museum. It's easier to recreate buildings that have right angles. Every wall of the Block is at a different angle."

After six months and 600 hours of work, Rothman and Chandel finished Northwestern's entire Evanston campus at the end of spring quarter. Ottino put Rothman in touch with Michael Beltran, mechanical engineering, who is the instructor of the Rapid Prototyping Lab in the basement of the Ford Design Center. Trained by Beltran, Rothman printed sections of the campus model in 44 pieces.

"This was the largest print completed so far in the Rapid Prototyping Lab," Beltran says. "And the detailed buildings were much more fragile than what we typically print. We worked together on a couple of test prints of Tech to figure out the best way to print something so delicate."

Three-dimensional printing creates objects by laying down successive layers of materials. First the printer deposits a layer of tinted glue in the shape of the object's outline followed by a layer of powdered material that sticks to the glue. This process is repeated over and over in layers that are 0.10 millimeter thick. Rothman started printing every night at midnight when no one needed the equipment for schoolwork; then he checked on it in the morning after eight hours of printing. The University paid for the printing, which was estimated to cost between $2,000 and $2,500.

The printed sections emerged in full blocks of powder. Rothman vacuumed out the excess, leaving the glued outlines behind. Because color ink was mixed in with the glue, campus buildings materialized in full color.

"I felt like an archaeologist," Rothman says of the refining process. "I had to use dentistry tools and soft brushes to remove all the excess powder from corners and holes."

After printing, the structures have to be treated with glue. Typically, 3-D printed objects are dipped into a vat of glue, but Rothman's delicate buildings were too fragile for this process. So he applied glue with a Q-tip and dried it by hand.

Now displayed permanently in Tech, the five-foot-wide scale model of Northwestern is the largest 3-D print ever created with Minecraft and has even grabbed the attention of the games' creators. It will also change continually as the campus changes. Rothman will keep it up to date and has already added a new courtyard outside the Allen Center since the model went on display. When Rothman graduates, a new student will take over maintaining the model. —*Amanda Morris*

The top photo shows the structure of Tech emerging from the powder deposited by the 3-D printer. In the middle photo, Rothman uses a tool to blow away the excess powder, which falls through the perforated stand below to be recycled by the printer later. Because color ink is mixed into the printed glue, the color is already present on the remaining structure. Bottom: The finished product—a miniature, to-scale, 3-D model of Tech.

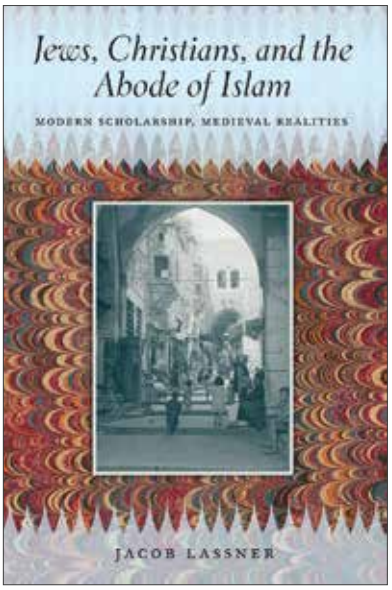
ON THE BOOKSHELF

Jews, Christians, and the Abode of Islam: Modern Scholarship, Medieval Realities

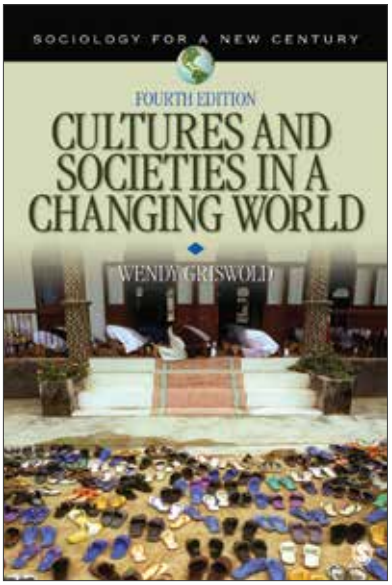
Jacob Lassner, history

University of Chicago Press, 2012

Jacob Lassner examines the triangular relationship that defined the political and cultural interaction among the three Abrahamic faiths during the Middle Ages—and that continues to define it today. He looks closely at the debates occasioned by modern Western scholarship on Islam to throw new light on the social and political status of



medieval Jews and Christians in various Islamic lands from the 7th to the 13th centuries. Drawing on a vast array of primary sources, Lassner balances the rhetoric of literary and legal texts from the Middle Ages with other, newly published medieval sources, describing life as it was actually lived among the three faith communities.



Cultures and Societies in a Changing World

Wendy Griswold, humanities

SAGE Publications, 2012

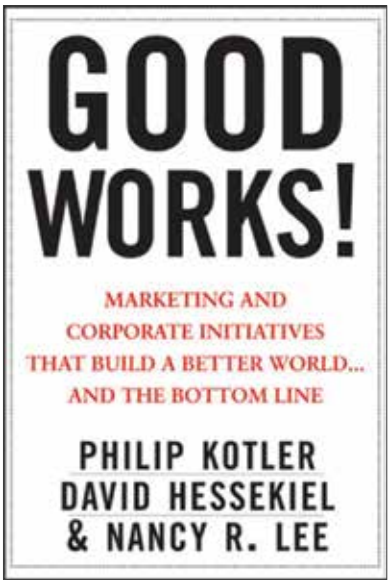
Author Wendy Griswold illuminates how culture shapes our social world and how society shapes culture. She helps students gain an understanding of the sociology of culture and explore stories, beliefs, media, ideas, art, religious practices, fashions, and rituals from a sociological perspective. Cultural examples from multiple countries and time periods will broaden students' global understanding, giving them a deeper appreciation of culture and society. The resulting insights will equip them to be more effective in their professional and personal lives and will help them become wise citizens of the world who can overcome cultural misunderstandings, conflicts, and ignorance.

Good Works!: Marketing and Corporate Initiatives that Build a Better World...and the Bottom Line

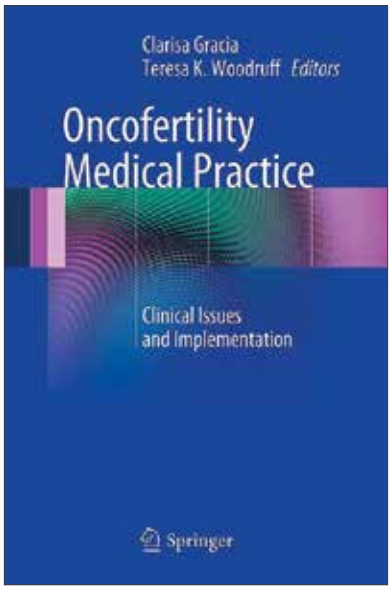
Philip Kotler, marketing, with David Hessekiel, Nancy Lee

Wiley Publishing, 2012

Businesspeople who mix cause and commerce are often portrayed as either opportunistic corporate "causewashers" who cynically exploit nonprofits or visionary social entrepreneurs for whom conducting trade is just a necessary evil in their quest to create a better world. Marketing and corporate social initiatives require a delicate balancing act between generating financial and social dividends.



Good Works! is a book for business builders, not a treatise on corporate social responsibility. It is for capitalists with the hearts and smarts to generate both positive social impacts and bottom-line business results. *Good Works!* is rich with actionable advice on integrating marketing and corporate social initiatives into broader business goals.



Oncofertility Medical Practice: Clinical Issues and Implementation

Clarisa Gracia (Editor), Teresa K. Woodruff, obstetrics and gynecology (Editor)

Springer, 2012

This is the third in a series of timely and indispensable books on fertility preservation for cancer patients; the first focused on advances in basic science research, and the second offered ethical, legal, and social perspectives.

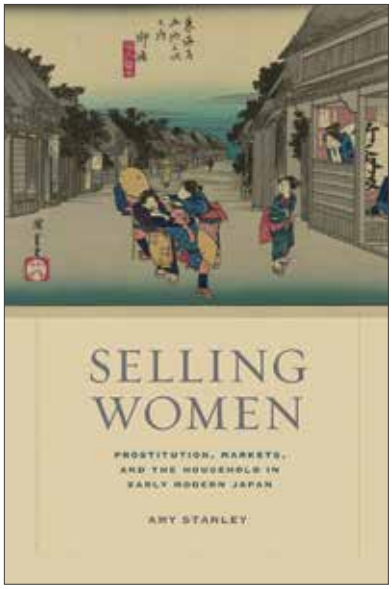
Elucidating the latest practices and emerging treatments in oncofertility, this book provides necessary information on the successes, risks, and limitations of fertility-preserving technologies. Authoritative and insightful, written by an impressive multidisciplinary cadre of specialists, it is a valuable, up-to-date resource for all those practicing in this demanding field.

Selling Women: Prostitution, Markets, and the Household in Early Modern Japan

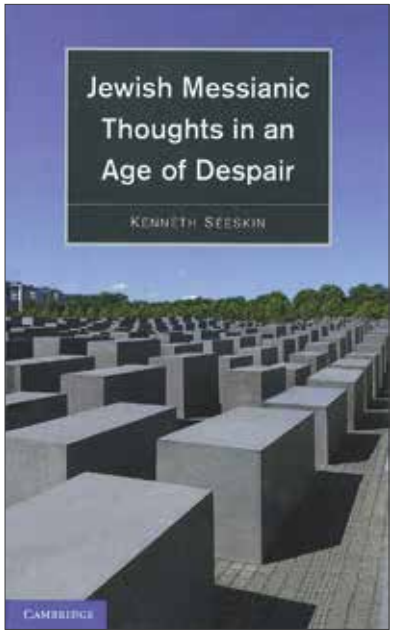
Amy Stanley, history

University of California Press, 2012

Amy Stanley traces the social history of early modern Japan's sex trade, from its beginnings in 17th-century cities to its apotheosis in the 19th-century countryside. Drawing on legal codes, diaries, town registers, petitions, and



criminal records, she describes how the work of "selling women" transformed communities across the archipelago. By focusing on the social implications of prostitutes' economic behavior, this study offers a new understanding of how and why women who work in the sex trade are marginalized. It also demonstrates how the patriarchal order of the early modern state was undermined by the emergence of the market economy, which changed the place of women in their households and the realm at large.



Jewish Messianic Thoughts in an Age of Despair

Kenneth Seeskin, philosophy

Cambridge University Press, 2012

Belief in the coming of a Messiah poses a genuine dilemma. From a Jewish perspective, the historical record is overwhelmingly against it. If, despite all the tragedies that have befallen the Jewish people, no legitimate Messiah has come forward, has the belief not been shown to be groundless? Yet for all the problems associated with messianism, the historical record also shows it is an idea with enormous staying power. The prayer book mentions it on page after page. The great Jewish philosophers all wrote about it. Secular thinkers in the 20th century returned to it and reformulated it. And victims of the Holocaust invoked it in the last minutes of their lives. Seeskin examines the staying power of messianism and analyzes it in a way that retains its redemptive force without succumbing to mythology.

STUNNING START-UPS WIN INNOVATION AWARDS

Courtesy of Kara Palamountain

Families stand in line at a vaccination site in Zambia. Northwestern Global Health Foundation's new HIV test is designed to work in locations, such as the one above, that are convenient to the patients.

Three spinoffs with Northwestern roots received "Up-and-Comer" awards at the 2012 Chicago Innovation Awards. The annual awards recognize the most innovative new products or services brought to market or public service in the Chicago area. Nine Up-and-Comer award winners were selected from 180 candidates.

The Northwestern-affiliated winners are the Northwestern Global Health Foundation, BriteSeed, and NuMat Technologies.

"The awards reflect the increasing presence of Northwestern as a hub for innovations and innovators in the local ecosystem," says Alicia Löffler, associate vice president for research and executive director of Northwestern's Innovation and New Ventures Office (INVO). "The companies that received awards also reflect Northwestern's strong interdisciplinary strength. Every single company involved more than one school."

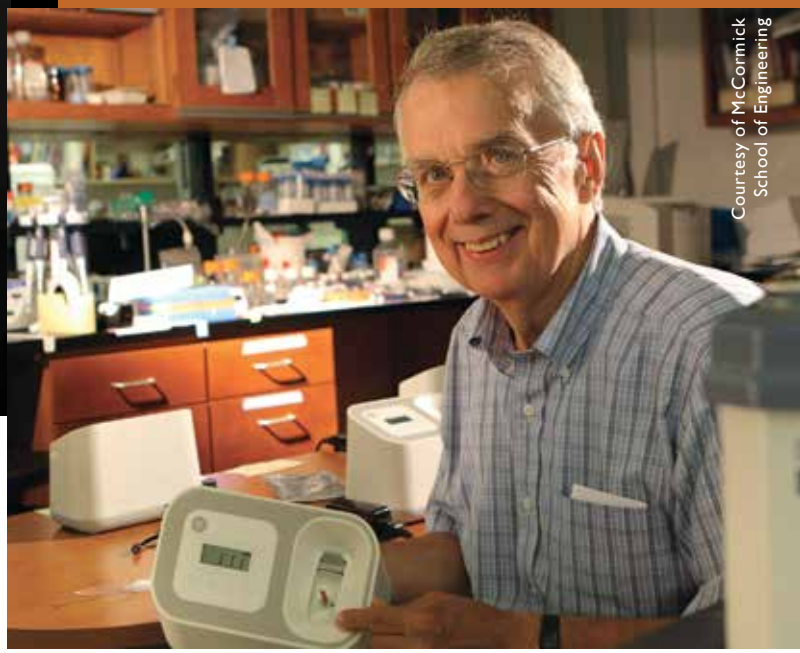
Northwestern Global Health Foundation

Today, mothers in Africa sometimes walk more than 10 miles to a clinic only to learn that conventional HIV test results for their babies are not yet available. Many never come back. Others never bother to have their infants tested in the first place. A new HIV test developed by the Northwestern Global Health Foundation (NWGHF) will help solve this problem. Designed specifically for use in developing countries, the test is a miniaturized, inexpensive version of the p24 HIV test.

NWGHF received an Up-and-Comer award for its first-of-a-kind HIV test that delivers a diagnosis in less than an hour while mother and child wait in the clinic. Before, the process of testing could take months. With this test, infants can be put on life-saving treatment right away.

"One and a half million infants in Africa and Asia are born to HIV-positive mothers each year, but only a fraction of HIV-positive infants are identified in time to start treatment," says David Kelso, biomedical engineering, who led the

Courtesy of Kara Palamountain


Courtesy of McCormick School of Engineering

David Kelso shows the LYNX p24 Test, which received the Up-and-Comer Award. The award is shown above with a close-up of the device.

development of the technology. "While adults can manage the disease for decades, an infant who isn't treated likely will die within a year or two."

NWGHF—an entity separate from Northwestern—was cofounded by Kelso and Kara Palamountain, managerial economics and decision sciences. Löffler, Robert Murphy, medicine: infectious diseases, Daniel Diermeier, managerial economics and decision sciences, and Matt Glucksberg, biomedical engineering, serve on the nonprofit's board of directors. According to Löffler, this is the first time a university has played an active role in supporting the development of products that will improve health in the developing world.

BriteSeed

For centuries, surgeons have relied on their sense of touch when in the operating room. Sensing a pulse helps them locate blood vessels, preventing accidental cuts that lead to unintended bleeding. As more and more operations become minimally invasive using laparoscopy, however, surgeons lose access to that tactile information.

BriteSeed, a medical device start-up company, received the Up-and-Comer award for its core technology, SafeSnips™.

SafeSnips™ integrates near-infrared technology into the tips of existing surgical cutting tools. The sensors detect the presence of blood vessels in the immediate cutting area and alert surgeons through video monitors used during laparoscopic surgeries.

"Not only does the tool show the presence of a blood vessel in real time," says Feinberg MD student and BriteSeed cofounder Paul Fehrenbacher, "but it gives information about the vessel's diameter and orientation as well as how fast blood is flowing through it."

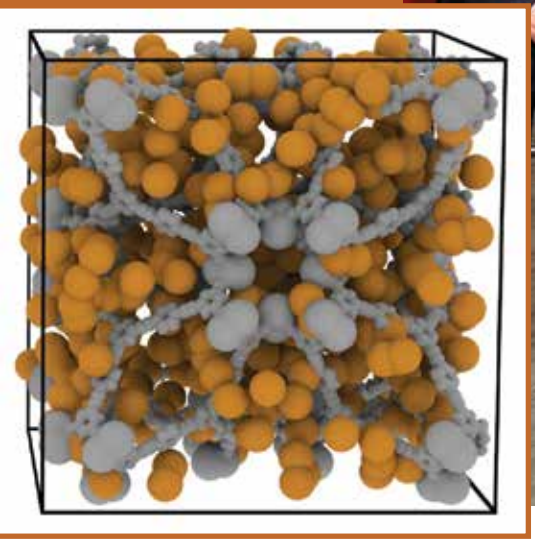
BriteSeed was born in the 2011-2012 NUvention: Medical Innovation program, an interdisciplinary experiential learning program designed to expose students to the entire innovation and entrepreneurial life cycle. After that course, the BriteSeed cofounders joined Chicago Innovation Mentors, an INVO program that offers coaching by a team of entrepreneurs who have built other Midwest science-based companies.

In addition to Fehrenbacher, the company's cofounders are School of Law 2012 alumnus Muneeb Bokhari, law student Jonathan Gunn, who has a PhD in biomedical imaging, and McCormick graduate student Mayank Vijayvergia. David M.


Courtesy of Paul Fehrenbacher

The BriteSeed team includes (from left to right): Paul Fehrenbacher, Mayank Vijayvergia, Jonathan Gunn, and Muneeb Bokhari.

Courtesy of Christopher Wilmer



The members of NuMat Technologies stand with the U.S. Secretary of Energy Steven Chu. Pictured from left to right are Omar Farha, Christopher Wilmer, Tabrez Ebrahim, Ben Hernandez, and Chu. The image on the left is an illustration of a metal-organic framework (MOF) structure. The MOF crystal (grey) stores natural gas (orange).

Mahvi, surgery, served as the team's mentor and is on the BriteSeed advisory board.

NuMat Technologies

When it comes to fuel for automobiles, many scientists believe that gaseous fuels—like natural gas or hydrogen—would be better for the environment than liquid fuels. Gases are more difficult to store, however, because they want to spread out and escape.

Using research from the laboratory of Randall Q. Snurr, chemical and biological engineering, and Joseph Hupp, chemistry, NuMat Technologies computationally designs and synthesizes metal-organic frameworks (MOFs), a new kind of nanoporous material that will change how the world stores, transports, and separates gases. MOFs have extremely high surface areas—one gram unfolded would cover an entire football field. Because gas molecules adhere strongly to the surfaces of their pores, MOFs soak up gases just like a sponge soaks up water.

NuMat Technologies created software that analyzes and quickly suggests ideal MOF structures for custom storage applications. This has the potential to transform products such as fuel tanks for natural gas vehicles.

"We view the Up-and-Comer award as further validation of the excitement surrounding our novel gas storage and gas separation technology," says NuMat's chief technology officer Christopher Wilmer, a PhD candidate in chemical engineering. "We are grateful to our supporters and sponsors, particularly ISEN [the Initiative for Sustainability and Energy at Northwestern], which has helped us enormously."

NuMat Technologies has been on a roll since the beginning of the year. The cleantech team—Wilmer, JD-MBA candidates Ben Hernandez and Tabrez Ibrahim, and research associate professor of chemistry Omar Farha—won five business plan competitions before receiving the Up-and-Comer award.

About the Awards

Established in 2002, the Chicago Innovation Awards honor 10 winners annually that fulfill unmet needs, spark a competitive response in the marketplace, and improve lives. Each year an expert panel representing 10 Chicago-area companies judges the entries. This year's winners were recognized on-stage before an audience of 1,500 people at Chicago's Harris Theater on October 22 and will ring the NASDAQ bell in New York City on February 25, 2013. Winners will also meet separately with Illinois Governor Pat Quinn and Chicago Mayor Rahm Emanuel to discuss their innovations and ways of advancing innovation in Illinois.

A complete list of this year's winners can be found at www.chicagoinnovationawards.com. *—by Amanda Morris*

REBUILDING THE LOST ARCHIVE

A typical research project using the Northwestern University Radiation Tissue Archive includes researching the data archive, selecting tissues to be sectioned, and processing them for regular histopathology, high throughput X-ray fluorescence elemental microscopy, or subjecting them to a variety of molecular analysis techniques focusing on proteins, DNA, or microRNAs.

From the 1950s until the end of the Cold War in 1989, the world lived in the shadow of the threat of nuclear war. While Americans dug bomb shelters and stockpiled food, scientists around the world worked to understand the biological consequences of nuclear radiation. Tens of thousands of mice, rats, and dogs were systematically irradiated during these studies, and the physical reactions were recorded. The animals' tissues, including lungs, spleens, and thymuses, were saved and preserved in paraffin for ongoing studies.

After the experiments formally ended in the early 1990s, Argonne National Laboratory—where some of the tests took place—began archiving the irradiated tissues for use in further studies. Then, without warning, funding was cut.

"They didn't even finish all the experiments," says Gayle Woloschak, radiation oncology. "The funding was cut, and the tissue samples from the studies were left to collect dust."

While working at Argonne in the mid-1990s, Woloschak felt compelled to study the preserved tissues. The samples included tissues that showed any sign of cancer, metastasis, or abnormality. Samples from blood that developed leukemia were also saved. Woloshak secured a grant from the US Department of Energy (DOE) to study mutations in these samples.

"Think about it this way: these are tissues from 49,000 mice and 7,000 dogs," she says. "No one is going to do an experiment that big ever again for financial and ethical reasons. That's what makes this data so valuable."

The collection of tissues comprising the archive is housed over several rooms in the Olson Pavilion and Ward Building. Both samples and data come from decades of research done by different US national laboratories; now they are all a part of Woloschak's collection, made possible by support from the US Department of Energy "Low-Dose Radiation" program and Northwestern's department of radiation oncology. The archive also preserves some of the tools, such as a beagle dog phantom (left at the bottom), used to calculate the exact doses received by different organs of irradiated animals.

NUCLEAR PARANOIA

The ethical reasons for not duplicating such an experiment are obvious. Cold War hysteria caused people to act in extreme ways. Students practiced civil defense training in their schools. They ducked and covered beneath their desks during routine bomb drills. Home economics classes taught girls how to furnish bomb shelters. *Life* magazine ran cover articles with titles such as "How You Can Survive Nuclear Fallout."

Even with fervent paranoia, some were still uneasy with the animal testing. According to Woloschak, participating researchers received volumes of hate mail. Because dogs react to radiation in ways that are similar to humans, they were selected for the experiments, which horrified many. An animal rights activist group even freed a group of irradiated dogs at the University of California-Davis. Emitting radiation, the dogs ran loose in the city for days.

Woloschak, whose computer wallpaper is a photo of her dog, understands the outrage.

"I have a dog, and I don't want another dog to die for experimentation needlessly," she says vehemently. "If we can use these tissues instead of wasting them, then we can avoid at least some further experiments."

MOVING TO NORTHWESTERN

And the tissues did come close to being wasted. After Woloschak moved to Northwestern in 2002, she was dismayed to hear that the tissue samples at Argonne were being disposed of for space reasons. With support from the DOE, she moved the samples to Northwestern in 2003 and began organizing an archive.

Each sample had been fixed and then embedded into a paraffin block. Shaving off a layer of the paraffin allows the tissues to be studied. Woloschak uses the tissues to study a type of microRNA that is associated with cancer. With certain cancers, the microRNAs are turned on; with other cancers, the microRNAs are turned off.

"New technology has allowed us to look at things in ways that we couldn't before," she says. "When researchers originally did these experiments, they didn't even know microRNAs existed. We weren't sure we'd be able to detect microRNAs in the first place, but we proved that we can."

Courtesy of Feinberg School of Medicine

Gayle Woloschak

While the hysteria surrounding nuclear bombs has faded over the years, the tissues can tell us about radiation treatments for cancer and help doctors prescribe the correct doses for those treatments. The tissues can also help researchers learn more about radiation exposure as experienced by people who live near nuclear power plants.

After publishing several papers that used the material and presenting her findings at conferences, Woloschak became identified with archiving radiation tissues. Representatives from several other institutions asked her if she could save their tissues as well. She collected samples from the Lovelace Respiratory Research Institute in Albuquerque, New Mexico, Pacific Northwest National Laboratory in Richland, Washington, UC-Davis, and the Armed Forces Radiobiology Research Institute in Washington, D.C.

With an estimated 20,000 samples, Northwestern is the official home for material from all US animal irradiation studies and has the world's largest set of tissues from irradiated animals. Too big for one room, the archive is stored among areas of Olson Hall and the Ward Building on the Chicago campus. Woloschak also serves on the advisory board for the tissue collections in the European Union, Japan, and Russia.

Tissue archive images by Tatjana Paunesku.

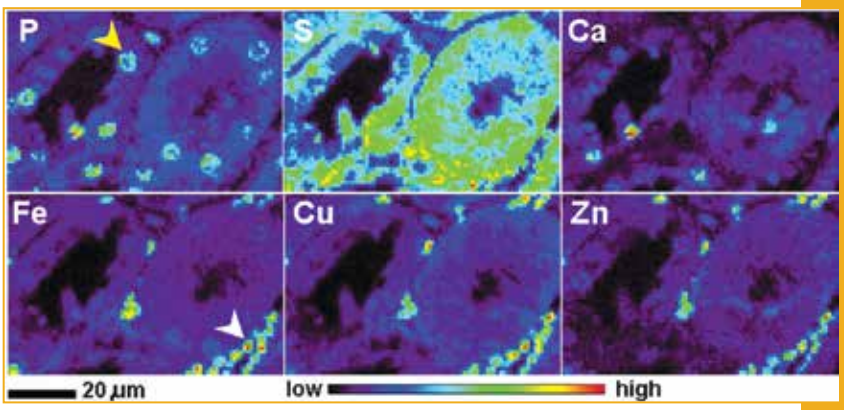
A GROWING ENTERPRISE

Twenty research groups from around the world are using samples from the Northwestern University Radiation Tissue Archive (NURA), and Woloschak hopes that many more will join. To facilitate this, she is building a website that displays all the data sets from the irradiated tissues (janus.northwestern.edu). The data will be available to anyone interested in viewing the numbers and analyses. She also ships materials to interested researchers.

A German dermatologist recently requested all the tissue samples from 16 dogs. He is studying the effects of radiation on the skin and will visit Northwestern in November to share the data from his research. Another group in Munich is using tissue samples to research the connection between radiation and heart disease.

"There are so many valuable questions that can be asked and answered with the tissues," Woloschak says. "Whenever people ask for something, I try to meet their needs. I want people to be able to use the samples in experiments that are relevant and meaningful."

To investigate the irradiated tissues further, Woloschak's research group developed a bionanoprobe that is housed at the Northwestern-run Life Sciences Collaborative Access Team (LS-CAT) at Argonne National Laboratory. The bionanoprobe can detect every element on the periodic table—including elements such as plutonium that are consistent with radiation—inside cells.



X-ray fluorescence microscopy for investigation of archival tissues. Published in *Health Phys.* 2012 103(2): 181-6.

"We can look at animal tissues and bones and ask where the plutonium really did go," Woloschak says. "Is it in the nucleus or cytoplasm of the bone tissue? This instrument has the best resolution in the world."

In addition to funding her tissue research, the DOE provides Woloschak with grant supplements to help maintain the archive, which her group organizes and catalogues. The process is slow, but by archiving, Woloschak helps push forward the understanding of radiobiology while minimizing the research costs and reducing the sacrifice of animals. —*Amanda Morris*

Picture This: The Worlds of Wonder at Core Facilities

In an era of economic uncertainty, institutions are looking at ways to economize. Many research universities are moving toward greater efficiency and effectiveness by cooperating in the use of expensive equipment and technology. Sometimes the cooperation works within the institution; at other times, it means allowing greater access to the equipment from neighboring colleges and universities as well as corporations. Not surprisingly, Northwestern is involved in both.

"There is a nationwide trend—and it's growing—to place core facilities in a bigger context," says Phil Hockberger, director of core facilities in the Office for Research. "They can be a big business—at Northwestern alone we invest more than $18 million in core facilities."

Core facilities are specialized laboratories with unique (usually expensive) instruments, services, and technical support. Approximately 50 such facilities serve the Northwestern community, plus two more are available at Argonne National Laboratory. Over the past four years, Northwestern has added more than a dozen new core facilities. Some of these are department cores. Others operate between departments or schools.

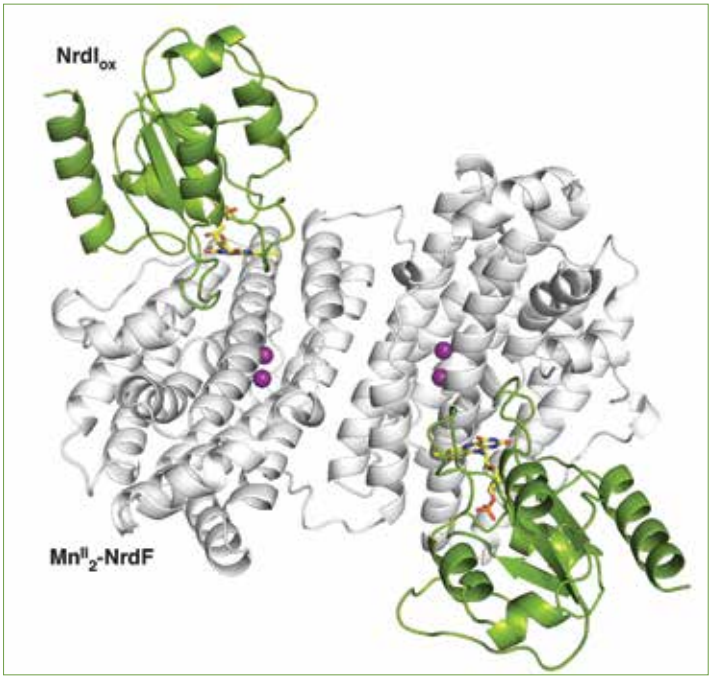
Most of these facilities are operated as recharge centers that require a fee for service. Researchers usually pay for these services through their grants and contracts. Because the fees do not cover all expenses, most facilities are subsidized by their departments, schools, centers, and the Office for Research. Federal regulations prohibit core facilities from serving as profit centers for their universities.

Hockberger sees a growing professionalism among those who administer the facilities. They are seeking professional, technical, and business training that better equips them to run their centers as businesses.

He also describes the move toward greater access among local institutions. The Chicago Biomedical Consortium (CBC) provided seed funding for the Chicago region's Open Access Initiative, involving faculty from Northwestern, the University of Chicago, and the University of Illinois at Chicago. Through this initiative, schools pool their specialized instrument and equipment resources for the benefit of all.

Take this quiz to test YOUR knowledge of the core facilities.

Which answer describes the pictures?



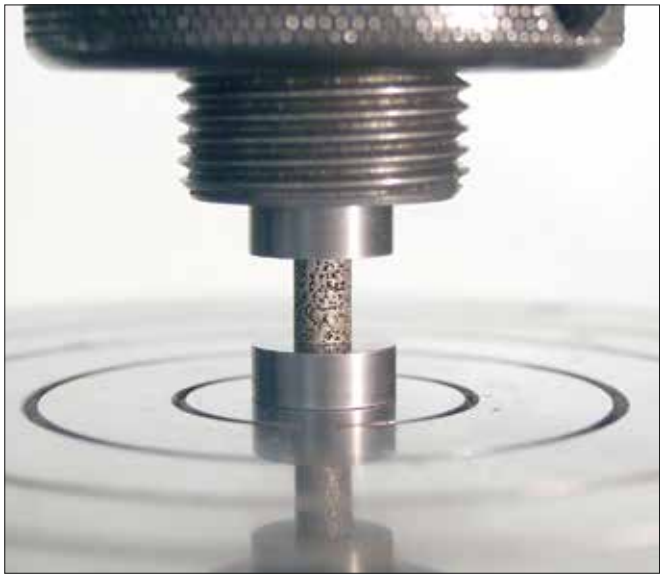
1

a. Martian rotini

b. Leftover St. Patrick's Day decorations

c. Model of X-ray diffraction of a protein complex

Answer: (c) This model of the NrdF:NrdI protein: protein complex was created for the Amy Rosenzweig lab in molecular biosciences at the Structural Biology Facility, which has instruments and personnel on both campuses and at the LS-CAT at Argonne.



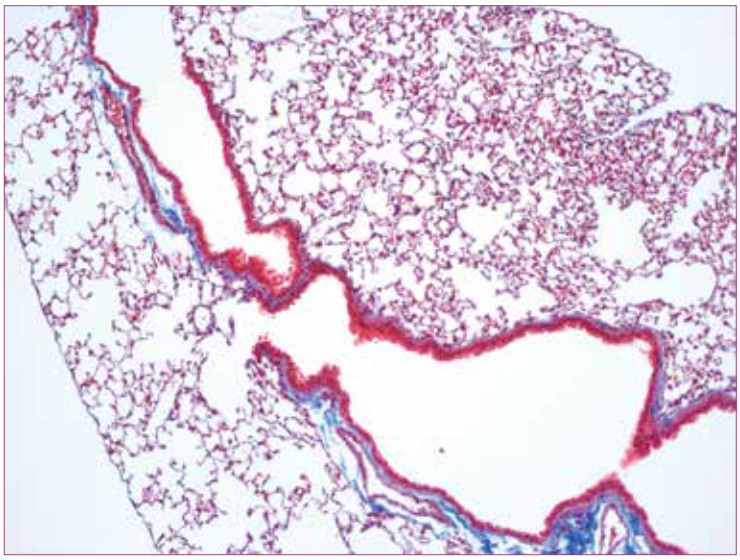
2

a. A compression test

b. A machine that mimics the feel of migraine headaches

c. A demonstration of what inflation does to a dollar's buying power

Answer: (a) Metallic foam from David Dunand's lab undergoes a compression test at the Central Laboratory for Materials Mechanical Properties (CLaMMP). Image courtesy of Mark Seniw, manager of CLaMMP and of the Mechanical Behavior Facility at McCormick.



3

a. A map of the Suez Canal

b. An image of a section of a mouse lung

c. A super-close-up of an oil spill

Answer: (b) Image of a section of mouse lung, magnified 200 times, from the Mouse Histology and Phenotyping Laboratory (MPHL). Image courtesy of MPHL.

4

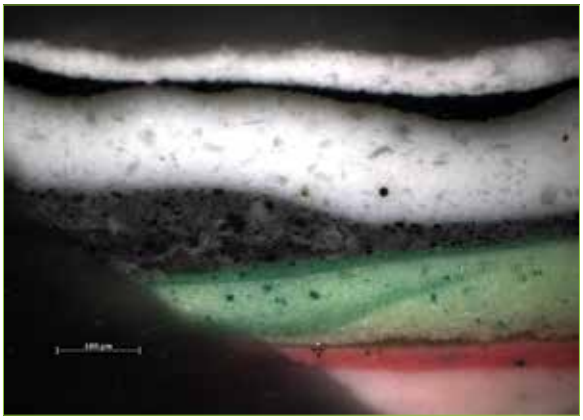
a. Movie still from *Honey, I Shrunk the Kids*

b. A plumber in a bomb shelter

c. A researcher using a spin coater

Answer: (c) Josh Goldberger, a former postdoctoral researcher in the Samuel Stupp group, uses a spin coater to coat a thin film of photoresist onto a silicon wafer in the Institute for BioNanotechnology in Medicine (IBNAM) cleanroom core facility. The lighting is yellow-orange to prevent ultraviolet light from prematurely exposing the photoresist, which Goldberger compares to the exposure of undeveloped film in a camera. Photograph courtesy of Josh Goldberger.

5



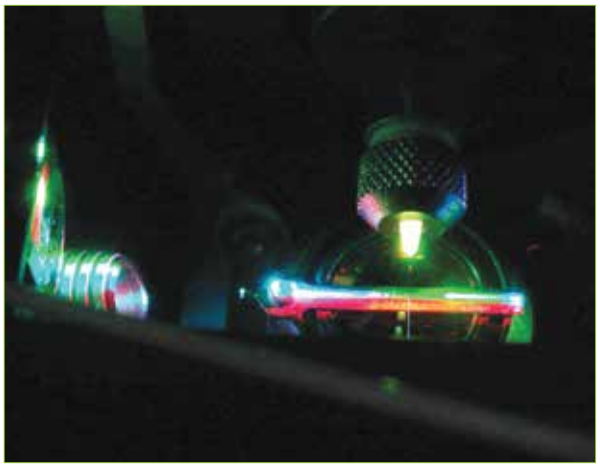
a. Close-up of a deli sandwich

b. Cross-section of a piece of sushi without its wrapping

c. Magnified paint sample from the Matisse painting *Bathers by a River*

Answer: (c) A paint sample from Henri Matisse's painting *Bathers by a River* has been magnified 200 times by an optical microscope at the Northwestern University Atomic and Nanoscale Characterization Experimental Center (NU*ANCE*). Image courtesy of Inge Fiedler.

6



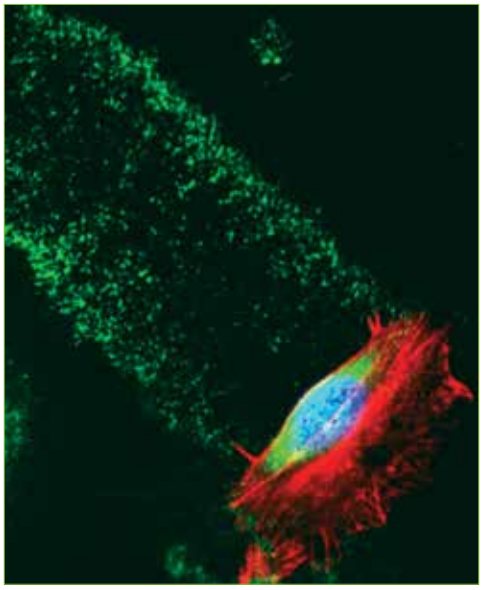
a. The intersection of lasers in a flow cytometer

b. A drill bit

c. A robotic insect

Answer: (a) Colorful lasers intersect with cells in the interrogation chamber of a flow cytometer at the Interdepartmental Immunobiology Flow Cytometry Core Facility in the Robert H. Lurie Comprehensive Cancer Research Center. Image by James Marvin.

7



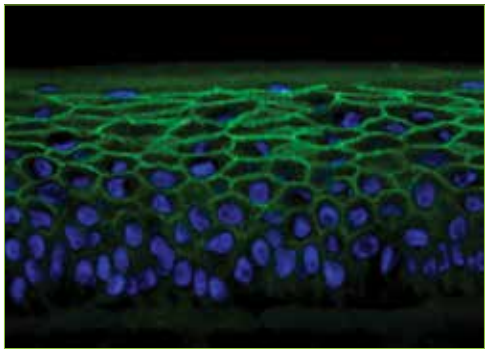
a. A new contact lens cleaner

b. A confocal microscope image of a cell migrating over the surface of a coverslip

c. A flying saucer coming in for a landing

Answer: (b) This image of a cell migrating over the surface of a coverslip was taken with a confocal microscope at Cellular Imaging Facility (CIF). The image was taken by Phillip DiBiase, a former student in the lab of Jonathan Jones, cell and molecular biology.

8



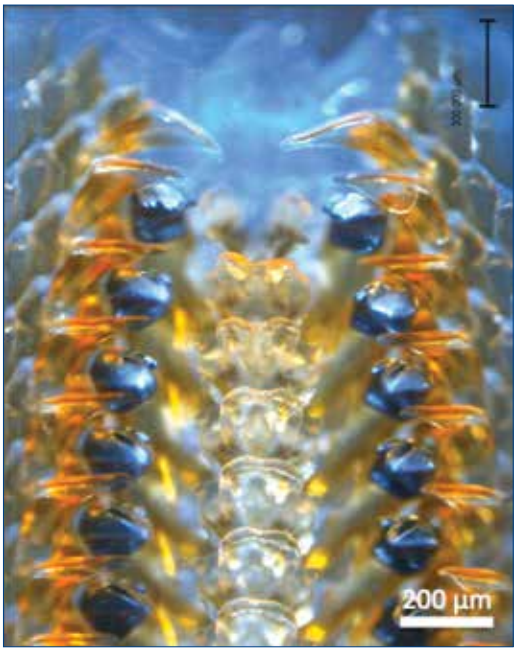
a. An abstract painting of blueberries on grass

b. A three-dimensional cell-cell adhesion molecule in an epidermal equivalent

c. The landscape of Iceland

Answer: (b) The image depicts immunofluorescence staining of a cell-cell adhesion molecule in a three-dimensional epidermal equivalent. Image courtesy of the lab of Spiro Getsios, dermatology, a member of the Skin Disease Research Center.

9



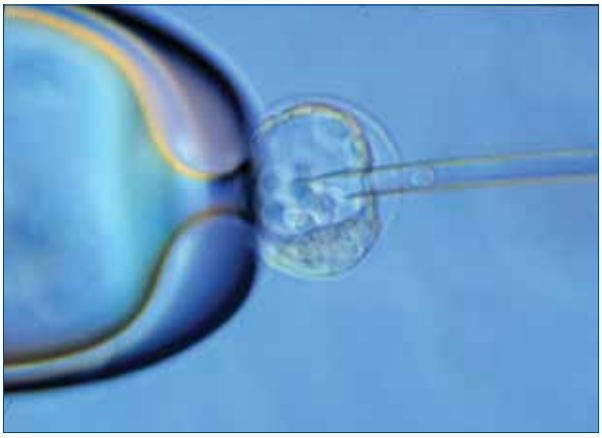
a. A crustacean skyscraper

b. A magnified view of a hair clip

c. A tooth viewed by atom probe tomography

Answer: (c) A three-dimensional map of a mollusk tooth. This analysis was run at Northwestern University Center for Atom Probe Tomography (NUCAPT) using atom-probe tomography, a micro-analytical instrument that produces an atom-by-atom, three-dimensional reconstruction of a sample in direct space. Image by Derk Joester, materials science and engineering.

10



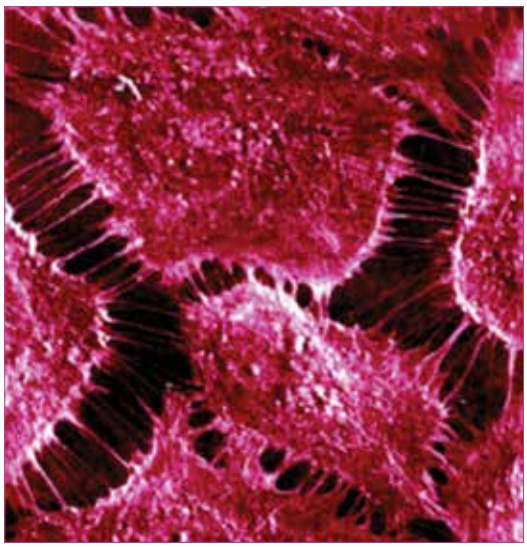
a. A scan of a tongue touching a lollipop

b. Genes being microinjected into an embryo during transgenesis

c. A dandelion seed landing on a drop of water

Answer: (b) A pipette on the left holds an embryo as it is microinjected by the needle on the right. The needle transfers genes into the blastocyst of the embryo during the transgenesis process at the Transgenic and Targeted Mutagenesis Lab (TTML). Image courtesy of Lynn Doglio, Center for Genetic Medicine, Feinberg.

11



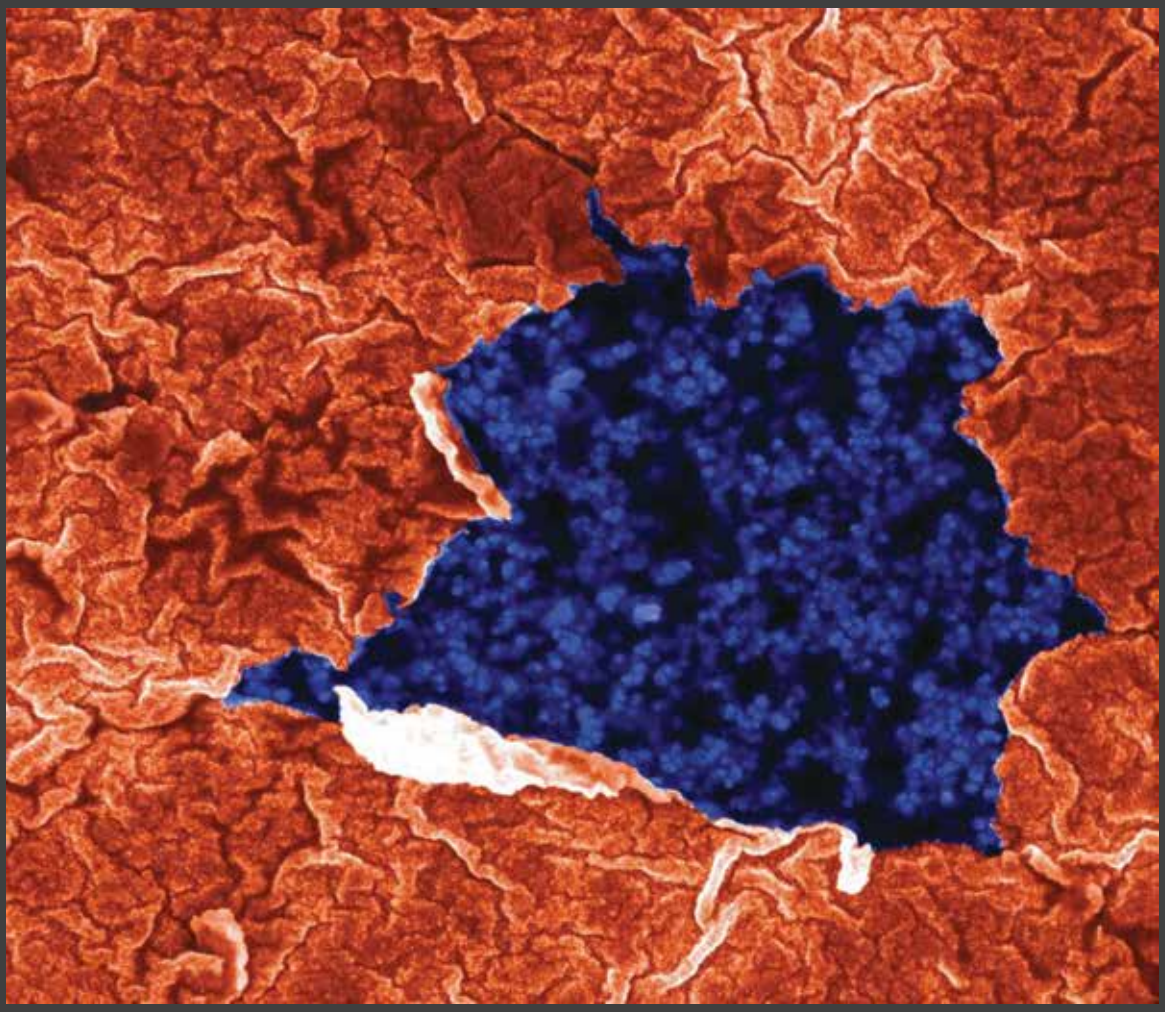
a. Human pulmonary endothelial cells

b. Laboratory–grown artificial meat

c. A close-up of a Venus Flytrap

Answer: (a) A modulus map of human pulmonary artery endothelial cells transfected with thrombin to study the dynamic nanomechanical property measurements to develop therapeutic strategies for acute lung injury. A collaborative project between Northwestern and researchers at the University of Illinois at Chicago, the image was taken by a bioscope catalyst at the Nanoscale Integrated Fabrication, Testing, and Instrumentation (NIFTI) Center. Image courtesy of Gajendra S. Shekhawat, materials science and engineering.

Center | Point



***Carbon Black Nanoparticles* by Dmitriy Dikin, mechanical engineering and physics and astronomy**

Carbon black nanoparticles have been used in car tires for decades. Because of their size and superior properties, they can withstand the extreme temperatures, speed, and grip that tires encounter on a daily basis. But only in the last ten years have researchers really begun to examine how these nanoparticles interact with each other and with rubber polymers. This knowledge will lead to the more efficient design and production of new materials. In this image, the blue dots are the carbon black nanoparticles, and the black area is the rubber polymer. The orange is a thin metal coating used to stabilize the material during analysis. In this instance, the metal film ruptured to reveal the nanoparticles beneath. This image was featured in Northwestern's annual Science in Society Scientific Images Contest.

To see all of this year's winning images, visit www.scienceinsociety.northwestern.edu/gallery/2012-scientific-images-contest-winners.

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