

inquiry@

2015-16

UC SANTA CRUZ
RESEARCH MAGAZINE

#1 in research
influence in
the world

Leading research influence

UC Santa Cruz ranked first in research influence among the world's top universities, according to the World University Rankings, published annually by *Times Higher Education* (THE).

"This placing should come as no surprise to anyone familiar with UCSC," said Scott Brandt, vice chancellor for research. "That is an accurate reflection of the world-class research that takes place across our campus. UCSC is too small to be best at everything, but

it is big enough to be best at everything we choose to do. That is as true of our research—as reflected in THE rankings—as it is of the educational opportunities that we provide to our students."

Slugs earned the top slot with a citation score of 100, tying for first place with MIT, and edging out Rice University at 99.9. The score is based on counting the average number of times publications by UCSC researchers were cited.

The spirit of **inquiry@UC Santa Cruz**



WELCOME TO THE INAUGURAL issue of *inquiry@UC Santa Cruz*. The Office of Research and University Relations are proud to sponsor this annual research magazine. The purpose of *inquiry* is to present a campus-wide snapshot of our world-class research and a sense of "who we are" as a community of researchers and to draw out the complex interplay between pioneering research at

UCSC and our investigators' vision and passion.

Reading through these briefs and features, one finds the diversity of high-impact research at UCSC striking. We see examples of UC researchers conducting and leading complex

inter-institutional scientific research to better understand our changing natural world; we see humanist archival scholarship retrieving worlds of lost cultural meaning; we see monographs on prison reform that are informing policy decisions; and we see the development of new technologies to aid and empower people with physical challenges. No wonder the *Times Higher Education* World University Rankings placed UCSC #1 in the world in research impact and #8 overall among world universities under 50 years old!

We hope you enjoy *inquiry@UC Santa Cruz* for 2015–16. It is a great privilege to support and foster the growth of research at UC Santa Cruz as we celebrate our 50th anniversary.

Scott A. Brandt
Vice Chancellor for Research
and Professor of Computer Science

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About the cover: The cover illustration by Keat Leong is based upon a gamma-ray burst of a galaxy.

BRIEF inquiries

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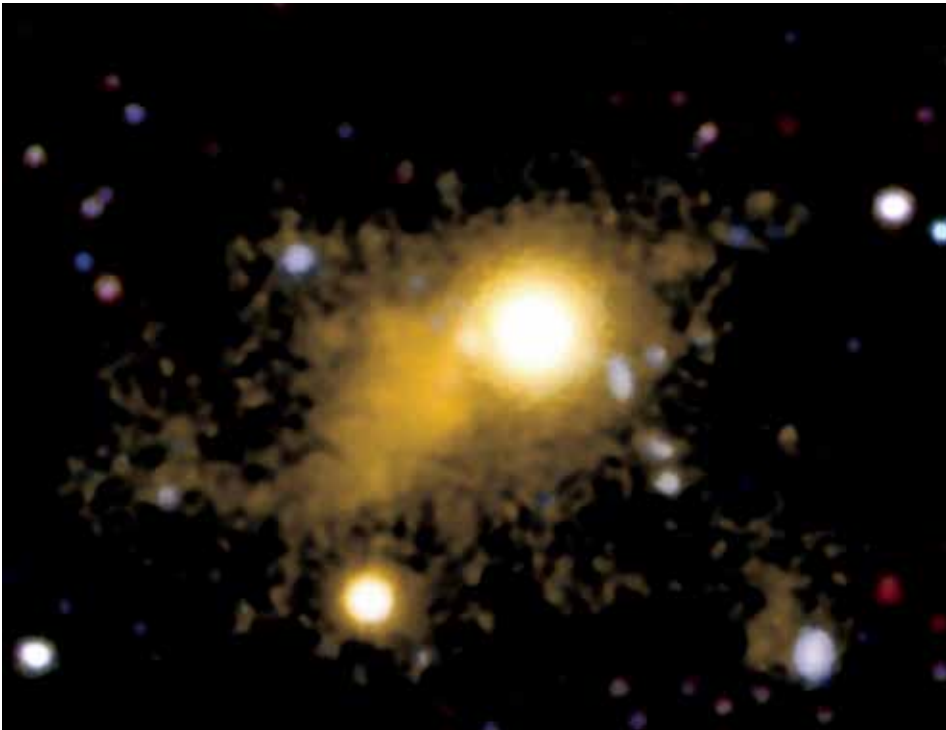
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The “Slug Nebula” detected by UC Santa Cruz astronomers extends across 2 million light-years of intergalactic space.

Cosmic Slug Sighting

When UC Santa Cruz astronomers caught strands of the “cosmic web” on camera, it was the first time anyone had glimpsed the intergalactic threads that were predicted to weave through the universe. The discovery was recognized by the editors of *Physics World* as one of the “top ten breakthroughs” of 2014.

“It’s a one-of-a-kind finding,” said J. Xavier Prochaska, principal investigator on the study. “But now we’ll look aggressively for more. Our studies are forcing theorists to revisit their models.”

Computer simulations of the universe predicted that matter, such as galaxies, is distributed in a web-like configuration. But visible evidence for these predictions was missing. Prochaska’s team, which includ-

ed UCSC astrophysicist Piero Madau, and former UCSC astronomer Sebastiano Cantalupo, provided that proof.

From the W. M. Keck Observatory in Hawaii, the researchers took advantage of a quasar they found in a new nebula (now named the “Slug Nebula”). The quasar’s bright light illuminated the previously dark filamentary pattern of nearby gases.

Next year, the researchers plan to use a new camera, currently in fabrication at the UC Observatories Lab at UCSC, capable of capturing both images and spectra.

Four years ago, Prochaska’s research group garnered a top ten break-through from *Physics World* for discovering pristine gas and confirming theories of the Big Bang.

**BIOMOLECULAR
ENGINEERING**

Single Cell Technology

A new nanobiopsy technique helps scientists peer into cells.

With a tip so tiny it can’t be seen with a microscope, a pipette engineered by UC Santa Cruz researchers is small enough to pierce a single living cell without causing any damage. The computer-automated technique, developed in Nader Pourmand’s multidisciplinary laboratory, Biosensors and Bioelectronics, was described in *ACS Nano*.

“We can now go in and sip a little content from a cell to see what it is doing, while it is doing it,” said Pourmand, professor of biomolecular

engineering in the UC Santa Cruz Baskin School of Engineering.

This nanopipetting method makes it possible for researchers to regularly monitor individual cells. Measuring minuscule changes in cell contents, such as sugar levels, can mark a cell’s metabolic march from healthy to abnormal. The scientists also showed they can extract single organelles and measure RNA or DNA samples to discover which genes are being turned on or off at any given time.

“Until now we’ve been looking at endpoints of disease, but there’s a lot we’re missing in between,” Pourmand said. “This technique can help us get those details.”

For this work, Pourmand’s

team became a finalist in “Follow That Cell,” a national NIH competition for novel solutions to study single cell dynamics.

**INFORMATION
TECHNOLOGY**

Connected Community

More than a decade of legwork by UC Santa Cruz information technology specialists garnered a \$10.6 million state grant to boost the fiberoptic highway for Internet connections south of Santa Cruz.

Those funds will help place 91 miles of data-carrying cable, from Santa Cruz to Soledad, to create a “backbone circuit” to back up lines if existing ones fail. The circuit will also offer more

Internet provider access options for communities along the way.

“Education and research demand this kind of Internet capacity,” said Brad Smith, the UCSC director of research and faculty partnerships in Information Technology Services.

Smith and his colleagues scouted for efficient ways to add fiberoptic lines to existing structures or upcoming construction projects. Once a route was identified, they teamed up with Sunesys, a telecommunication company that previously installed lines from the campus to Sunnyvale, and the Corporation for Education Network Initiatives in California.

“The synergy of this project is nice,” said Smith. “We were able

Sea Star Scourge

For the past two years, sea stars along the Pacific coast have suffered catastrophic die-offs. The disappearance of these key predators could have profound effects on their tide pool and near-shore ecosystems.

In collaboration with UC Santa Cruz and other institutions, biologists at Cornell University identified a “sea star associated densovirus” as the most likely cause. Although the densovirus was a novel discovery for researchers, the infectious agent was found in museum specimens of sea stars collected in 1942. The study was published in the *Proceedings of the National Academy of Sciences*.

“The question is why a virus that’s been around for years went rogue,

or whether environmental stressors made the sea stars more susceptible,” said Peter Raimondi, UCSC professor and chair of ecology and evolutionary biology.

There may be good news, though. “In the last six months, we’re seeing more sea star babies than we’ve seen in some places for the last 15 years,” said Raimondi, who leads the Pacific Rocky Intertidal Monitoring Program. “If the disease is gone, this new generation could replenish populations more quickly than expected.”

Marm Kilpatrick, associate professor of ecology and evolutionary biology, and Melissa Miner, a research specialist at Long Marine Laboratory, also contributed to this study.



Tissue is disintegrating on the two lower arms of this sea star affected by sea star wasting syndrome.

PHOTOS: SLUG NEBULA, S. CANTALUPO, X. PROCHASKA, UCSC; SEA STARS BY MELISSA MINER

BRIEF inquiries

to use UCSC expertise to solve a university problem and benefit the community."

The project is estimated to take two years and \$13.3 million dollars to complete, Smith said.

LINGUISTICS

Native Tongue


Learning other languages can be difficult. So, when UC Santa Cruz linguists wanted to understand Irish Gaelic, they went straight to the source. To decode the complex language, the researchers make ultrasound videos of the tongue while native speakers form words. The project, "Collaborative Research: An Ultrasound Investigation of Irish Palatalization," was awarded a \$261,255 grant by the National Science Foundation.

Although Irish Gaelic is Ireland's official language, it's spoken by less than five percent of the population. One unusual aspect of the language is that every consonant can be pronounced two ways; either with the tongue raised and pushed forward, or raised and pulled back.

"It's very difficult to describe what the tongue is doing without actually seeing it," said Grant McGuire, an assistant professor in the Linguistics Department and co-investigator of the study. "Ultrasound allows us to see the tongue movement in real time."

The precise tongue movements are documented by placing an ultrasound probe under the chin of native Irish speakers while they talk. So far, the team has

Sea Otter Supermoms



A female sea otter and her pup

of ecology and evolutionary biology.

Just to survive in a cold water habitat, these small marine mammals need to eat 25 percent of their body weight in food every day. "But we didn't know how much more energy a mom needed to provide for her pup," Thometz said.

To calculate the daily caloric needs of pups, from birth until six months of age, Thometz observed 26 wild sea otters to construct their daily activity budgets. Then, to determine the energetic cost of these activities, she recorded oxygen consumption during activities of seven young otters (in rehabilitation for release back into the wild) at the Monterey Bay Aquarium. Thometz then estimated that moms had to double their energy intake when caring for a large pup. After pregnancy and nursing, females may be too energetically depleted to meet those demands without risking their own lives, she said.

"Sea otters are apex predators in the kelp forest. If we understand what impacts their population, we'll understand more about our coastal ecosystems," Thometz said.

Thometz discovered the high-energy needs of pups may push their moms beyond their metabolic means. Her findings on "end lactation syndrome" were published in the *Journal of Experimental Biology*. The study was co-authored by Terrie Williams, professor

OTTER PHOTO: JOE TOMOLEONI; COUGAR ILLU. BY CORLIS SCHNEIDER

studied 16 people from three regions of Ireland.

Also on the project are linguistics professor Jaye Padgett, former UCSC grad student Ryan Bennett, and Irish colleague Máire Ní Chiosáin.

"We're studying one endangered language. But this fieldwork teaches us more about the way all languages work," McGuire said.

BIOMOLECULAR ENGINEERING

Reclassifying Cancer

Cancers are often categorized—and treated—according to where they are found in the body. But it may be more effective to base treatment on the molecular makeup of cancers, regardless of where they occur, according to a study published in *Cell*.

The same role can be played by cells in different parts of the body, explained Josh Stuart, a professor of biomolecular engineering at UC Santa Cruz and senior author on the paper. For example, cells that develop to form layers on surfaces may line the bladder, the throat, or other places. With similar origins, these cells may also share molecular pathways leading to cancer, and

respond to the same treatments.

As part of the TCGA Pan-Cancer Initiative, a team from UCSC and the Buck Institute for Research on Aging led researchers to analyze data from 3,500 patients with 12 different cancer types. When the

cancers were grouped by "cell of origin," the data suggested that 10 percent of these cancers could be reclassified, potentially leading to different treatment options.

"This molecular information gives us a new kind of microscope

to look at cancer," said Stuart.

The researchers are now refining their results, analyzing 35 tumor types from 11,000 patient samples.

The UCSC-Buck team is led by Josh Stuart, David

Haussler, the director of the UCSC Genomics Institute, and Christopher Benz, of the Buck Institute in California.

MOLECULAR, CELL AND DEVELOPMENTAL BIOLOGY

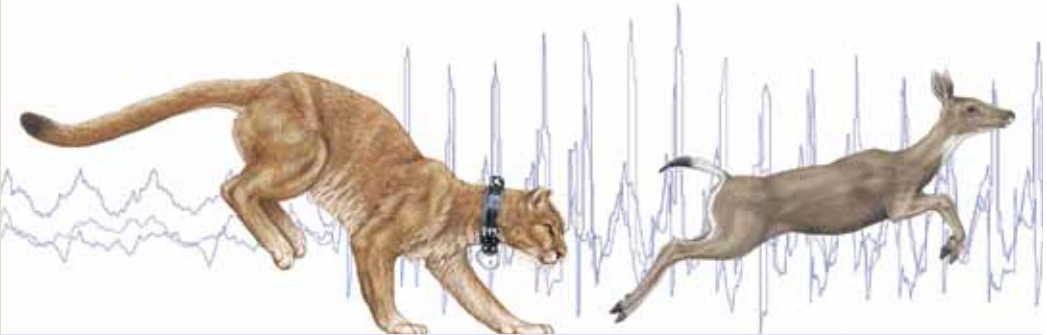
Inheriting Memory

Studies have shown that parents can pass on memories of fear and famine to their children. But scientists don't know how such experiences are handed down. A research team at UCSC demonstrated how "epigenetic" memory, created by changes in the way DNA is packaged in cells, could be inherited. The study was published in *Science*.

"We're used to thinking about DNA sequences being passed from parent to child," said Susan Strome, a professor of molecular, cell and developmental biology, who led the study. "Less clear is whether the way DNA is packaged can also be passed from parent to child, and through cell divisions."

When DNA is tucked into each cell, the way DNA is wrapped affects whether genes are accessible to getting turned on or off. Histones are proteins that help wrap DNA. So, changes to histones may modify that packaging process and cause "epigenetic" effects, altering the expression of genes without changing the DNA itself.

In this study with roundworms, Strome's lab chemically changed one specific histone marker in either an egg or sperm, and put a fluorescent tag on it. After fertilization



People make pumas eat and run

Pumas don't like hanging around human dwellings. That's good news for people. But that aversion makes the big cats kill more often when they live near high-density housing, according to a study published in the *Proceedings of the Royal Society B*. That behavior may affect local prey populations and the reproductive success of the pumas.

After a kill, mountain lions usually spend several days close to the carcass, eating their fill, explained Justin Smith, a Ph.D. candidate in the UC Santa Cruz Environmental Studies Department, and lead author on the study. "When humans are around, the animals leave their kill more often. That's a lot of time and energy to give up, especially for females raising cubs," she said.

The researchers followed 30 pumas that were outfitted with GPS mon-

itoring collars, as part of the Santa Cruz Puma Project, led by Christopher Wilmers, associate professor of environmental studies. They found that females living in the highest housing density areas killed 36 percent more deer each year than females in more pristine habitats.

"We might be optimistic about results that show pumas can hunt successfully in a developed landscape," said Smith. "But we know it takes substantial energy to hunt, and some of these females are killing a lot more."

In a previous study, led by Terrie Williams, UCSC professor of ecology and evolutionary biology, researchers calculated the caloric cost of various hunting strategies—waiting, stalking, or pouncing. The results, published in *Science*, showed pumas save their high-calorie burning efforts for the bigger prey payoffs.

BRIEF inquiries

(and commingling of the egg and sperm chromosomes), the bright tags persisted only on chromosomes that were direct DNA descendants of the altered egg or sperm. This showed how one “parent” could transmit epigenetic information to its offspring—a step toward elucidating mechanisms for more complex memory inheritance.

“The implications are profound for considering how environmental and nutritional conditions that parents experience could affect a child,” Strome said. “Those conditions may affect how DNA is packaged, and that can be inherited.”

PSYCHOLOGY

Property and Power

The global rise of violence against women reflects inequalities in the structure of societies. In developing countries, where property confers power, women who own land are less likely to be victims of abuse, according to a study published in *Psychology of Women Quarterly*.

“Violence against women doesn’t start as an abusive relationship,” said Shelly Grabe, an associate professor of psychology at UC Santa Cruz who led the research. “The abuses of power start at a much higher level. If we want to eradicate abuse, we need to go back to those larger structural relationships. Of those larger relationships, land ownership is key.”



Feeling Blue

The National Endowment for the Arts awarded UC Santa Cruz a \$45,000 grant to support “Blue Trail: Imagination and Innovation for Ocean Sustainability,” a series of interactive installations for the San Francisco waterfront.

The mascot for this project, “Oceanic Scales,” was inspired by the micro-organisms of the sea. Through an interactive digital art installation and game, the exhibit invites visitors to explore the role of phytoplankton in maintaining a balanced ocean ecology.

“Call it art. Call it science. Call it cultural curiosity,” said Jennifer Parker, associate professor of art, and founding director of OpenLab, UC Santa Cruz’s art-science research center. “We’re

exploring how art can engage people to think differently about our natural environment.”

Blue Trail resulted from conversations among campus colleagues looking for new opportunities to encourage public awareness of the environmental crisis in our oceans. The physical creation of the Ocean Scales exhibit incorporates sustainable construction into the theme.

“OpenLab develops work for experiencing art and science research that is accessible to the general public,” Parker said.

UC Santa Cruz was one of 886 non-profit organizations to receive an Art Works grant.

Installation view of UC Santa Cruz OpenLab’s Blue Trail: Oceanic Scales art and science project at the California Academy of Sciences in San Francisco, CA.

Grabe interviewed 492 women in Nicaragua and Tanzania. She gathered information that included their age, education, number of children, experience of violence, and land ownership. Her analysis suggested that shifting control over resources—land in particular—can dramatically change women’s lives.

One interviewee said: “Those times he used to beat you, he beats you because he knows you depend on him...But if he finds you have your own place, he can’t be able.”

“My data documents that we need to challenge the roots of abuse, rather than dealing with consequences,” said Grabe.

Rose Grace Grose and Anjali Dutt, graduate students in psychology, were co-authors on this study.

Dance Moves

The phrase “going through the motions” implies laziness or lack of interest. But elite dancers often substitute hand motions for full body movements while they learn demanding dance routines. This practice,

called “marking,” may improve the quality of the finished performance, according to a study published in *Psychological Science*.

“Marking is an unusual cognitive device that we see in other areas. Basketball players use it to create muscle memory for free throws,” said Ted Warburton, a professor of theater arts at UC Santa Cruz. “But in dance, it’s more than a form of mental rehearsal. It’s a unique tool that makes a mental connection to an action, but also can enhance the quality and expression of that action.”

In this study, 38 advanced ballet students were divided into two groups to learn a basic routine. Judges awarded higher scores, for execution and artistic expression, to performances given by dancers who were allowed to mark during rehearsal.

This technique may spare strain on the bodies and minds of dancers, said Warburton. But it might also be useful in other learning situations.

Co-authors on the study included Margaret Wilson, a UCSC associate professor of psychology.

GEOPHYSICS

Fault Finding

The seafloor jumped about half the length of a football field when a magnitude-9 earthquake hit Japan in 2011, triggering a devastating tsunami and surprising scientists.

“That’s the largest slip recorded—ever. The question was: Why?” said Emily Brodsky, a UC

Santa Cruz geophysicist and co-author of three papers about the Tohoku-Oki earthquake published in *Science*.

The answer was in the temperature of the rocks beneath the sea.

During earthquakes, tectonic plates generate friction when they grind against each other. High levels of friction create intense heat that takes several years to dissipate from rock. Those frictional forces can be calculated from temperature measurements, explained Patrick Fulton, a UCSC seismologist on the heat-seeking mission.

The UCSC scientists joined an international research team to get core samples from the fault zone. Then, they strung 55 temperature sensors across the fault to measure the background heat. Their findings: Three-tenths of a degree of excess temperature remained at the fault.

“That small change tells us the friction was very low, making that huge slip possible,” said Fulton.

Results from the two other *Science* papers showed a layer of clay at the fault zone also contributed to the slippery site.

Next, the researchers plan to take temperature measurements from other earthquakes to see if low readings always correspond to big jolts.

Age of extinction

Paleogeneticist
Beth Shapiro
studies ancient DNA
for future conservation

► BETH SHAPIRO SPENDS A LOT OF TIME on the northern end of the planet, excavating frozen bits of creatures that lived long ago. On these mucky, mosquito-infested field trips, she searches for DNA that still lingers in the bones, hair, tusks and skin of ice-age-era mammals like musk ox and mammoths. Then, back in the Paleogenomics Lab at UC Santa Cruz, she calculates how old the specimens are, extracts their DNA, and carefully decodes this ancient genetic material.

By revealing changes in genetic diversity through time, ancient DNA can shed light on species' evolution and extinction. Combining that information with climate records and other historical data, Shapiro can also show how shifts in the environment drove these changes. This kind of research offers a new way to understand the life of Pleistocene animals, plants, and early humans. The epoch, marked by glacial and interglacial cycles, lasted from 2.6 million to 11,700 years ago.

In addition, this examination of the prehistoric has potential for future conservation—by learning why some species proved more vulnerable to past climate changes or human influence.

"We can use that information to make predictions and plans about what to do for species that are being affected by climate change today," said Shapiro, an associate professor of ecology and evolutionary biology at UCSC. Her work has generated new discoveries and garnered a "genius grant" from the MacArthur Foundation.

So far, the oldest sequenced genome fragment, from a 700,000-year-old horse, is more than half a million years older than biochemists had predicted could survive. Shapiro and her collaborators identified the age of the extremely old permafrost layer where it was found, and sequenced and analyzed the genetic material. The data, including other ancient and modern horse DNA, indicated big fluctuations in the horse population that corresponded with extensive climatic changes. The journal *Nature* published the results in 2013.

The horse DNA weathered 700 millennia only because it landed in permafrost, which acts like a giant freezer for everything from mammoth kneecaps to musk ox horns.

That's why the frozen expanses of the Yukon, Alaska and Siberia are prime research territory for Shapiro. These lands are also the terrestrial remnants of the Bering Land Bridge that once connected Asia with North America. The area hosted herds of megafauna and saw major Pleistocene extinctions.

This bone-rich "laboratory" gives her research team a large-scale opportunity to understand how species responded to climate changes before, during, and after the last ice age, which peaked about 20,000 years ago. They find remains "wherever permafrost is melting: at sites of active riverbank gold mining, or during spring, when snowmelt makes the rivers run high and fast, and water washing around the bends digs through the permafrost, exposing bones stored within," Shapiro said.

Climate change is now causing a bigger meltdown. A boon for research in the short-term, it threatens to defrost ancient DNA along with the once "perma" frost.

Heading north

Shapiro's compass did not originally point to a life of research in Arctic environs. As an undergraduate and former journalism major at the University of Georgia, she signed up for a field geology and anthropology

course one summer, so she could travel west and camp in national parks. That sparked her interest in science, and she graduated with a Bachelor of Arts and Master of Science in Ecology.

"Every major decision I've made in my life seems to be based on where I get to go," said Shapiro.

After college, she wanted to study in England, so she applied for both Rhodes and Marshall scholarships. Landing the prestigious Rhodes took her to Oxford, where she met ancient DNA pioneer Alan Cooper. He did fieldwork in the Yukon and Siberia; she signed on as his first grad student and has continued to travel north ever since.

Shapiro got her start when the discipline was still young. Analyzing ancient DNA was barely possible until the advent, three decades ago, of a gene-amplifying process called polymerase chain reaction. Although PCR is still in use, the emergence of next-generation sequencing (NGS) technology reinvigorated the field. This newer technique homes in on the genetic molecules of interest and can work with even the smallest shreds of DNA; it also costs less and produces reams of data that can be crunched with computational approaches.

"NGS is a huge advance. We've been able to get DNA from older bones than we ever thought possible, and we have begun to get DNA from unlikely places like hot tropical sites," said Shapiro.

The genetic material from older specimens and warmer sites tends to be the most fragmented and difficult to reconstruct. Even with NGS and frozen DNA, the task is challenging. DNA is easily damaged. Mutations accumulate during a lifetime, and after death, DNA succumbs to water damage, oxidation, bacterial decay, UV light and other elements. (Thus *Jurassic Park* is off the table—dinosaur DNA has completely disintegrated.)

Contamination is another technically demanding issue. Ground-up mammoth bone, for example, contains DNA from all sorts of sources, including bacteria, fungi, and other organisms that colonized the bone—and sometimes the genetic material of the people who handled it in the field or in the lab. In fact, many of the first scientific claims for ancient DNA sequences turned out to be sequences from modern humans instead.

"We can use... information to make predictions and plans about what to do for species that are being affected by climate change today."

PHOTO: ELENA ZHUKOVA

RESURRECTING THE PAST?



Shapiro's brand-new book, *How to Clone a Mammoth: The Science of De-Extinction*, isn't a how-to manual.

Making an exact copy of an extinct animal is impossible. But some

day, an animal might be assembled with some of the genetic code from an extinct one.

The idea is controversial, scientifically difficult, maybe unattainable, and poses all kinds of quandaries. Yet it's worth exploring the ideas, the goals, the impacts and the ethics, said Shapiro.

Her book disentangles current-day science from science fiction, and argues that reviving individual species is misguided and probably unethical.

But she sees value in resurrecting extinct traits to "help living species adapt to a changing environment," and to revitalize and restore ecosystems and biological interactions.

Shapiro is a faculty member of the UCSC Genomics Institute's Genome 10K Project, which aims "to understand how complex animal life evolved through changes in DNA and use this knowledge to become better stewards of the planet." The project is working toward assembling a collection of DNA sequences that represent the genomic diversity of 10,000 vertebrate species.

One of the possibilities, she said, is to identify mutations or diversity that once existed within a population, "and then come up with new technologies to reengineer these populations on the brink of extinction to contain diversity that's recently been lost."

"De-extinction could be a game changer for our modern conservation crisis and that is what makes the science potentially so useful," she concluded.

Age of extinction

"Contamination is easier to detect now and we have good techniques and protocols to prevent it during excavation and transfer to the lab. But it's still difficult to distinguish host from non-host DNA," Shapiro said.

The ice age

Shapiro's discoveries have overturned a few ideas. It turns out that late Pleistocene extinctions started earlier and lasted longer than previously realized. Many species began to decline about 40,000 to 35,000 years ago in a warmer interglacial period, significantly before the coldest temperatures, and long before humans arrived in the area around 14,000 to 12,000 years ago. While human hunting likely weakened the already small and genetically constricted populations, it did not set off the chain of events as one theory suggested.

Researchers compare the amount of genetic diversity in a species over time by sequencing DNA from living animals as well as those that lived at different time periods. Lots of diversity correlates with big populations, while less diversity means small populations.

"We're learning from hard empirical evidence. One thing we see is that species did not respond to climatic stress in the same way as each other," Shapiro said. The woolly rhino, wild horses, and mammoths went extinct. But caribou, bison, and musk ox survived, although they experienced a drastic drop in genetic diversity.

All these megafauna actually thrived in cold periods. Perhaps the warm interglacial and post-ice-age periods caused the most strain, Shapiro suggested, favoring species that were better able to move between patches of suitable habitat—as habitat, too, shifted in response to climate fluctuations.

Shapiro keeps returning to the site of this huge natural experiment—next year she'll bring undergraduates on a new, every-other-summer, UCSC Arctic Ecology field course—unearthing the past, in part to contribute to making sound conservation decisions for the future.

"Genetic diversity is disappearing from this planet at an astounding rate," said David Haussler, UC Santa Cruz distinguished professor of biomolecular engineering and co-founder of the Genome 10K Project that Shapiro is now a leader of. "Beth is just the kind of charismatic thought leader we need right now to help forge the way forward. She is totally unafraid of new ideas, and brilliant enough to make them work."



Engineering independence

Researchers design tools for blind and visually impaired people

▶ LIKE MOST FOLKS, Kate Williams uses her cellphone for digital pictures. She can't resist snapping away during all the activities her five grandchildren enjoy. But choosing which pictures to share poses a challenge—not only because each image captures a special moment, but also because she is blind.

Although text-to-speech programs have opened up cellphone use to blind people, few tools exist to describe to Williams the images she has stored. "One of the reasons I don't take more pictures is because of the difficulty of organizing them," said Williams, who leads an employment training program at LightHouse for the Blind and Visually Impaired, a non-profit advocacy group in San Francisco. She relies on her sighted friends and family to help

browse her pictures and share them with others.

But at the Baskin School of Engineering, computer science graduate student Dustin Adams plans to change that with a prototype mobile app, called VizSnap. His project is just one of the assistive technologies that UC Santa Cruz researchers, led by Professors Sri Kurniawan and Roberto Manduchi, are creating to help blind and visually impaired people with everyday tasks.

The winning shot

World health officials estimate that some 285 million people are blind or have low vision. Most blind people, such as Williams, still retain some light

Engineering independence

perception. She uses her sense of shadows to aim her camera at nearby blobs and hopes for the best. For Williams, taking pictures is more about recording a memory than getting the perfect shot.

“Blind people like to take photos for all the same reasons that sighted people do,” Adams said. “They want to capture a happy moment in time, or share it with their friends and family.”

Since 2011, Adams has been part of UCSC’s Interactive Systems for Individuals with Special Needs Lab, founded by Kurniawan, a professor of computational media and computer engineering. Work on the photo-organizing app began in 2012, while Adams did a summer research internship at IBM, in Tokyo. There, he was introduced to the concept of blind photography—and the need for better tools—by his mentor Chieko Asakawa, a leader in accessibility research, who is also blind.

When Adams returned to UCSC, at the end of the summer, he continued the project with Kurniawan. Now, he’s preparing for a three-month user study of the prototype iPhone app. His award-winning design works by collecting ambient sound when the phone’s camera is being aimed, and then allows the user to record a voice message after taking a shot. Both sound files are linked to the image, and can be replayed on demand as a user scrolls through the camera roll. The app also enables users to play spoken information about the date, time, and GPS location associated with each picture.

“It would be great if that could be an app,” said Bryan Bashin, executive director of LightHouse, who believes that a photo-organizing tool would serve a very real need in the blind community.

Listening for cues

Choosing a project that benefits visually impaired people isn’t always easy for sighted engineers, said Manduchi, who runs UCSC’s Computer Vision Lab.

Ten years ago, when he first started studying assistive technology, the professor of computer engineering dove into the development of a laser-guided “virtual cane” without first consulting blind users. His hand-held device, which detected distances between the user and objects in the environment, was an engineering success. But as a piece of assistive technology, it was fatally flawed. Manduchi discovered that people preferred their traditional canes because the low-tech design was cheap, light, durable, foldable, and never ran out of power.

“I learned a lot,” said Manduchi, with a laugh. “I learned that I needed to make more blind friends, and talk to orientation and mobility professionals.”

One of Manduchi’s latest projects—which already has input from the visually impaired community—is an effort to improve public transit navigation. Still in its early stages, the pilot study puts wireless transmitters on some buses and bus stops on the UCSC campus.

Using Wi-Fi signals, the system communicates with users’ mobile phones, and alerts people with a spoken message when they are near their bus stop, and again when their bus arrives. Users can also query for a list of stops as they proceed along the route, circumventing hard-to-hear announcements on bus speaker. The app even warns travelers when they should prepare to disembark.

Unlike other existing bus travel apps, Manduchi’s design doesn’t use GPS to track a rider’s progress. Instead, it picks up on pings between buses and stations. That’s important because GPS can be inaccurate or unavailable in some areas, Manduchi noted. And, using GPS continuously on a long trip can quickly drain a cellphone’s battery.

Early trials of Manduchi’s Wi-Fi system have received positive reviews from blind users. But, he emphasized that much more testing is needed. If the system passes its engineering and usability tests, it will still require infrastructure investments to work in the real world, including outfitting bus fleets and stations with new transmitters.

A sense of style

In the meantime, Lourdes Morales, another graduate student in Kurniawan’s lab, hopes to address a more immediate need for many blind people: getting a job. According to the American Foundation for the Blind, only about 30 percent of working-age adults who are blind or have limited vision are employed in the United States.

Morales, who worked hard to reach graduate school despite her own severe visual impairment, was drawn to study technology that supports the professional advancement of blind people. “I liked the goal, to give blind people the same opportunities to develop in academic and professional environments,” she said.

For the past two years, Morales has been building a tool to help blind people create documents that are visually appealing for sighted readers. Most software programs that read text aloud will, by default, ignore formatting and style, such as capitalization,

indentation, and font changes. Without that information, it’s hard for blind people to learn sighted style conventions, and find formatting mistakes in their own work. That can be a big deal—especially on resumes.

“Having a bullet point out of place on that resume indicates to a recruiter that this person may not be detail oriented,” said Kate Williams. She advises her students in the LightHouse employment training program to run their resumes by a sighted friend before submitting them to potential employers. The stakes are high, and even small errors can be costly.

One of the most popular screen readers, Job Access With Speech (JAWS), can be configured to read back information about a document’s format and style. But to hear all of the document’s features, the program takes users through a full playback of the text, interspersed with formatting notations. This

mode can interfere with reading for meaning, or introduce tedious delays when users want to quickly assess a document’s overall appearance.

Furthermore, JAWS isn’t easy to learn. “It does require a fair amount of training,” said Tim Elder, president of the San Francisco chapter of the National Federation of the Blind.

Morales wants to help blind people do better. “When they rely on sighted people, they have to wait for them. And help might not always be available, or may cost money,” she said. “Their productivity is being affected.”

Her program works as an add-on to Microsoft Word, the most widely used word processor among the blind people Morales surveyed. By running the tool along with a screen reader, users can hear a report summarizing only the style and formatting features of a Word document, such as the number of times text is italicized, or the number of different font sizes that appear. Then, the tool offers users the chance to review each feature in more detail, reporting one-by-one the location of each instance of underlined text, for example. In each instance, users have the option to either undo special formatting, or move on.

Initial tests of the program have returned some positive feedback and suggestions for improvements, along with a few unexpected results. “I came into the project assuming that blind people just needed a tool to make formatting easier,” said Morales. But some users, after appreciating for the first time the wide variety of format and style choices available, wanted to learn more about the reasons sighted people apply such features as bold type or italics. In response, she is now working on modifications to the software that could help it double as an educational program for blind people.

Ultimately, Morales and her UCSC colleagues aim to create technologies that are tuned to the needs of the blind community. Whether in the realms of professional advancement, mobility, or personal enjoyment, the researchers hope that their tools can help blind people move forward in their lives with greater independence and confidence.

At left: Caitlin Hernandez (’12), blind from birth, enjoys helping UCSC researchers test their technologies, in between pursuing a master’s degree in special education, performing with a theater troupe, singing a cappella, and tap dancing.

“I like to give back when I can,” she said, “and be part of something that could help other blind people and myself.”



PHOTO: LYNNE SHANE

A cold trail

Researchers drill into Antarctic ice to understand the effects of climate change

► SLAWEK TULACZYK keeps a shotgun case in his office. It's an odd piece of equipment for a glaciologist. More appropriate are the ice axe, crampons and helmets lying around in his room. But the case came in handy for hauling a gun to Alaska, where he was "harassed by a really weird bear." Does he take the gun to Antarctica? "No," he said. "That's the nice thing about working in Antarctica. It's a pretty safe place."

Only someone who has been to Antarctica eleven times would call the continent safe. Sure, there are no bears to scare off, but dangers lurk everywhere, especially in the remote terrain where Tulaczyk works. For almost a decade now, his team has been studying the Whillans ice stream in West Antarctica—a river of ice hundreds of kilometers long that is, oddly enough, slowing down, even as climate change is causing glaciers and ice streams elsewhere to speed up.

These ice streams feed into the ocean, and the pace at which they flow directly affects global sea levels. So, if Tulaczyk and his colleagues can understand the unusual behavior of the Whillans ice stream, their work will help climate scientists fine tune their models and better predict the relentless rise of sea level due to global warming.

To decipher the dynamics of the Whillans ice stream, the team is looking at two main features: one is the subglacial Lake Whillans that lies nearly three-quarters of a kilometer beneath the ice stream; the other is its "grounding zone," where the ice lifts off from land and begins floating on water.

A quirk of geography first focused attention on the Whillans ice stream, one of a handful of massive ice streams that carry ice from the West Antarctic

ice sheet down to the Ross Ice Shelf. For scientists studying these ice streams in the 1960s and 1970s, before there was GPS, Whillans was the first ice stream they encountered that was close to the Transantarctic Mountains. In the otherwise featureless terrain of snow and ice, the mountains were an invaluable aid for navigation. You couldn't get lost studying Whillans, so it became the hub of scientific activity.

During the early 1960s, the Whillans ice stream was moving at about 600 meters per year—which might not seem like much, but for a river of ice about 800 meters thick and about 100 kilometers wide, that's a lot of ice entering the ocean. "It discharges as much water as the Missouri River," said Tulaczyk, a professor of earth and planetary sciences at UC Santa

as a buttress, preventing the glacier from sliding faster and faster into the ocean. But climate change is thinning such ice shelves, causing the glaciers behind to speed up, leading to what glaciologists call a negative mass balance. The water that would otherwise remain frozen on Antarctica is now ending up in the ocean faster than in the decades past, slowly raising sea level worldwide.

For now, this is not the fate of Whillans or some of the other ice streams that empty their ice into the Ross Sea, forming the Ross Ice Shelf—the biggest mass of floating ice on the planet, with a surface area the size of Texas. Whillans is decelerating dramatically. "Within decades, if I live long enough, I might see this ice stream completely shut down," said Tulaczyk.



PHOTOS: TULACZYK BY ELENA ZHUKOVA; RESEARCHERS BY R. SCHERER; WISSARD BY J. RAINE

far left: UC Santa Cruz researchers collected sediment samples from beneath the West Antarctic ice sheet.

left: The WISSARD Deep Field Site is located 530 miles from the edge of the Ross Ice Shelf in Antarctica's Ross Sea.

Cruz, and one of the three principal investigators on the Whillans Ice Stream Subglacial Access Research Drilling (WISSARD) project.

But Whillans is slowing down. Modern measurements using GPS show that its speed is now below 400 meters per year. This is at odds with what's happening in other parts of West Antarctica.

For instance, farther along the coastline, the Pine Island and Thwaites glaciers are both speeding up. These two glaciers together drain about five percent of the West Antarctic ice sheet into the Amundsen Sea. When the ice from a glacier enters the sea, it doesn't melt right away. Rather, it forms a floating platform—called an ice shelf—which acts

Does that mean climate change is having no effect on the Whillans ice stream? Tulaczyk's answer is an emphatic "no." Rather, Whillans' behavior tells us that the Antarctic ice sheet is so big that it has its own internal dynamics. Even without any climate change, these ice streams would be slowing down and speeding up. "Why do these changes take place at the rates that they do? That's the key thing we need to understand—if you ever want to build reliable models of predictions of what's going to happen to an ice sheet 100 years from now," said Tulaczyk.

In January 2013, the team became the first to drill "cleanly" into a subglacial Antarctic lake. With a sterilized nozzle spewing out near boiling water

A cold trail

at high pressure (the water was also filtered and irradiated with UV light to prevent contaminating the pristine environment), they melted a hole through nearly 800 meters of ice to reach Lake Whillans.

One perplexing piece of the Whillans puzzle is that the lake isn't always there. Periodically, the water appears and disappears—as do many other subglacial lakes. The process begins when meltwater from the base of the Antarctic ice sheet ponds up because something in the bedrock beneath the ice dams the water. The lake, as it forms, begins pushing up the ice—these changes in ice elevation led to the lake's discovery in the first place. At some point, the water pressure becomes too much; the dam breaks and the lake empties. In the case of Lake Whillans, this process has happened three times since it was discovered in 2007. Tulaczyk wondered: Does the periodic release of water have any effect on the movement of the ice stream?

To answer that question, Tulaczyk needed to understand the movements of the Whillans ice stream and its relation to the lake beneath. He'd have to embed instruments in the ice and deploy them on the surface. For help, Tulaczyk turned to UCSC colleagues, seismologist Susan Schwartz and engineer Daniel Sampson. Along with veteran driller Dennis Duling, of the U.S. Antarctic Program, the team spent two backbreaking summers drilling six boreholes into the Whillans ice stream,

"You are either driving a snow machine for hours on end, or packing up sleds to trail along behind you, and then having to set up camp and fall asleep. It was that kind of work," said Sampson.

And there are dangers too. One day, Sampson slipped and a fully loaded sled, weighing nearly half a ton, ran over his legs. "I screamed thinking I was done for," he said. "Fortunately, the snow was soft enough that my legs went into the snow." He was fine.

But all such work is helping make sense of the way the Whillans ice stream moves.

The instruments have already revealed two things. One is that the relatively small discharge of water

from Lake Whillans (about 0.1 cubic kilometers) is not having much of an effect on the movement of the ice stream. The second insight has to do with why the ice stream is slowing down. "This particular ice stream locks up, doesn't move, and then twice a day, it kind of leaps forward about half a meter," said Schwartz. The twice-a-day movements are related to tides. But the researchers also see that the ice stream occasionally skips a beat, leading to its overall deceleration.

Over the next few years, the team wants to understand why the ice stream gets stuck in the first place, and what causes it to break free, a dynamic that Schwartz calls "stick-slip motion." Climate models have to account for all the ways in which ice streams and glaciers can end up in the ocean. "People have not considered this kind of frictional stick-slip motion in models, and that could have a very large effect on rates," said Schwartz.

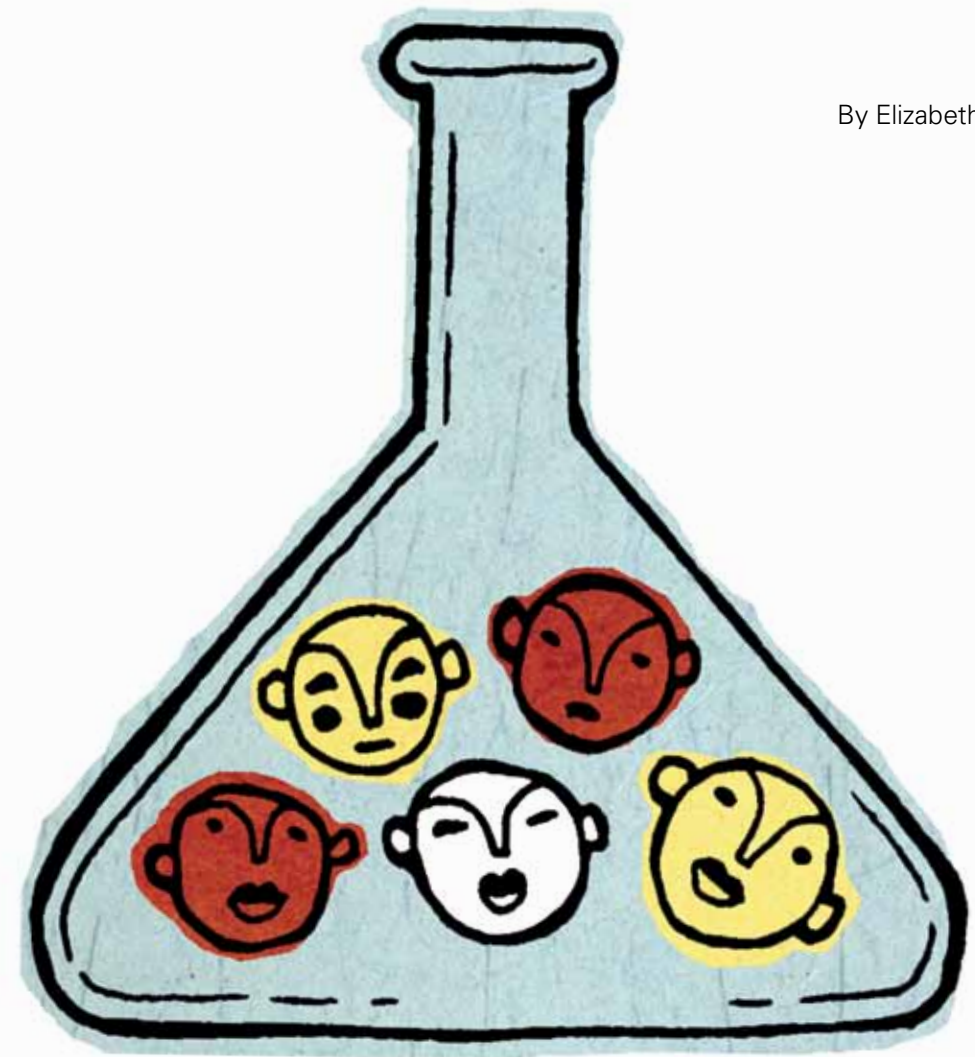
Even without such detailed knowledge, the effect of climate change on Whillans is clear. In January 2015, when the drillers became the first to ever penetrate an ice stream near its grounding zone, their instruments and cameras found signs of fresh sedimentation. Rocks, once embedded in the ice, have been raining down on the sea floor. A preliminary analysis showed this top layer of sea-floor sediment formed during the past few decades. This means the ice is melting, dropping rocks, and then retreating.

"Climate change is potentially pushing the ice sheet back, shrinking it," said Tulaczyk. So, while Whillans may be slowing down, the warming sea surrounding Antarctica is nonetheless eating away the ice at its margins.

"This is the frontline of climate change in Antarctica, the fight between the relatively warm sea water and the ice itself," said Tulaczyk. It's clear the ice is losing, but just how much of a fight is it putting up? Knowing that will help us better predict future sea-level rise. "We want to go back," he said. But even as he prepares his next project proposal, Tulaczyk is aware that climate change isn't waiting.

"Why do these changes take place at the rates that they do? That's the key thing we need to understand—if you ever want to build reliable models of predictions of what's going to happen to an ice sheet 100 years from now."

By Elizabeth Devitt



Just science

The Science and Justice Research Center opens conversations between science and society

► WHEN A RECENT MIDNIGHT SCREENING of the 1987 film *RoboCop* drew sci-fi fans to a downtown Santa Cruz theater, not everyone was in line for entertainment. Two UC Santa Cruz students in an innovative research program set up the showing to provoke conversations about science and the society it's supposed to serve.

When the film first premiered, cyborg cops were pure fiction. But today's technologies—brain-powered artificial limbs, self-driving cars, and the Apple Watch to share your every heartbeat with others—chip away at the boundaries between man and machine, often with unintended consequences. The breakneck pace of innovation leaves little time for questions. And questioning scientific advances after the fact is often far too late, said event co-organizer Jennifer Trinh, a graduate student in physics.

Just science

"We have these dreams of quantum computers and augmented realities, but where will they end up?" asked Trinh.

"Slow science" may be the antidote to this accelerating pace. The term fits the inquisitive, cross-disciplinary approach of UCSC's Science and Justice Research Center. In a one-of-a-kind training fellowship sponsored by the center, Trinh and eight other graduate students are learning to probe the implications of their science, long before their research results leave the lab.

"With science and technology taking off, we can't just do it because it's in front of our face," said physicist and philosopher Karen Barad, co-director of the training program. "Older models of ethics say there are questions of pure scientific knowledge, and then there are questions of uses. But the world doesn't divide like that. You can't say: I'm just building the [atomic] bomb, and what happens after that isn't my responsibility."

Seeing the more subtle shades of justice isn't easy either. "Justice is always a question," Barad said. "It would be ironic to presume to know what justice was beforehand, and then make sure that happens."

Barad founded the Science and Justice Training Program with Jenny Reardon, now a professor of sociology at UCSC and director of the Science and Justice Research Center. Drawing on the deep science backgrounds and keen sense of inquiry that both women share, the program is "for all those young scientists and engineers out there who also care about social issues," said Reardon.

Such an opportunity didn't exist when Reardon, as a 14-year-old, conducted marine biology experiments in the basement of her Kansas home. Her efforts won the grand award in environmental sciences at the 1987 General Motors International Science and Engineering Fair. As an undergraduate, she earned degrees in political science and biology from the University of Kansas. Then, poised to fast track into molecular biology research, Reardon realized she didn't want to spend the rest of her professional life with a pipette in her hand; she had other interests, too. Through graduate studies, fellowships and teaching positions at several universities, she tried to bridge her love of natural sciences with her passion

for humanities and public policy. But she never found the right interdisciplinary fit until she arrived at UCSC—a campus with the right combination of like-minded colleagues and innovative culture—to create what she'd been looking for all along.

"Santa Cruz is known for creating new conversations," said Reardon. "So, Science and Justice [Research Center] was possible here."

When Reardon arrived at UCSC with a grant from the National Science Foundation (NSF), she allocated some of that money to host a meeting on genomics and justice. Since UCSC scientists devised the database that allows researchers to examine the human genome, Reardon thought the campus was the perfect place to start.

Before that first conference convened, Reardon and her new colleagues talked about how to create an intellectual community that would keep the discussions going, long after the meeting ended. Partly inspired by a ride on the Great Meadow's spectacular bike path, they conceived of "a working group of interested students, research staff, and faculty committed to gathering questions about science and justice." Thus, the Science and Justice Working Group (SJWG)

was born: the forerunner for the training program, the center, and all the innovations to follow.

Early on, the SJWG found that focusing on specific problems provided an effective way for people to share their expertise. For instance, former anthropology graduate students Cris Hughes and Chelsey Juarez turned to Reardon for guidance during their field research in Mexico's state of Baja California. As part of a team that was trying to identify human bodies, the two were stymied by the required categories for assigning race. Anthropologists had developed the forensics racial database in the American South, so it didn't represent all bodies found elsewhere. The inappropriate categories made it hard to properly ID the bodies and return them to their families. To change those measures, the researchers would need DNA from relatives—but the Mexican communities viewed such technology with suspicion.

"If these families are not reached, or are less inclined to provide DNA samples, the identification potential drops significantly," Hughes noted. "It's just another

example of how science can greatly inform [us] on social justice issues."

To help, the SJWG convened "conversations" with forensic professionals, social scientists and historians. Through these dialogues, Hughes and Juarez developed a deeper understanding of the problem. This led to key relationships with other scientists who partnered with them to create a survey on forensics and the approach to race. Now, both women work with a richer set of tools and continue to transform ideas about race within their profession.

Such successes prompted Reardon to apply for a grant under the NSF's Ethics Education in Science and Engineering Program. Working with Barad and postdoctoral fellow Jake Metcalf, she used the funds to formalize the working group approach into the Science and Justice Training Program. Launched in 2010, the program encourages applications from graduate students in any field—from engineering to digital arts. In addition to their regular studies, the selected fellows take a special seminar course, attend six "working group" events, and work in pairs to produce a public event related to their research. This work now leads to a graduate certificate, which the students earn alongside their traditional doctoral degrees. Since the program's inception, 24 certificates have been awarded.

The film festival featuring *RoboCop* was the joint public project of Jennifer Trinh and Jeff Sherman, a Ph.D. candidate in politics. Sherman's own research explores the increasingly complex ties between military drones and international policy. "Going through this fellowship program opened my eyes to whole new areas of research I never would have thought to investigate," said Sherman.

Partnering physicist Trinh with political scientist Sherman is an example of the choreographed mixing that gives the graduate fellows experience in creating "awkward conversations," said Andrew Mathews, an associate professor of anthropology and co-director of the research center. With dual degrees in anthropology and forestry, Mathews understands how hard it is to build bridges across the natural and social sciences. "It takes [the fellows] out of their comfort zone," he said. "But that's the place to be, because questions of justice come up when you're not doing 'business as usual.'"

Navigating issues outside of one's field also takes trust, which comes from creating a community among individuals with disparate academic backgrounds. They gather at potluck dinners, faux fireside chats (the fire is drawn on a dry-erase board), and low-pressure mixers where students discuss their projects-in-progress. In 2011, the Science and Justice Research Center, under Reardon's direction, became the umbrella organization for that community.

Beyond the graduate fellowship, events sponsored by the SJRC range from conference-room chats—such as a recent discussion with NPR science correspondent Joe Palca, who earned his Ph.D. in psychology from UCSC—to three-day conferences that draw keynote speakers such as science fiction author Ursula Le Guin.

The SJRC also creates interdisciplinary opportunities through a visiting professor position. This three-year appointment attracted award-winning journalist Sally Lehrman, a senior fellow at the Markkula Center for Applied Ethics at Santa Clara University. Among her contributions to UCSC, Lehrman teaches an op-ed writing workshop for the graduate fellows, and she encourages them to write about their research for non-scientific audiences.

"In journalism we want our work not just to be something people pick up and read, but something people see as fuel for their engagement in society," said Lehrman. "That's the same instinct that Jenny [Reardon] is talking about—the feeling that the public should be involved in the future of science."

For that to occur, Reardon knows that SJRC must take its programs off campus. She's looking for ways to create civic spaces—perhaps in city churches—where people can discuss the challenges new technology poses for the future.

As word about the SJRC spreads through journal articles, talks at universities around the world, and visits from other leading scholars, the center's influence grows. Reardon thought back to her first grant from the NSF, when reviewers wrote about the risk and reward of her proposal. The risk, she said, was that the program could only happen in Santa Cruz. The reward? "If we can manage to do it, it's what everyone needs," Reardon said. "Santa Cruz is making it evident that we can do it."

"Justice is always a question. It would be ironic to presume to know what justice was beforehand, and then make sure that [it] happens."

"...You can't say: I'm just building the [atomic] bomb, and what happens after that isn't my responsibility."

Reforming prisons

Psychology professor Craig Haney takes on solitary confinement

By Becky Bach

► IMAGINE LIVING in a cell barely big enough to hold a king-sized bed, a small sink, and a toilet. But there's no big bed, only a narrow bunk. There's no window either, just a fluorescent light that turns on, then off again, each day. The door opens only from the outside and it doesn't open often. This is solitary confinement, a place where prisoners lose all forms of social contact, sometimes for so many years they never regain the ability to be a friend, or part of a family, again. It's more akin to torture than reform. And it's a practice that Craig Haney, a psychology professor at UC Santa Cruz, has studied—and criticized—for more than 20 years.

"The emphasis ought to be on keeping prison isolation as brief and humane as possible and only as a last resort," Haney said.

Haney has interviewed about one thousand prisoners, some of whom have endured solitary confinement for more than two decades. He's witnessed the anguish, loneliness, and even madness, caused or enforced by isolation. His psychological evaluations are the evidence he takes to courts, legislative committees, and classrooms, to make the case for scaling back the use of solitary.

After waging this battle for decades—as a lawyer, an academic and a fellow human—he may be winning.

Solitary confinement was in vogue in the 1800s. Back then, some believed that a man might atone and make his peace with God if left alone long enough. But by the end of the century that theory was debunked as counterproductive and harmful.

Although the use of long-term prison isolation is rare in the developed world, in the U.S. the penal practice was revived during the 1980s and '90s when prison populations swelled as a result of tough-on-crime laws and increased mandatory sentencing requirements. At the same time, prison administrators dropped the veneer of prison as a place for rehabilitation, cutting therapeutic and recreational programming, and cementing its function as a tool of punishment. Crowded prisons were dangerous, and overwhelmed administrators began sending some men—whose primary offense might only be a gang-affiliated tattoo—to "the hole" for an indefinite period. Although women prisoners also get solitary confinement, incarcerated men outnumber women by

more than a ten-to-one ratio, so the absolute number of women in isolation units is much smaller, Haney noted.

In California, many of these isolated prisoners are held in a



Craig Haney

"Security Housing Unit" at Pelican Bay State Prison. Located near the Oregon border, the entire facility is devoted to solitary confinement. But throughout the country, an estimated 80,000 prisoners, almost all men, are held in isolation. Some institutions call it "administrative segregation" or "intensive management." No matter the name, it's still solitary confinement: a life lived essentially around-the-clock within the same four walls.

In this so-called "separate world," one prisoner told Haney: "You get irrationally angry, depression would come in. You had to deal with it every day, fight it off, push it back. You are always on the edge, scared."

Some prisoners survive by developing a strict, entirely self-imposed discipline. But no one emerges unscathed.

Haney has "mapped the nature of the suffering" for prisoners and the statistics are sobering. In one study he found that more than 91 percent of prisoners in solitary suffer anxiety; 88 percent experience irrational anger, and the same percentage have headaches. He could find no comparably traumatized population in the medical or psychiatric literature—the closest match was a study on former East German psychiatric prisoners, but even they were healthier than the inmates.

Haney's first exposure to the trauma of imprisonment came when he was a student at Stanford, where he earned his law degree and a doctorate in psychology. There, with social psychology maverick Philip Zimbardo, he conducted the famous 1971 Stanford Prison Experiment, a prison simulation that was aborted when the

students playing "guards" began abusing the students playing "prisoners."

Ever since, Haney has focused his studies on improving prison conditions, an emphasis that colleagues say distinguishes him not just as an academic, but also as a force for change. "Haney has become a powerful voice for the disenfranchised, recognized internationally as a leader in the effort to make our prisons into places of rehabilitation, rather than dungeons of dark despair," said Stuart Grassian, an expert on solitary confinement and a former Harvard Medical School psychiatrist.

When Haney arrived at UCSC in 1977, he was already immersed in examining the backgrounds of prisoners on death row and others accused of capital crimes. His efforts uncovered dramatic similarities in their backgrounds: Many of these inmates had suffered severe poverty, abuse or neglect.

He also studied the way the death penalty was implemented and imposed in the United States. "The system of capital punishment operates in a way dramatically at odds with the way the public thinks it does," Haney said. "It is nowhere near as

PHOTO: CRAIG HANEY BY C. LAGATTUTA

Reforming prisons

rational, nowhere near as fair, and nowhere near as effective.”

His early research showed, for example, that asking a potential juror—in front of others—if they’d be willing to impose the death penalty biased the juror pool. It eliminated death penalty opponents from participating and suggested to the jurors that perhaps the death penalty was the correct sentence, Haney said. In 2005, he published many of the lessons gleaned from such studies in an award-winning book, *Death by Design*. His research contributed to changes in the way the system operated, from jury selection to jury instructions.

As his work progressed, Haney spent more and more time investigating the effects of the increasing use of solitary confinement, although he still considers his main focus to be on the effects of imprisonment in general. “It became the tail that wags the dog,” he said. He testified in the 1995 case *Madrid v. Gomez*, in which U.S. Chief Judge Thelton Henderson ruled solitary confinement violated the rights of the mentally ill with an oft-quoted statement: 23 hours in isolation “may press the outer borders of what most humans can psychologically tolerate.”

Haney was also one of the “critical forces” behind *Brown v. Plata*, the 2011 U.S. Supreme Court case that ruled overcrowding violated prisoners’ constitutional rights, said Mona Lynch, a UC Irvine professor of criminology who earned her doctoral degree as Haney’s student in 1997.

“The emphasis ought to be on keeping prison isolation as brief and humane as possible and only as a last resort.”

“He was key to making the link between the conditions in the prison and what that did to people and how it rose to the level of being unconstitutional.”

That work is slowly beginning to pay off. The prison population in California has declined following the Supreme Court’s order. In addition, many politicians and prison administrators across the country are beginning to understand that solitary confinement isn’t the best way to address prison conflict

and disruptive behavior, Haney said. From a financial standpoint, isolation is expensive. For administrators facing budget cuts, it’s hard to fund the extra staff required to hand-deliver meals and escort prisoners to exercise. Moreover, public awareness—and disapproval—is growing, leading some states to cut back its use. For example, in Mississippi and Washington the number of isolated prisoners has been slashed, and Maine reduced its numbers by 70 percent in just four years. In New York and Colorado, isolation is no longer used for the mentally ill. And, just this year, New York City declared an end to solitary confinement for prisoners younger than 21 years of age.

To be clear, Haney recognizes the occasional need to separate prisoners, sometimes for their own safety. But their time alone should be short and free from unnecessary deprivations, he said.

When not in court, visiting prisons, or teaching courses on psychology and law, Haney can often be found in his corner office in College Ten, a well-lived-in space with family photos and 15-foot-long bookshelves. Haney has no plans to leave,

or retire, anytime soon. “Santa Cruz has been an absolutely ideal intellectual environment for me,” Haney said.

His career has been a success by any standards. The recipient of numerous awards, Haney is considered “a leader and a superstar in the field,” said Keramet Reiter, a UC Irvine assistant professor, herself an expert on solitary confinement.

But Haney isn’t resting on his laurels. He’s writing a book on solitary confinement and contributing to a project funded by a UC President’s Research Catalyst Award to improve prisoner medical and mental health care. In addition, he’s organizing an effort to spur criminal justice reform using evidence-based methods, an undertaking that Haney hopes to base at UC Santa Cruz. He also just returned from the Bipartisan Summit on Criminal Justice Reform, where the urgent need for substantial criminal justice reform dominated the agenda.

Despite the remaining hurdles, Haney has hope: “There appears to be a growing consensus among groups from across the political spectrum,” he said. “The time for significant change finally has arrived.”

By Heather Rock Woods



Border Crossings

Artist John Jota Leaños creates animated documentaries to reveal hidden stories

► **COYOTE HAS A CHORUS OF MEANINGS:** For many indigenous tribes, the animal represents a trickster figure; in the Southwest, it’s someone who is culturally and ethnically mixed, who passes as both Latina/o and white; and it refers to people who smuggle immigrants across the Mexico–U.S. border.

All these interpretations apply, more or less, to artist John Jota Leaños, a Guggenheim Fellow and an associate professor of social documentation at UC Santa Cruz.

Leaños claims membership in the playfully self-named tribe *Los Mixtupos* (emphasis on mixt-up). His dad is Mexican-American, his mom Italian-American, and he’s a California native. He enjoys the political-multicultural term Xican@, the equivalent of Chicano/Chicana—although he sometimes quasi-mockingly calls himself a gringo. In other words, Leaños embraces complexity in his life—and in his art.

Of course he doesn’t physically smuggle people, but he does try to slip ideas—political, dissenting, alternate—across mental borders. Willing to use any art form to counter mainstream media, documentary animation is his central method for sharing previously untold stories. Adding dark humor to his multimedia approach, Leaños’ narratives entice people to consider different perspectives.

“Documentary animation is very rich for telling alternate stories that are complex and multivocal,” he said.

Border crossings

Leaños trains students in this increasingly important tool through UCSC's Social Documentation graduate program, part of the Film and Digital Media Department.

Animation has been a staple of serious filmmaking since it was first used in a 1918 documentary about the sinking of the *Lusitania*. It can recreate scenes when no footage exists and convey concepts, scientific and otherwise, that are difficult to describe in words.

Leaños has found it to be a powerful device for rendering multilayered stories. In his most recent film, *Frontera! Revolt and Rebellion on the Río Grande*, 16th- and 17th-century animated characters leap to life—fighting, dancing, and performing spiritual ceremonies. The tale begins with the mythical horned serpent of thunder and lightning slithering out of the sky and disappearing into the Río Grande, starting a new round of drought and violence. Infographic maps erupt in flames at hotspots, exposing the reach of indigenous unrest in colonial Mexico leading up to the successful Pueblo Revolt of 1680.

This history still lives, Leaños said, in the New Mexico and Arizona Pueblos that have sovereignty today as a result of that revolt. He reinforces the connection between past and present by relying on the voices of modern-day Pueblo people in *Frontera!*

In one sequence, an animated narrator sits among the slot machines in the City of Gold Casino, wittily recounting oral history: "To this day, it is said that the first white man the Pueblo people encountered was black...." This black man, Esteban, was probably a Moroccan Moor and slave, one of four who survived a 1528 Spanish expedition to the New World. Their rumors about the "seven cities of gold" brought the conquistadors—portrayed by Leaños as drooling cartoon characters—north from New Spain into the Pueblo homeland.

Esteban's legacy, says the narrator, "is one of confusion in the borderlands, where blood is still being spilled." Then the windows of her slot machine scroll through present-day images: armed border guards, a starving man traversing the desert, and crosses for graves.



Horned Serpent (animation still). With animation, Leaños adds new dimensions to his documentaries. *Frontera!* begins with the mythical horned serpent of thunder and lightning slithering out of the sky and disappearing into the Río Grande.

"I look for ways to tactically engage my audience, especially the Native and Latino communities," he said. "I'm not trying to keep something from people intentionally, but having certain cultural knowledge may unlock a layer of perception and meaning, like gaining access to a new level in a video game. It's a tactic of flipping the script on the white-dominated media."

Despite the serious content, Leaños employs pop-culture design and appealing approaches.

The film's visuals are *mestizo*—mixed—everything from comic-book "bam-pow" style to spare, beautiful charcoal renderings. There is humor, too. Conquistadors and missionaries wear sunglasses and rapper-like bling. And there's hip-hop: Leaños' trilingual song recounts how drought, hunger, the prohibition of Native religion, and systematic atrocities committed against the Pueblos by the colonial government, soldiers and priests, all provoked the communities to rebellion.

They drove the Spanish occupiers from the Río Grande region and reclaimed their ceremonies and culture—a respite from foreign rule that lasted for 12 years.

This account of struggle and victory is "enthalling," declared the *Latin Post*, an English media site. Both PBS.org and Latino Public Broadcasting presented *Frontera!* during National

Hispanic Heritage Month in September 2014. The documentary won "Best Animation" at the 39th Annual American Indian Film Festival and "Best Short Film" at the XicanIndie Film Fest.

With funding from his Guggenheim Fellowship, a United States Artist Award, and other awards, Leaños spent two years on research, collaborating with indigenous archeologists, history keepers and artists.

"Representation remains at the core," he said. "You start with the question: How do we represent this culture, this character, this idea?" To get those answers, he worked with Native, mestizo and Chicano/a partners in New Mexico and the San Francisco Bay Area.

"The stories, imagery and perspectives of the Pueblo people were central to the project," said one of the

film's producers, Aimee Villarreal, an anthropologist (UCSC Ph.D. '14) and assistant professor of Comparative Mexican American Studies at Our Lady of the Lake University in Texas. The documentary's positive reception in Native American and Chicana/o communities showed "that we were successful in our attempt to produce a film that animates the spirit of activism and solidarity that is at the heart of this story," she said.

Figuring out what to include in the film took time because it was a 20-minute piece, not a 500-page book. "As an academic, I'm always thinking about how can I integrate complexities in a short time-based piece. There are layers of stories, academic research and oral histories in *Frontera!*" Leaños said.

One of the intricacies the team dealt with was how to convey the violence of the events without making it too cartoonish. "Certain Pueblo consultants told us that we needed to illustrate the violence in order to depict what communities suffered and why they took desperate means to alleviate and decolonize their lives," Leaños said. "However, we had much internal debate about this. Should we not show violence? How do we represent it?"

These lesser-known episodes from the past matter, Leaños said. Remembering the Revolt, considered the first American Revolution by the Pueblo peoples, gives them a sense of power. Forgetting it lets the dominant culture glorify conquistadors like Oñate, who killed 800 Acoma people in 1599, enslaved surviving women, and cut off one foot from captured men.

Continuing to explore the ideas of the frontier, colonization and resistance, Leaños' next research project is a sequel of sorts, called *Eureka!*

"We all know the story of the California Gold Rush, right? But we don't," he added with a smile.

This new animation will focus not just on the Gold Rush at John Sutter's mill, but also on the Taos Revolt in 1847. Both events took place on land annexed from Mexico during the Mexican-American War. According to Leaños' research, Sutter and the American rulers of the New Mexico territory treated the indigenous people brutally. "When you go to Fort Sutter, you hear nothing of that. It tells only a snippet of the story," Leaños said.

"It is the poverty of knowledge and perspectives that gives me impetus to tell stories this way"—full of complexity and coyote humor.

From the Whitney Museum to Los Angeles buses

As a social art practitioner, Leaños' art and audiences are diverse. *Frontera!* aired on PBS.org and Latino Public Broadcasting. His public awareness video about the dangers of sugar, flour and salt, called *Evil White Foods*, played on the Metro Los Angeles bus system and in community clinic waiting rooms.

His films, installation art and performance work have been exhibited at venues including the Sundance Film Festival, the 2002 Whitney Biennial in New York, the San Francisco Museum of Modern Art, and the Museum of Contemporary Art in Los Angeles.

In 2009, Leaños premiered a multimedia opera, *Imperial Silence: Una Ópera Muerta / A Dead Opera in Four Acts*. It fuses dark-humored animation with Mexican folklore dance, theater, Mariachi music, hip-hop, bossa nova, and blues.

"*Imperial Silence* is a performance that journeys to the 'other' side to illuminate cultural taboos around silence, death and dissent—especially in war and empire—in the satirical Mexican and Chicana/o tradition of the Days of the Dead," said Leaños, who is the piece's originator, director, librettist and animator.

To bring it to life/death, he worked with composer Cristóbal Martínez (who also worked with Leaños on *Frontera!*), the Mariachi ensemble Los Cuatro Vientos, and artist Sean Levon Nash.

The animations in the opera have screened and won awards at national and international film festivals including Sundance, Cannes, and Morelia International Film Festival.

"Culture work is intended to elicit a response," Leaños affirmed. "We're creating art through the lens of culture so we can transform society and ourselves and work toward social justice."

The fine art of gaming

Scholars infuse computer games with art, literature, and purpose



Screenshots of characters Grace and Trip from *Façade*, the first fully realized interactive drama created by Michael Mateas, director of the Center for Games and Playable Media, and Andrew Stern, a programmer analyst at UCSC. This computer game was a research experiment in electronic narrative that integrated art and artificial intelligence technologies.

► **COMPUTER GAMES ARE GROWING UP.** The behind-the-screens technology that makes gameplay more realistic—and more fun—also paves the way for gaming to move beyond the world of shooter games and into the realms of classic literature and real-life applications.

At the UC Santa Cruz Center for Games and Playable Media, researchers are blending art and artificial intelligence to develop tools that advance the impact of computer games. The top-ranked gaming program attracts students like Stacey Mason, a doctoral fellow in computer science, whose background in literature could eventually make her a player in the booming \$80-billion-dollar-a-year games industry.

The computer algorithms that already generate fantastically rendered video games can also create interactive literature, educational media, and social games with life-changing applications. Such “playable media” could have the same impact on this century that television and film had on the last.

The Center for Games and Playable Media (CGPM) has become a world-class hub of innovative research on computer game design, with a program that *Princeton Review* ranks 8th of the top 25 graduate programs for 2015. At the Center, students, faculty and staff weave artificial intelligence, games, art and design into new and compelling forms of art and entertainment, including interactive narratives in which players can influence story arc and dialogue.

For Mason, the Center was an ideal place to explore interactive fiction. While an undergraduate at the University of Florida, Mason had abandoned computer science for English literature. But an inspiring course on interactive narratives nudged her back toward computer science. “It was the perfect marriage between my interest in computer science and my interest in literature,” she said. She soon discovered that many of the canonical works in interactive narrative were published by a single company outside Boston. After graduating, she contacted the company’s founder and ultimately persuaded him to hire her as an editor. Three years later, Mason came to UC Santa Cruz to tackle a Master of Fine Arts degree at the Digital Arts and New Media Program, immersing herself in the nitty-gritty of writing an interactive story called *Between the Cracks*.

Today, she’s come full circle back to computer science as she pursues a doctoral degree at the Expressive Intelligence Studio (EIS)—one of the Center’s several labs and collaborative studios. EIS brings together teams of faculty and students to build interactive

media powered by artificial intelligence (AI)—systems with knowledge about the way humans behave. This merging of artistic and computer expertise is exactly the kind of thing the Studio’s two co-directors, Noah Wardrip-Fruin and Michael Mateas, want to see.

Programs centered in only one discipline can hinder collaboration. That’s because games are inherently interdisciplinary, said associate professor of computational media Wardrip-Fruin. “When students in one discipline try to find students in other disciplines to work with, they end up in a very utilitarian relationship. If the game program is based in the arts, they look for someone in computer science and say, ‘Hey, will you be my programming monkey?’ And if they are based in computer science, they will find someone in the arts and say, ‘Hey will you make this look and sound pretty?’”

At UCSC, the solution has been graduate programs where arts and computer science students collaborate from the beginning of a project. Hoping to build the same interdisciplinarity at the undergraduate level, Wardrip-Fruin and newly hired associate professor of art, Robin Hunicke, have submitted twin proposals for a Bachelor of Arts in Gaming and a revised Bachelor of Science in Computer Game Design. “My dream,” said Wardrip-Fruin, “is to eventually have ways for students in other divisions—say students in the humanities who are working on the interpretation of games—to also be part of this community.”

Another of the Center’s goals is to bring new voices to the game development community by making it easier for anyone to make games. To that end, EIS designs tools to make it as easy to develop a game as it now is for your uncle to blog about his model train sets.

The Center is also developing AI algorithms that enrich social interactions between players and game characters, and create far more possibilities for gameplay. Many computer games are “scripted,” meaning that every scenario is planned in advance, including the story line, scenery, movement, and dialogue. It’s essentially a computerized version of a *Choose Your Own Adventure* book, in which players must choose whether to go through the right door or the left, and then flip to page 27 or page 152 to get alternate versions of the same story. In scripted narratives, scenarios are limited; climbing out a window isn’t an option.

But digital games don’t have to work this way. Even the 1970s arcade game “Pong” used a simple physics simulator to generate the movements of the ball, rather than scripting every possible path in advance. What is important, the ball’s movements

ILLUSTRATIONS: COURTESY MICHAEL MATEAS AND ANDREW STERN

The fine art of gaming

are generated in real time, in response to how the player “hits” the ball. Game makers say the ball’s movement is “procedurally generated.”

Many successful games now rely on procedural gameplay for the movements and interactions of objects, characters, and players. For example, in the game *Minecraft* when a player walks through a forest, the individual trees are generated on the spot by an algorithm, rather than being created ahead of time by an army of human 3-D modelers. In other games, when a helicopter falls from the sky, the way it turns and bounces on impact is procedurally generated in real time. This makes gameplay faster, more flexible, more realistic, and more fun. Procedural games are also cheaper because scripted scenarios require more writing and hands-on artistry. But in commercial games, such as *Call of Duty*, even while the physics of gameplay is generated procedurally, dialogue and story arc have remained tightly scripted.

Enter CGPM—not only with procedurally generated dialogue, but also with procedurally generated stories and social interactions. Ten years ago, Michael Mateas—director of the Center for Games and Playable Media—released an innovative game called *Façade* whose AI dynamically mixed together bits of scripted dialogue. In the game, a player goes to visit two old friends, Grace and Trip, whose marriage is falling apart. The goal is to navigate difficult conversations without being thrown out of Grace and Trip’s apartment. If Trip asks what you think of a photo he took in Italy and you say “romance,” he might respond: “Everything in Italy was SO romantic, the scenery, the food, the wine! Oh! And the art, the art! Isn’t that right, Grace?” But don’t follow up by saying how lovely Grace is looking, or Trip will sulk and might throw you out.

With the aid of novel artificial intelligence procedural algorithms, *Façade* almost magically blends multiple behaviors. Trip mixes a drink, pursues a conversational gambit, and makes the right facial expressions, all while the game’s AI “drama management system” artfully mimics the dramatic beats of theater or film.

“If characters can put on a meaningful performance and we can feel empathy, caring, or anger,” explained Wardrip-Fruin, “games can open up an emotional palette that can help shape how people think about their lives.”

Until *Façade*, none of this was possible, but it was just a first step in developing more advanced AI games.

In 2013, EIS released the award-winning social-AI game named *Prom Week*. Players help characters get a date in time for the high school prom. To build the game, a team of EIS grad students spent hours watching films such as *Mean Girls* and gleaned 5,000 social rules, divided into categories such as “buddy up,” “romance down,” or “start enemy.”

Although entertaining, *Prom Week* was largely a platform for testing out EIS’s social-AI game engine *Comme il Faut* (French for “as it should be,” or etiquette). That kind of technology comes with a serious side that has attracted funding from both the National Science Foundation (NSF) and the U.S. Department of Defense.

For example, *Comme il Faut* could be used to make “games” in which police officers hone negotiating skills or oncologists learn how to discuss terminal illness with patients. Right now, costly professional actors offer the only way to provide such realistic training. The *Comme il Faut* research is important enough that the U.S. military’s research arm, DARPA, is fund-

ing a CGPM project to create realistic game characters for training environments.

For the Expressive Intelligence Studio, emotion is the name of the game. “We are interested in exploring experiences that include the full spectrum of human emotion,” said Stacey Mason. “People don’t necessarily demand a flashy game; they want a good story.”

One UCSC doctoral student, Peter Mawhorter, proposed a theory of “choice poetics”—a reference to Aristotle’s classic on story telling. Like a skilled playwright, Mawhorter’s choice algorithm achieves specific emotional effects by pacing the easy and difficult choices a player must make.

“If characters can put on a meaningful performance and we can feel empathy, caring, or anger,” explained Wardrip-Fruin, “games can open up an emotional palette that can help shape how people think about their lives.”

Three scholars bring perspectives to the history of China

Outsider insights

► DYNASTIES OF WAR, REVOLUTION, and imperial rule fill the records of China’s past. Historians, both in this country and abroad, examine how the legacy of these events influenced subsequent culture. Scholars based in China tend to view that history through its relationship with their own traditions.

However, the three China historians at UC Santa Cruz are all outsiders to the culture. Through unique blends of scholarship and collaboration, they connect ideas from other social sciences and branches of history to big events in Chinese history. These cross-cultural perspectives help them reveal history that is often more complex than it first appears, and their collaborations continue to create new opportunities for research.

For these UCSC historians, outside perspective comes from their own life experiences, as well as conversations and collaborations with scholars from other fields.

Displaced youth

In 1979, Emily Honig spent two years in Shanghai, working on her dissertation research at Fudan University and studying the lives of women workers in the city. “I was interested in social networks and where people came from and how that impacted their experience,” she said.

Today, Honig is a professor of history at UCSC, and she’s working on a project conceived during those dissertation days. Her book-in-progress explores the “sent-down youth” movement, a program that Communist leaders envisioned as a way to “re-educate” urban youth in the traditional ways of life. Not coincidentally, her collaborator is Xiaojian Zhao, a former next-door neighbor from the Fudan student dormitories. Now a professor of Asian-American history at UC Santa Barbara, Zhao was one of the millions of urban teenagers sent to live with peasants in the countryside during the 1960s.

Outsider insights

About five years ago, the women traveled to the rural village where Zhao lived during her teenage years. The two visited the county's archive, and archives from other areas that hosted urban youth. There they found a wealth of information that hadn't been described in any other books or journals.

In particular, some records revealed unexpected associations. Honig said she and Zhao kept finding lists of items like tires, tractors, electrical wire, broadcast cable, and high-pressure water pumps. At first, the researchers ignored these records, thinking they were irrelevant to their questions. But the sheer abundance of these lists forced the researchers to take a closer look. The women then realized that the county offices of the "sent-down youth" movement were requesting material goods from the city offices.

"There was this whole behind-the-scenes economic exchange between major industrial cities like Shanghai and Beijing and remote areas, even though state policy basically said that local villages can't acquire equipment from anywhere," Honig said. "But because of the 'sent-down youth' movement, unbelievable amounts of material goods were sent to the countryside."

She thinks it was a way for Shanghai families to send goods to the towns where their children were living, hopefully enabling the villages to establish factories where the kids could work instead of the fields. Stories of riding tractors or transporting equipment from the cities could seem too mundane to arise during interviews or in memoirs. But once asked about it, people who were transplanted during their youth can tell plenty of stories about equipment, Honig said.

The collaboration with Honig is useful, said Zhao, because they each bring different scholarly and personal perspectives to the topic. She and Honig have presented their work at international conferences, and Zhao said their book is already anticipated by Chinese-speaking scholars.

Rural voices

Working with someone closely connected to an issue was also critical for Gail Hershatter, a distinguished professor of history at UCSC and member of the American Academy of Arts and Sciences, when she researched her most recent book. Published in 2011, *The Gender of Memory: Rural Women in China's Collective Past*, presents rural women's perspectives about their lives during the country's transition to socialism.

Hershatter gathered material for her book with Gao Xiaoxian, a researcher involved with rural development

projects in her home province of Shaanxi, about 900 miles west-northwest of Shanghai. The two women met at a conference in 1992, and they shared an interest in learning about the life in the countryside during the revolution. Hershatter feels that her collaborator was essential to the research process. Gao Xiaoxian worked



Gail Hershatter, left, chatting with a villager in west China, 1999.

in the countryside and was already accepted by many villagers. That meant it took less time for the women to accept Hershatter into their community and feel comfortable enough to share personal stories.

As Hershatter inquired about rural life, she discovered the written and oral record of the countryside was bursting with stories that people were eager to tell, yet no one had asked about. Even today, research in the countryside is challenging; the area is large and there is little infrastructure.

From 1996 to 2006, Hershatter and Gao interviewed 72 women, and a few men, from villages in central and southern Shaanxi province. Rural women were not shy about complaining about their lives. Once you asked, Hershatter said, "you'd better have four or five hours because all these pent up stories would come pouring out." The women talked of the physical labor of working in the fields, travails of raising children, the constant work of sewing clothes, and attending party meetings in the village.

The two collaborators also searched regional archives, looking for materials that revealed governmental goals for building socialism. These materials also reported problems that occurred while ending arranged marriages, reorganizing ownership of farm fields, and increasing agricultural production.

From the state's perspective, the new policies created a new era of freedom for women. But from the women's perspective, socialism did little to ease daily hardships. Men left the villages for paid work nearby. Women took over the agricultural duties, working in the fields during the day to maximize

Hu notes that a trio of China historians in one department is rare at universities today, and that concentration of scholars bolsters the impact of their research.

grain production. At night, they also cooked, cared for the children, and sewed clothes and shoes. Some women reported basically not sleeping for years.

"If you look at the state trying to do this big modernization project by drawing on peasant labor, women are the center of it because their paid and their unpaid [domestic] labor is underwriting the whole project," Hershatter said.

Reviewers of her book noted that it provides the first personal accounts of major government campaigns of the 1950s. "[T]his is one of the rare books that transform our understanding of the Chinese revolution and, at the same time, makes us think about the way we practice history," wrote Jacob Eyferth, an East Asian historian at the University of Chicago, in the May 2014 issue of *The PRC History Review*.

Hershatter expects more scholarship about rural China and the revolution to emerge in the future. Since starting this project, she's noticed that graduate students in history programs at some Chinese universities are being encouraged to interview their aging grandparents before their stories are lost.

Intellectual evolution

Sometimes perspectives disappear over centuries of cultural change. Dai Zhen was an influential 18th-century Chinese intellectual who assimilated

European knowledge of mathematics and astronomy into Chinese culture. Dai also challenged the imperial hierarchy with talk of individualism. His cultural influence wavered during the end of the 18th century and the beginning of the 19th century. But in the 20th century, Dai reappeared as a revered figure. Some of his humanitarian and individualistic philosophy was used as a slogan during the Cultural Revolution.

However, historians studying the impact of Dai's work tend to focus either on his scientific knowledge or his philosophical legacy. Minghui Hu, an associate professor of history at UCSC, wanted to investigate Dai as both a scientist and philosopher, and then follow the way both aspects of Dai's ideas percolated through Chinese culture.

In his new book, Hu recounts how Dai absorbed the latest astronomical knowledge from Jesuit missionaries who arrived in China during the 17th century. That knowledge also fueled Dai's social criticism and philosophical legacy. Hu's book, *China's Transition to Modernity: The New Classical Vision of Dai Zhen*, will be published in June. "As a historian, I wrote this book intending to restore what [Dai] was doing back to its time," he said.

Even though he grew up in Taiwan and memorized classical Chinese texts during school, Hu considers himself an outsider to Chinese culture. He came to the United States at the age of 25, to attend graduate school in science and technology studies, a field that uses history, sociology, and philosophy to examine the intersection of science and culture. He went on to obtain his doctorate in the history of science, and Hu's adviser recommended that he combine his science background with his ability to read classical Chinese texts to study the history of Chinese science.

Hu notes that a trio of China historians in one department is rare at universities today, and that concentration of scholars bolsters the impact of their research. All three—Hershatter, Honig, and Hu—have collaborated with scholars in, or from, China. They also incorporate theories from the humanities and social sciences into their historical inquiries. That depth and breadth of experience has attracted graduate students from all over the world, many of whom are now professors at other universities and colleges. Of their efforts, Hu said: "We are trying to become a major center of China history in the UC system, and in the country."



A view of the main thoroughfare of Volodymyr Volyns'kyi, or Ludmir. This predominantly Jewish community was home to the only woman known to have acted as a Hasidic rebbe, a charismatic Jewish leader.

PHOTO COURTESY: ALTER KACZYNE/VIVO

The edges of humanities

Nathaniel Deutsch creates connections with the overlooked corners of history

Is there a custom that when the midwife dies, all of the children whom she brought into the world accompany her funeral procession with candles in their hands?

► ONE NIGHT, IN THE EARLY 1800s, a young girl visited her mother's grave in the small, predominantly Jewish town of Ludmir, in present day Ukraine. What follows next is a mix of lore and legend. According to some, she tripped and hit her head. Her critics claimed the girl fell into a swoon and was possessed by a malignant spirit. By the girl's own telling, she received a "higher soul." Whatever the truth, the next morning the girl awoke and began a different kind of life, one that led to her refusal to marry and, instead, devote herself to study and prayer. Although her real name is uncertain, the girl came to be called "The Maiden of Ludmir," the only woman known to have acted as a Hasidic rebbe, a charismatic Jewish leader, in recorded history.

As many of the details about this woman's life are hearsay or conjecture, it falls to the work of scholars such as Nathaniel Deutsch, a professor of history at UC Santa Cruz, to establish the facts and bring context for their meaning.

"She was a marginal figure in a lot of ways, existing in a patriarchal society," said Deutsch, author of the first scholarly book about the Maiden of Ludmir. "But I believe telling stories about people and ideas that are on the margins is nonetheless important."

Deutsch, also the director of UCSC's Institute for Humanities Research and co-director of the Center for Jewish Studies, has dedicated his career to giving the spotlight to those who have dwelt at society's edges. In addition to *The Maiden of Ludmir: A Jewish Holy Woman and Her World* (a finalist for the National Jewish Book Award), Deutsch has also

published *The Gnostic Imagination*, on Gnosticism and Jewish mysticism, *Inventing America's "Worst" Family*, about a poor family from Indiana that became targets of the eugenics movement, and *Black Zion: African American Religious Encounters with Judaism*, among others.

There is a tendency, Deutsch said, for us to focus the bulk of our attention on what lies at the center of things. Often "the margins" are studied for the sake of comparison, to learn something about the mainstream. "But there's no reason to have this privileging of the center, whether it's a group that is in the majority or an idea that is prevalent," he said.

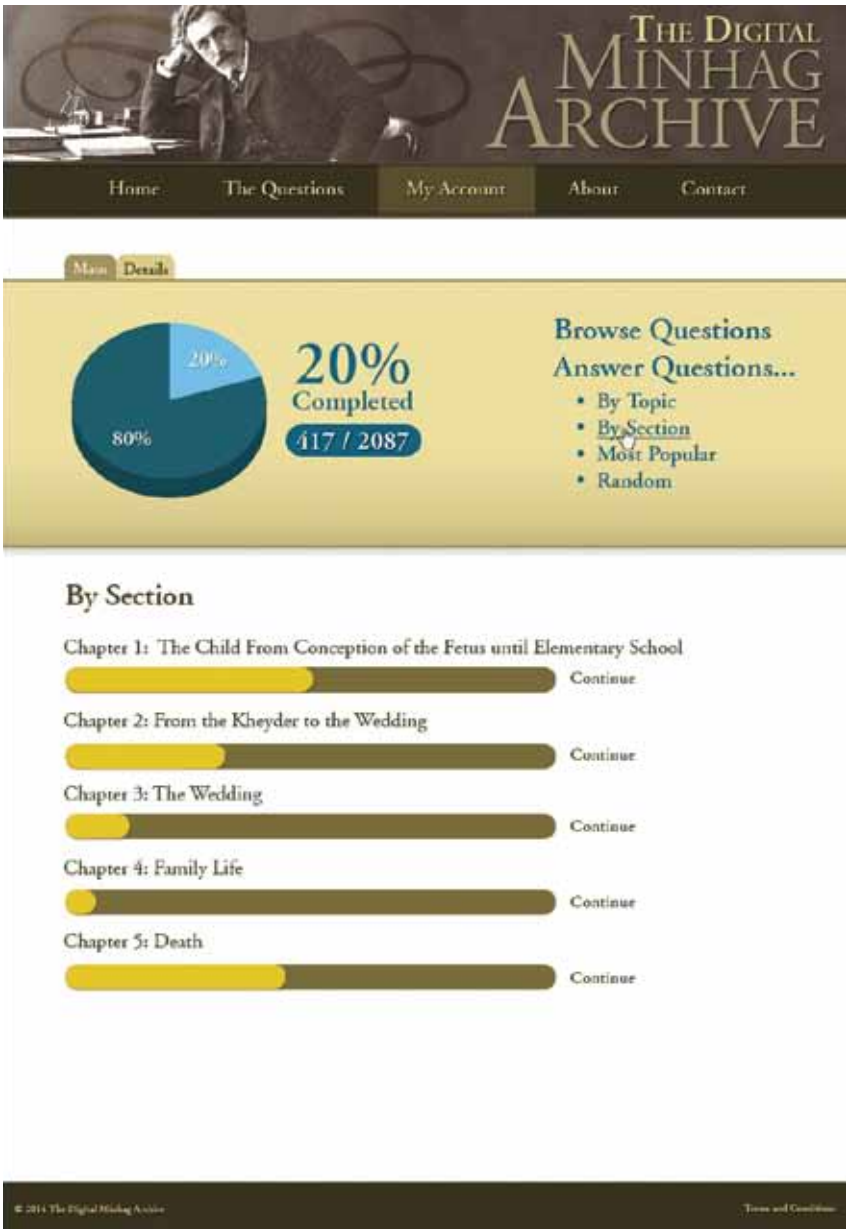
An-sky's ethnographic dream

It was through research for *The Maiden of Ludmir*, that Deutsch came across a reference that would alight his imagination anew, consuming his research life for the better part of a decade: *What stories do you know about the Maiden of Ludmir?*

That query was one among thousands, part of a lengthy questionnaire prepared for an ethnographic study of Jewish communities within the Russian Pale of Settlement, an area of Western Russia which once held 40 percent of the global Jewish population. The document was but one component of an ambitious research expedition—cut short by the outbreak of World War I—designed by the playwright and socialist revolutionary known as An-sky.

Born Shloyme Zanvl Rappoport, the aspiring ethnographer saw the decline of the traditional Jewish way of life in his own lifetime, Deutsch said.

The edges of humanities



A screenshot from The Digital Minhag Archive, a web-based survey and database of contemporary Jewish practice built around An-sky’s “Jewish Ethnographic Program.” The website takes its name, “minhag,” from the Hebrew word for “custom,” and will launch in 2015–16.

Pressure to assimilate into Russian society, poverty, immigration to other lands, and violent pogroms at home were eroding the connection to tradition. But An-sky’s project, “The Jewish Ethnographic Program,” sought more than documentation, said Deutsch. It was part of a quest to document what An-sky considered to be a kind of Oral Torah, one created by the common people rather than the rabbinic elite. The collected answers—drawn from

folk tales, traditions, parables and aphorisms, songs and melodies, habits and beliefs—would “create a new kind of Jewish culture that would use traditional themes, traditions and artifacts in new cultural forms, such as plays or museums, that would be rooted in earlier traditions.”

Yet, the questions were so extensive, 2,087 in number, so almost comically exhaustive (*Is there a custom to place a cat, pieces of cake, or something else, in the crib before one lays the child in it? Does one whisper something in the cat’s ear at that time? or What do people say when a child farts? and Do the dead leave their graves at night?*) that had the forms gone out, An-sky’s task would have been near-Sisyphean in nature.

“There is something quite utopian in An-sky, which I found appealing,” said Deutsch, who received a Guggenheim Fellowship in 2006 that supported this research.

The questionnaire paints an all-encompassing portrait of Jewish life—including groups who have been classically overlooked. When asked if he had a favorite question, Deutsch recalled one relating to midwives:

Is there a custom that when the midwife dies, all of the children whom she brought into the world

accompany her funeral procession with candles in their hands?

“One of the things I really like about the question is that one of the categories of people, of Jews, that the questionnaire looks at—in many ways for the first time—is not only women, but also classes of women that really haven’t been well documented otherwise,” Deutsch said. “And one of those classes is midwives and the role midwives play in their communities. There is a whole section devoted to them. They’re important to every culture that relies on them, but it’s easy to take them for granted if you’re a member of a group that’s excluded from the birth process, which men typically were.”

Almost all the Jewish settlements within the former Russian Pale were annihilated during the Holocaust. As Nazis advanced into Soviet territory, they rounded up Jewish communities, marched them into the woods and shot them en masse. Many of the customs, stories, lullabies and folkways that An-sky was unable to collect, died with them.

New answers to old questions

Though Deutsch’s translation of the questionnaire took only a few months, publishing the book that holds the translation, *The Jewish Dark Continent: Life*

he had gotten to know while writing *The Maiden*.

“It was, I soon realized, a naive hope,” he wrote in *Dark Continent*. “The problem was not that the Program’s questions failed to inspire rich commentary ... but that they inspired too much.” It would take years, he said, to get to the final question. He did collect an essentially complete set of answers from a Hasidic friend living in Brooklyn, where Deutsch and his family once lived. Though no one person, he said, could possibly answer all of the questions.

He now seeks to continue An-sky’s work, by creating a crowd-sourced, online repository of contemporary

“This is about studying what it is to be a person, a human being, studying our relationship to ideas,” he said. “Literature, identity, language—these are fundamental things.”

and Death in the Russian Pale of Settlement, took eight long years. In addition to an introduction and commentary, the questions themselves are richly annotated to give context and meaning. In 2013 the Association for Jewish Studies awarded the book the Jordan Schnitzer Book Award for its “rigorous research, theoretical sophistication, innovative methodology, and excellent writing.”

“The knowledge Deutsch brought to this book is exceptional,” said Brian Horowitz, a professor of Jewish history at Tulane University who reviewed the book. “It would have overwhelmed many—you have to know the Slavic and Jewish languages, the Hebraic traditions, the Torah, and the folkways.”

Deutsch’s immersion into the world of An-sky was so complete, Horowitz said, that he effectively transformed himself into a contemporary. “He’s no water carrier. He has the knowledge of a rabbinic sage of the time.”

While writing the book Deutsch sought to repair the “rupture” he felt was symbolized by An-sky’s unanswered questionnaire, and the loss of the Russian Pale way of life. To do so, Deutsch approached two former residents of Ludmir, whom

Jewish practice. Along with computer science doctoral student Jacob Garbe, who received a Master of Fine Arts in UCSC’s Digital Arts and New Media in 2013, Deutsch is close to completing a website that houses an English-Yiddish edition of The Jewish Ethnographic Program. Visitors to the website can create accounts and respond to the questions in the “Program.”

There are almost an unlimited number of ways to use technology to make historical documents interactive. But what makes this project meaningful, said Garbe, is the narrative behind the questionnaire. “It’s a compelling example of how you can make history a more permeable, breathable thing,” he said. “Since it was never put out to the communities it was crafted for, it’s interesting to bring it to people’s awareness and say: Now you can answer these questions. You can add your part of the story to this historical document.”

It’s a project, Deutsch said, that exemplifies why the humanities are important.

“This is about studying what it is to be a person, a human being, studying our relationship to ideas,” he said. “Literature, identity, language—these are fundamental things.”

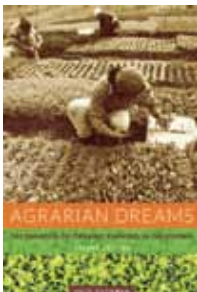


Vote Local

Among countries where citizens can vote, the United States holds one of the lowest voter turnout records. Ironically, when states restrict voting rights, those efforts are always more effective than campaigns designed to bring more voters to the ballot box. However, the same state laws that help create low turnouts may offer insights for reform, said **Melanie Jean Springer**, an assistant professor of politics at UCSC.

In her book, **How the States Shaped the Nation: American Electoral Institutions and Voter Turnout 1920-2000**, Springer analyzed 80 years of voting history. Her research showed that each state has considerable influence on local voting culture. For instance, some states require that voters have particular kinds of photo identification, which may be too costly for some citizens to obtain. Paying attention to those state-specific effects is the ticket to building more participation.

“We need to look at the history of how states encourage or discourage voting,” Springer said, “and then be more mindful about how we aim to engage people.”



Green Dreams

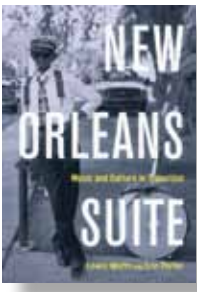
Early on, the organic farming movement found wide appeal among California’s back-to-nature crowd. But it wasn’t long before this “weird hippie interest” became a selling feature in high-end restaurants, said **Julie Guthman**, a UC Santa Cruz professor of social sciences.

In the second edition of **Agrarian Dreams: The Paradox of Organic Farming in California**, Guthman takes another look at the influence of agribusiness and foodie sensibilities on the organic food movement.

“There’s all this attention on organics, yet only one percent of U.S. farmland grows organic food,” said Guthman. “This is because the market still turns on a voluntary system of regulations and consumers’ willingness to pay more.”

The high cost of land puts growers under great pressure to get more crop value per acre. So, the system ends up being very similar to conventional agribusiness models.

“It’s a California story, but the implications are much wider,” said Guthman.



Jazz Fusion

It’s been fourteen years since **Eric Porter** and **Lewis Watts** met as new professors at UC Santa Cruz. With a mutual passion for jazz history, their collaboration was only a matter of time. Involving New Orleans, the birthplace of jazz, was inevitable.

When Hurricane Katrina stormed through the city, wreaking cultural transformation in its wake, the men found the story they wanted to tell: Porter with prose, Watts with images. Their book, **New Orleans Suite: Music and Culture in Transition**, was published by UC Press in 2013.

“We wanted to showcase the role that cultural practices play in everyday lives in New Orleans, and also the way these practices were mobilized to rebuild the city,” said Porter, a professor in the History and History of Consciousness Departments.

In black-and-white photography, Watts, a professor emeritus of arts, reveals the place and its people before and after the hurricane hit. “We managed to meld words and images to approach the city through its music,” he said.



Carrying On

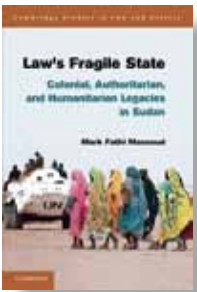
In the early 1990s, New Queer Cinema emerged as an amalgam of art and activism.

The movement was fueled by a potent combination of politics, AIDS, camcorders, and cheap rent, said **B. Ruby Rich**, author of **New Queer Cinema: The Director's Cut**.

“When I started formulating these ideas, the AIDS epidemic was still new,” said Rich, a professor in the Social Documentation Program and the Film and Digital Media Department. “There was an enormous amount of panic, grief and shock in the community. New Queer Cinema represented a second phase, a time to gather strength and try to express something other than mourning. I coined the name as a way to try to clear a space for this.”

With this book, Rich brings back her early essays about the rise of gay and lesbian cinematic themes, and updates her writing with new testaments to LGBT influences on film and life.

Rich is also the editor of *Film Quarterly*, the film journal of the University of California Press.



Looking for Law

The politically unstable setting of Sudan might appear an unlikely place to investigate the power of law. But it seemed ideal to **Mark Fathi Massoud**, an assistant professor of politics and legal studies at UC Santa Cruz.

Sudan was the first sub-Saharan African country to achieve colonial independence from the British. Its post-independence period has been wracked by warfare, slaughter, and instability. Massoud’s family fled from there in 1983, when war resumed after a decade of relative calm.

“I hoped to learn more about my homeland and the people who had stayed behind, and also to make sense of how law matters and fails to matter in the most unexpected places,” Massoud said.

The culmination of Massoud’s research, **Law’s Fragile State: Colonial, Authoritarian and Humanitarian Legacies in Sudan**, was published by Cambridge University Press in 2013.

His book received the 2014 Law and Society Association’s Herbert Jacob Prize for the best book in law and society published in the previous year.



Anil Ananthaswamy ('00) Becky Bach ('14) Elizabeth Devitt ('13) Jennie Dusheck ('85)



Melissae Fellet ('11) Heather Rock Woods ('94) Helen Shen ('12) Danielle Venton ('11)

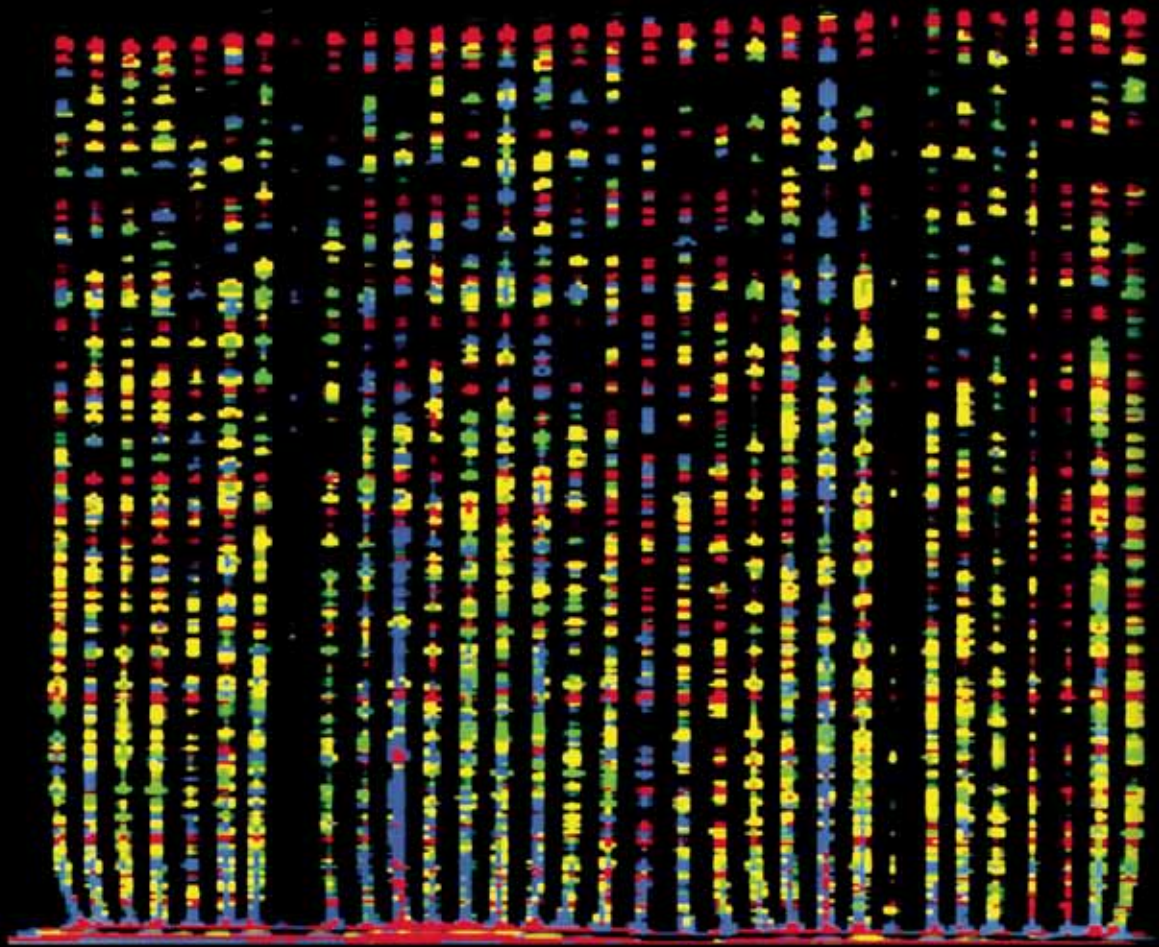
Contributors

ALTHOUGH THE BANANA SLUG—UC Santa Cruz’s mascot—is considered a solitary creature, a team of “slugs” came together to create the inaugural edition of this research magazine. More specifically, eight Bay Area alums representing every decade of the Science Communication Program returned to campus to report each of the feature stories.

The internationally recognized program was founded in 1981 by John Wilkes, who received his B.A., M.A., and Ph.D. in English literature from UCSC. “The cross-disciplinary emphasis at Santa Cruz is great for producing science journalists,” said Wilkes, in an oral history interview with one of his students, Sarah Rabkin (SciCom ‘85).

Under the guidance of director Robert Irion (SciCom ‘88) since 2006, the program differs from all other journalism studies by requiring applicants to have a background as a working scientist. So far, about 300 writers have completed the SciCom Program, forming a slug network that stretches around the world. Our alumni cover the science beat at *National Geographic*, NPR, the *New York Times*, NASA, the National Institutes of Health, major research universities and medical centers, museums—and, right here under the redwoods.

Learn more
news.ucsc.edu



Who says you need a medical school to defeat cancer?

Sequencing the human genome has finally put a cure for cancer within our reach. And while you'd think a prestigious medical school would have been the first to crack the code, in fact it was the bioinformatics experts working with big data at UC Santa Cruz.

Breakthroughs come from a willingness to question the status quo. And for 50 years, UC Santa Cruz

has been blazing a trail of bold, progressive inquiry that benefits both the individual and the planet. No university in the world has research cited more often than ours.

Is it really possible that some of the world's most exciting inquiry is being conducted in a redwood forest on the campus of UC Santa Cruz? Go to UCSC.edu/whosays to see for yourself.



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THE ORIGINAL
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