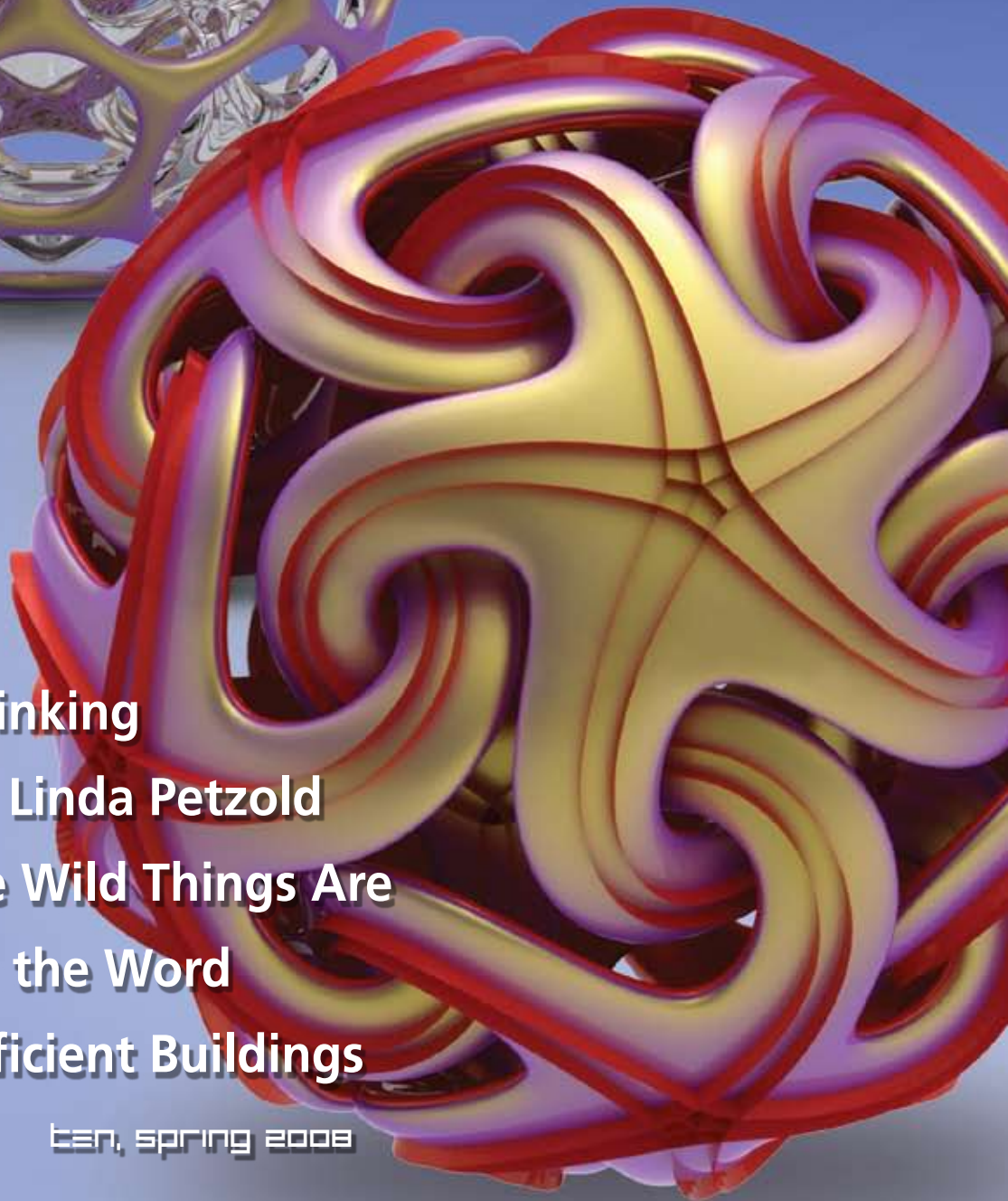
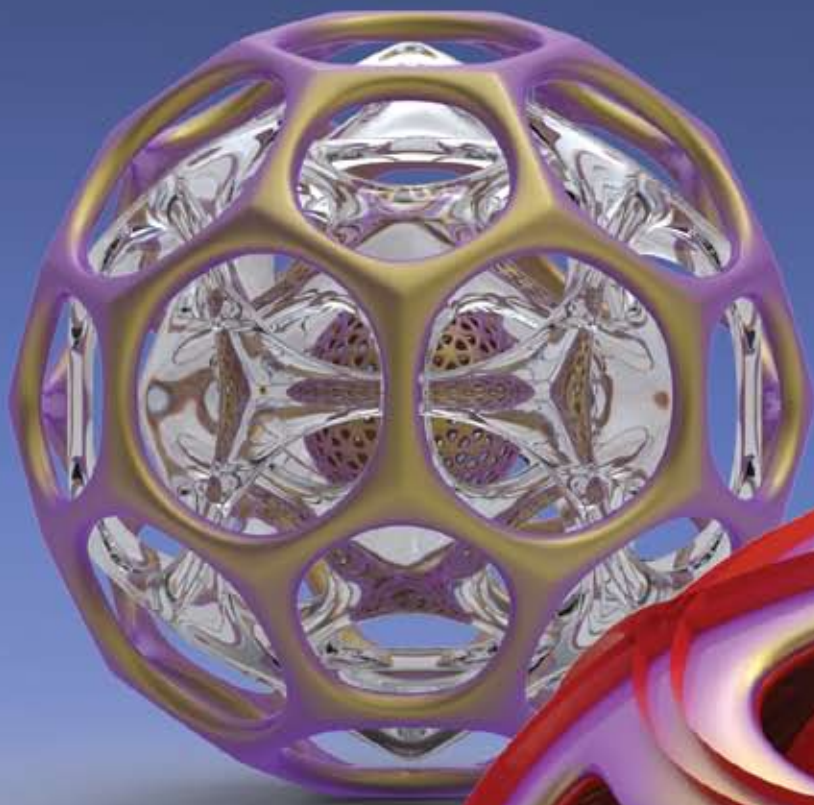


CONVERGENCE



The Magazine of Engineering and the Sciences at UC Santa Barbara



Spatial Thinking

Q&A with Linda Petzold

Where the Wild Things Are

Spreading the Word

Energy-Efficient Buildings

ENR, SPRING 2008



Letter From the Deans

Diversity... and More Energy

In this issue, we're proud to feature two articles focusing on the diversity in engineering and the sciences at UC Santa Barbara. Our Q&A talks with Linda Petzold, professor of Computer Science and Mechanical Engineering, about her career as a prominent woman in male-dominated fields, and our article *Spread the Word, Stay the Course* takes a look at the many outreach programs engineering and the sciences have undertaken to broaden the candidate pool for our next generation of engineers and scientists.

We're also revisiting energy, the focus of our last issue, as we look at making buildings more efficient in their use of energy. We've returned to energy both because it's a vital subject of continuing interest and because we've just launched the UC Santa Barbara Institute for Energy Efficiency. Unlike the many energy institutes and other organizations that focus on the supply side of the problem, looking to replace fossil fuels with alternative sources, our Institute is focused on the demand side. We've created an umbrella under which we're bringing together the many technologies we're researching and developing to increase the efficiency with which energy is used. We believe we can reduce demand for energy far faster, and to a far greater effect, than alternative sources and forms of energy can be developed.

Matthew Tirrell
Dean, College of Engineering

Steven Gaines
Acting Dean of Mathematical, Life and
Physical Sciences, College of Letters &
Science

Evelyn Hu
Co-Director, California
NanoSystems Institute

About the Cover:

Creating pictures of Carbon 60 molecules (middle) and high-genius two-manifold meshes (foreground) has always been a challenge for scientists and artists alike. Our *Spatial Thinking* article inspired *Convergence's* creative director to try and represent both these kinds of shapes in a less traditional manner.

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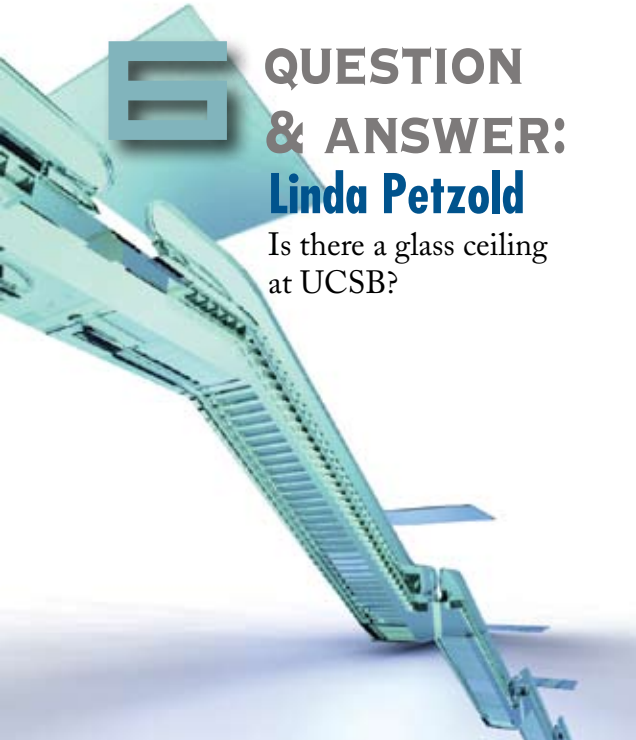


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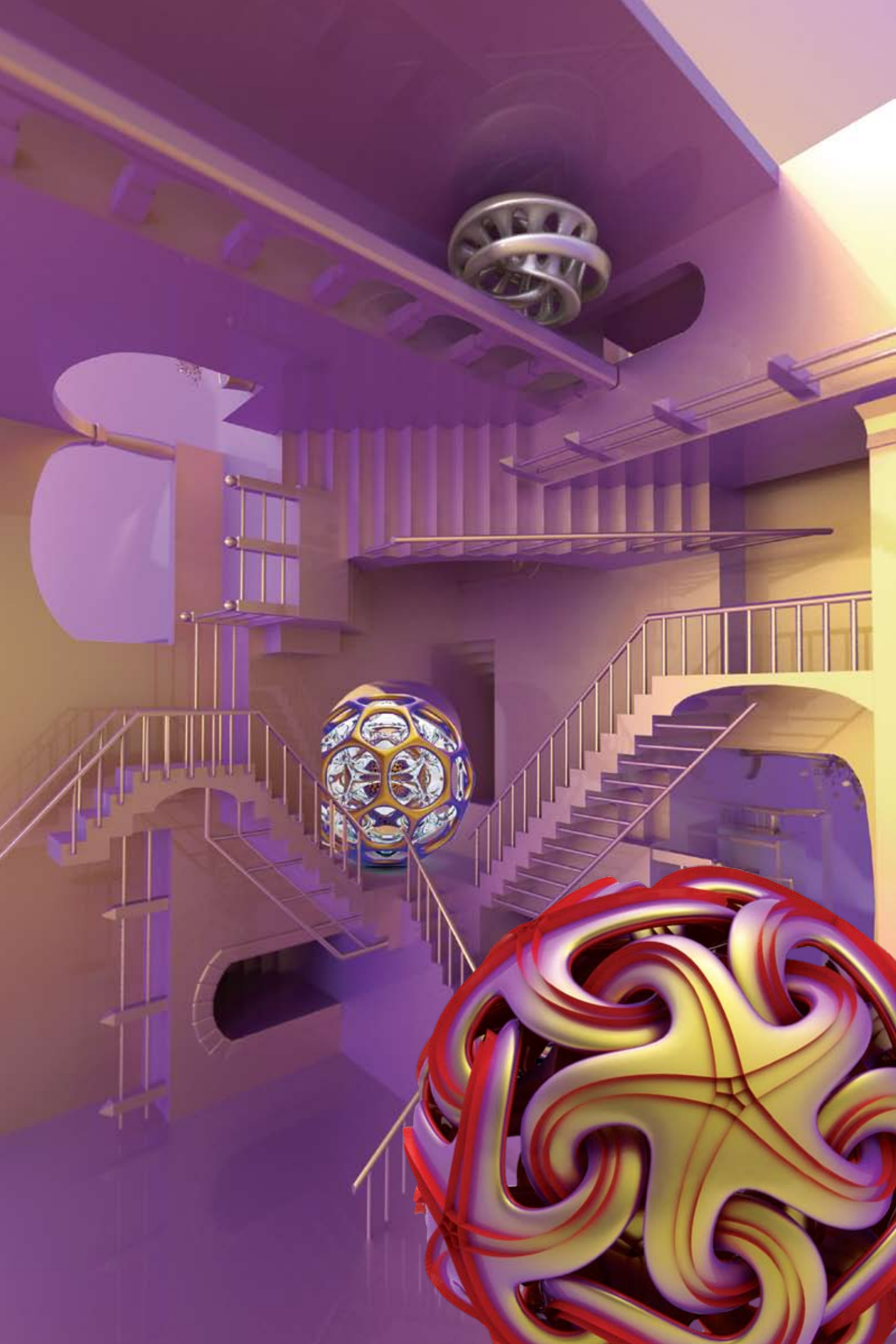


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CONVERGENCE

The Magazine of Engineering and the Sciences at UC Santa Barbara



SPATIAL THINKING

Which Y is Up?



With roots in geography and a reach into subjects ranging from music and psychology to black studies, spatial thinking is big at UC Santa Barbara. It all comes together at the UCSB Center for Spatial Studies, known as spatial@ucsb.

UCSB Geography Professor Michael Goodchild is making the case for space. The problem with much of modern science, he says, is that it's neither here nor there. Physicists, psychologists, sociologists and other students of the human and natural worlds look for the rules that, like the laws of quantum mechanics, apply without respect to where things are. "It has become customary to strip away context," he says. As the director of UCSB's new Center for Spatial Studies—known as spatial@ucsb—Goodchild is now working to put that context back.

Known worldwide as a leader in the theory and development of geographic information systems (GIS), Goodchild is not alone in his zeal for spatial thinking. Not just in the sciences, but also in the arts and humanities, UCSB already has a strong spatial emphasis, exemplified in a wide array of research efforts and creative initiatives that involve spatial analysis, technology and presentation. spatial@ucsb now acts as a nerve center and help desk for all this activity.

One goal of spatial@ucsb is to promote spatial thinking in academia and beyond. That includes explaining what spatial thinking is and why it's so important. Another aim is to raise UCSB's profile and influence, as spatial thinking and spatial technologies assume greater importance in science, technology, business, and everyday life.

At a basic cognitive level, spatial thinking is three-dimensional perception and recall. Strong spatial thinkers can easily recognize the same assembly of blocks in different positions (in so-called "mental rotation" tests). They always turn in the right direction when leaving buildings and never have trouble locating their cars in parking lots. Well-developed spatial thinking leads to spatial literacy—the capacity to learn about, analyze and explain the natural and social worlds through spatial visualization, technologies such as GIS, and spatial displays such as maps.

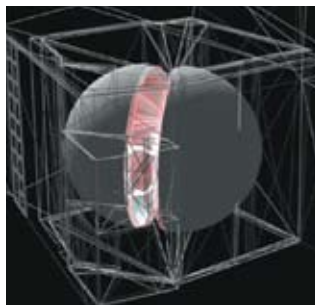
Spatial thinking has long played a crucial role in physical and social science. It has led to breakthroughs as varied as the discovery of the structure of DNA by James Watson and Francis Crick in 1953, a tour de force of three-dimensional visualization, and the curbing of deadly diseases. In the 1850s, surgeon John Snow helped end a cholera epidemic by drawing a simple map that showed how new cases of the disease in one London neighborhood clustered around a water pump, which authorities then closed. A century later, researchers discovered the link between asbestos and cancer by noting the high incidence of the disease near locations where "liberty ship" freighters were built during World War II.

The Near and Far of It All

What these examples have in common is a concern for how things and people exist in space—their height, depth, width, shape, and relation in space, typically expressed in terms of x, y, and z axes. How near and far they are to other things (or people) is crucial. So are all the data tied to the same location. Where two or more things happen at the same place—like cancer cases clustered around shipyards—spatial analysis may uncover cause-and-effect links that otherwise could remain buried in statistics.

Spatial thinking is at the core of several important physical sciences, including geography, epidemiology, geology, meteorology, and environmental sciences in general. It also plays an increasingly important role in social sciences—UCSB's Center for Spatially Integrated Social Science (CSISS) is devoted specifically to that role.

Don Janelle, spatial@ucsb program director, says, "One of the benefits of the spatial perspective is that it's an incubator for interdisciplinary work" (Janelle, a research professor of Geography and the Institute for Social, Behavioral and Economic Research, also directs the program SPACE—Spatial Perspectives for Analysis and Curriculum



Enhancement—at CSISS). “The block where you live has its own politics, health patterns, demographics and culture. It’s all there; the spatial perspective gives you a way to integrate it,” he says.

At UCSB alone, says Janelle, spatial analysis has attracted the interest of faculty in the Departments of Mathematics, Anthropology, Religious Studies, Psychology, Music and Black Studies, to name just a few. UCSB’s new Allosphere—a spherical enclosure three stories high, used for creating and studying 3-D phenomena in light and sound—is a nexus for spatial research in the arts as well as engineering, quantum physics and nanoscience.

Why a Spatial Center?

spatial@ucsb has its roots in geography and in Goodchild’s work with GIS, the computing technology that processes and analyzes location-linked data. In 1988, he won a \$10 million grant from the National Science Foundation to set up the lead site of the National Center for Geographic Information and Analysis. The mission of this research consortium was to “interact as widely as possible” with scientists worldwide, he says, rather than focusing on building resources at Santa Barbara. This was one reason why he began thinking about a new kind of program, designed to foster a community of spatial thinkers at UCSB, including arts and humanities as well as sciences.

His idea became reality in 2007, when spatial@ucsb started up, with a three-year commitment from the office of UCSB Chancellor Henry Yang. Goodchild’s goal is to put spatial@ucsb on a solid, long-term foundation of funding from private donors and research grants.

The center has a large menu of activities, including academic presentations (the “ThinkSpatial” public lectures and “brown bag” lunch-hour events), regular meetings of graduate students from different disciplines to share research interests involving spatial perspectives, workshops on spatial tools and their applications, and the UCSB Spatial Review, a Web portal to examples of spatial perspectives from across the university. Expanding the use of GIS is another important part of the spatial@ucsb agenda. The center offers a course in GIS for graduate students, and it offers drop-in consultation to help UCSB faculty and students design GIS programs for their research or creative projects.

spatial@ucsb acts as a GIS resource for UCSB researchers who “are trained to use numbers and words,” says Black Studies Professor George Lipsitz. “The existence of spatial@ucsb is essential for us to get knowledge that, as a small department, we wouldn’t otherwise have.” For instance, Janelle introduced Black Studies researchers to Social Explorer, an online site that

produces detailed maps from Census data going back to 1940. Lipsitz says Social Explorer is “especially useful for [tracking] migration and neighborhood change.”

Spatial analysis is an important tool for Lipsitz (who focuses on topics such as housing discrimination and the impact of transportation on access to jobs) and for several other Black Studies researchers. One is Clyde Woods, who, says Lipsitz, “works at the intersection of race and space” by analyzing black migration patterns. Another is Gaye Johnson, who uses geographic analysis in her studies of black and Mexican relations in Los Angeles. Lipsitz says GIS is a “wonder” in the detail of economic and social data that can be processed and displayed geographically. “You can do readings of banks vs. payday lenders, and grocery stores vs. liquor stores.”



Interfacing with Computer Science

spatial@ucsb also helps continue the interaction of geography and computer science that created modern GIS technology. It has close ties with the Four Eyes Lab (the name stands for Imaging, Interaction and Innovative Interfaces), where UCSB computer scientists work on improving human-computer interaction and creating display systems that mimic 3-D reality. Four Eyes co-director Tobias Höllerer recently gave a spatial@ucsb brown-bag talk on the lab’s work with “anywhere augmentation,” a merging of GIS, global positioning and mobile computing in portable systems that enable users to “annotate any physical object wherever they go.” By simply pointing to an object, such as a building, one could mark it for others who are using the same database... The other co-director, Matthew Turk, says spatial@ucsb gives computer scientists “gives computer scientists access to data and spatial computation problems that we wouldn’t otherwise know about, giving rise to new opportunities for collaboration.”

The mission of spatial@ucsb goes well beyond the promotion of geographic ideas and tools, important as these are. Janelle says it is “not trying to impose a geographic discipline” on other fields of study. The center treats spatial thinking as essential to disciplines that never get near a map.

The center’s research network reaches into cognitive science and education, for instance. Professor of Psychology Mary Hegarty, a member of spatial@ucsb’s executive committee, researches spatial thinking from two angles. One is to study how people read visual displays such as maps and diagrams. Her other focus is on spatial thinking ability and the question of whether it can be taught.

The jury is out on the teachability of spatial thinking, Hegarty says, but she points out that it is a crucial skill in a number of fields. Chemists need it to visualize molecular structure. Radiologists must be able to visualize tissue in three dimensions using layers of two-dimensional images, and surgeons need to navigate through the body in three



Images will be projected in real time – from an MRI, for instance – so that “people can stand inside the cortex of a colleague’s brain,” says JoAnn Kuchera-Morin.

dimensions. Not everyone is blessed with the same level or type of spatial intelligence. Hegarty says men are better than women at mental rotation tests, while women are better at others, such as remembering an array of objects and spotting the ones that have moved. But she says it’s important to make everyone as good a spatial thinker as he or she can be, just as schools try to increase everyone’s verbal skills even though “we know there are differences in verbal ability.”

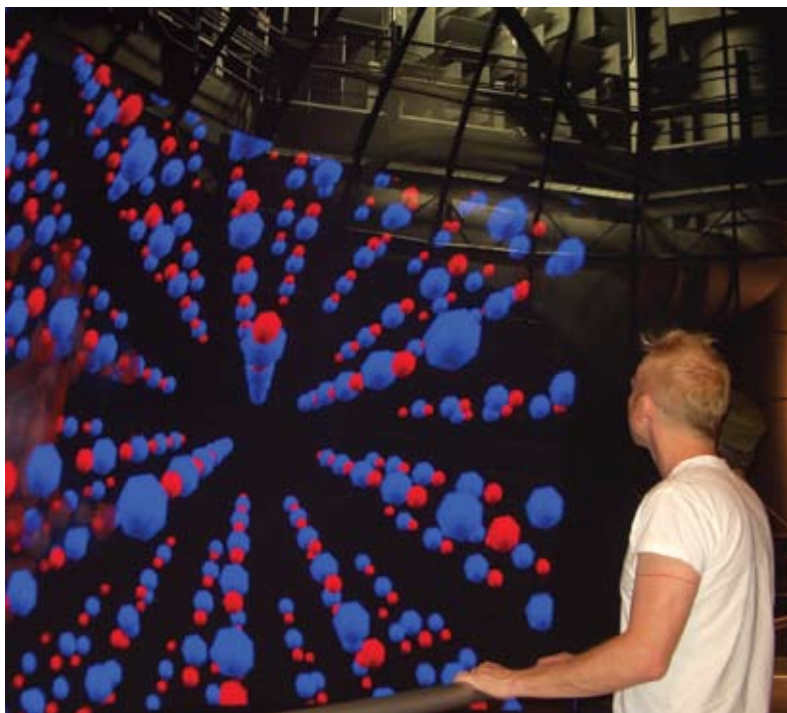
Arts and the Allosphere

Spatial thinking plays an important role in the arts and is central to some, such as sculpture. Art and spatial science come together at the Allosphere, housed at the California NanoSystems Institute (CNSI). The structure was completed in 2007 and is now being equipped with speakers and projectors. When all the audio and video elements (including 500 speakers) are in place, the Allosphere will be able to simulate 3-D environments and structures at all scales, from the atomic to the cosmic.

The Allosphere’s director, JoAnn Kuchera-Morin, says images will be projected in real time—from an MRI, for instance—so that “people can stand inside the cortex of a colleague’s brain.” Kuchera-Morin, a Media Arts and Technology professor who also has collaborated on research with Goodchild since the mid-1990s, says the Allosphere offers the possibility of presenting data “in new and exciting ways” such as “sonifying” it—turning it into sound. The facility also will serve as a lab for 3-D movie technology and a venue for visualizing structures as minute as quantum dots. In these ways, the Allosphere represents a new technological leap for spatial thinking, though the objective is not fundamentally different from what Watson and Crick were doing 55 years ago. Now, as then, scientists are trying to think about things as they really are—in space, in context—and artists are trying to create works as close as possible to real life.



www.spatial.ucsb.edu
csiss.ncgia.ucsb.edu
www.spatial.ucsb.edu/reviews
ilab.cs.ucsb.edu
www.mat.ucsb.edu/allosphere



A researcher in the Allosphere interacts with the three-dimensional display through the touch-sensitive handrail.



question & answer: *Linda Petzold*

Linda Petzold is a renowned computer scientist and mechanical engineer, and one of the few women to have reached the highest levels of the two fields. She was Chair of UCSB's Department of Computer Science from 2003 until 2007. Before coming here in 1997, Petzold was a professor at the University of Minnesota, and earlier, an adjunct professor at the University of Illinois at Urbana-Champaign. Prior to that, she worked at Sandia National Laboratories and then Lawrence Livermore National Laboratory. Petzold, who is known for her work on differential-algebraic equations, has been honored by many organizations, including the National Academy of Engineering and the Association for Women in Mathematics.

Petzold talked to Convergence about her experiences as a woman in science and engineering, and offered some advice to other women about breaking through the glass ceiling, sticking up for themselves, and mixing motherhood with the demands of academia.

How did you get interested in science and then decide to make it a career?

I've been interested in science since I was a young child—I've always loved science. My father's a mechanical engineer. He always seemed to be doing interesting things, and I was always asking him about them. He was a great role model. I always had the idea that it would be fun to design things, to change the world.

You completed high school in just 3 years. Was it difficult for you to fit in?

I was always the weird smart girl. It's not very cool in U.S. society, in high school, to be a smart girl... I don't have a daughter so I don't know exactly what it's like for girls now, but in watching my son I get the impression that it's still not OK to be smart. My dad said, 'When you get older, it'll be an advantage, being smart.' He was right.

While in high school, you attended a National Science Foundation-funded summer program for gifted students. How did that influence you?

I grew up in a working-class neighborhood—the same neighborhood my dad grew up in, and he was the first college graduate in this family—where it was unusual for kids even to go to college, let alone to think about being researchers. The NSF program did two things for me: It opened up the idea that maybe I could do research, and it showed me that it was OK to be a smart person... It was a big eye-opening experience for me to meet all those other smart kids and to realize that it's OK to be one.

When you went to college, did you intend to major in computer science?

I thought I was going to be a chemist, but the chemistry lab wasn't my best environment. I ended up with holes in lots of my T-shirts. I went to see the chemistry professor about a homework problem and got talking with him, and he suggested that I take a class in computer science. I took it and I just really fell in love with computing... by the end of the year I had switched my major to math and computer science.

In the early years of your career did you have a mentor? How important do you think that is for young female scientists?

A good mentor is tremendously helpful in any field. I had two really terrific mentors, and they were both men. Your chances in science and engineering, even nowadays, of



having a female mentor are really low. I'm frequently asked, 'How many women have you mentored?' and I find the question frustrating, because the few of us who are here can't possibly bear the burden of mentoring the entire next generation all by ourselves, if that next generation's going to be any bigger. There's no question that men have to be involved. Men can be great mentors for women, and women for men.

There are a number of other women in high-ranking faculty positions at UCSB, including Evelyn Hu, Scientific Director of the California NanoSystems Institute, and Alice Alldredge, former Chair of the Department of Ecology, Evolution and Marine Biology. Do you think they serve as role models for young female scientists?

They definitely do, and I haven't met a woman here in science or engineering who wouldn't be an excellent role model.

How do you think campus groups like Women in Computer Science (WiCS) and larger organizations like the Women in Science and Engineering (WiSE) help?

I think they give people a sense of community. Students can meet people who are similarly inclined, and it also introduces them to potential female role models. WiSE is great. They hold workshops, which I think are great opportunities for women to network with other women in the field.

As a woman in the male-dominated fields of computer science and mechanical engineering, have you experienced or observed discrimination?

For the longest time I really didn't believe that bias existed—I think that's partly because I just didn't have time to see it and I didn't want to see it. I really never thought about it until I was a full professor, and now I certainly don't

Former Harvard University President Lawrence Summers suggested at a conference in 2005 that innate differences between men and women could be one reason fewer women excel in science and math careers. His remarks prompted an outcry, and Summers later resigned. Do you think there's any truth to what he said?

Undoubtedly there are some differences, but there's a huge statistical distribution in aptitudes and abilities in both men and of women, and one thing I've learned from doing science a long time is there's a need for people with many different interests and strengths. And shame on Summers—He deserved to get fired.

What do women uniquely bring to science and engineering?

Women are well known to have strong abilities at integration, and right now many of the frontiers of science are multidisciplinary... The women do seem to be doing well in those areas. Some of the problems are so complex there's a need to work in teams. A more team-based, consensus-building approach, at which women do well, is definitely the wave of the future. I think there's more of that approach now, but there are still not many women to drive it.

It's been nearly a decade since the landmark Study of the Status of Women Faculty in Science at MIT focused attention on the experiences of women in science and engineering. What did you think of that study?

I was shocked at how well that study described my own experiences. The interesting thing was that the junior women were not the ones who were conscious of any discrimination. It was the senior women who were most disaffected. It's this invisibility thing. It's a very subtle issue that you're not even aware of until someone points it out to you.

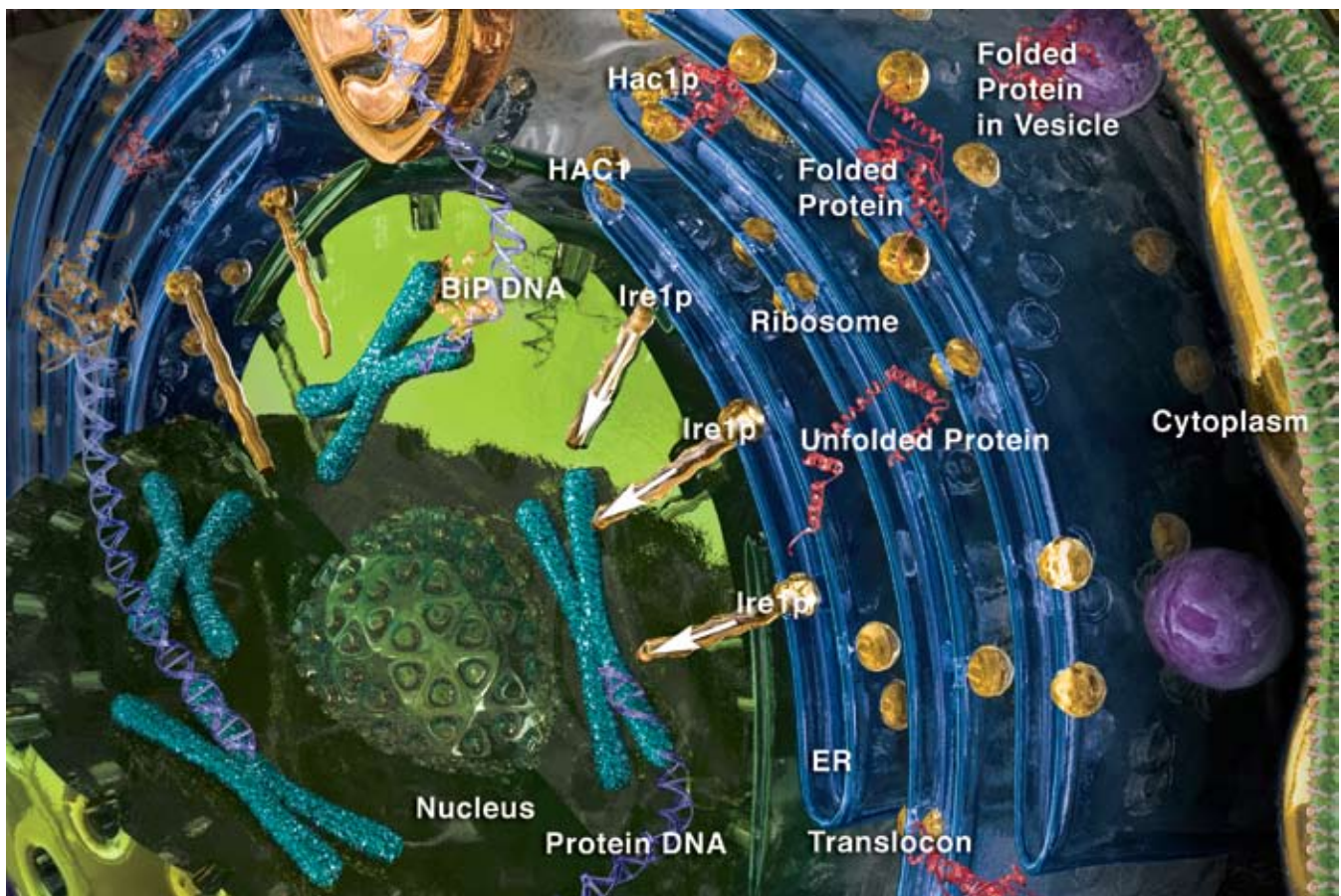
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think about discrimination every day. But I do remember the first few times I got an invited lecture. My colleagues would say, 'You just got that because you're a woman,' Right after I had my baby and I started traveling again, I'd hear, 'Why are you here? Didn't you just have a baby? Who's taking care of your baby?' Well, he has a father who was quite capable of taking care of him. I've never felt threatened or that I've lost opportunities, but it's still more than just an annoyance...

I think the first time I really felt it big time was after I got my first big grant, for \$2 million. A prominent colleague who had a competing proposal was actually very angry at me when I got the grant, and basically told me to concentrate on less ambitious objectives.

Despite efforts to recruit more women in male-dominated disciplines like computer science, they are still underrepresented. Why hasn't there been more progress in that regard?

Somehow we're not recruiting the women students into engineering and the sciences as we should, and that's compounded in computer science. We have a huge, nationwide problem that's multifaceted... There's a problem with the image of computer science. Then there was all the negative press about offshoring and how there weren't going to be any jobs. A lot of work was moved offshore, but the job market is extremely robust right now. They've offshored



Professors Linda Petzold and Frank Doyle are currently using computational modeling to understand the unfolded protein response that occurs in a yeast cell's endoplasmic reticulum.

a lot of the straight programming jobs, so now the jobs are more creative, and have a lot to do with integration.

Still another part of the problem is our approach to computer science education. Five years ago we were deluged with students. We were preparing them to go to the Googles and the Microsofts and we did a tremendously good job of that... but then the dot-com thing went bust and we didn't have as many students, but we were still teaching them in the old way. We have a very rigorous, technical, and in some ways narrow curriculum, but we're working on that. We've added a new Bachelor of Arts program in computer science. It's also a rigorous technical degree, but you can do a track in a number of different disciplines: economics, biology, geology. Another thing we do is we assume a lot more programming experience than a lot of the women have when they arrive. A lot of guys joined the programming club in high school or did programming as a hobby. That would seem to be a big disadvantage for women, yet there's a lot of evidence that you don't need that programming background to be successful in computer science.

What are the challenges faced by female faculty members in science and engineering?

I think getting recognition for your work is the biggest challenge. My guess is men don't think about nominating women colleagues as much as they think about nominating men. There needs to be a system in place to ensure salary equity and promotion equity. I think the younger female faculty members around here, of childbearing age, are very nervous about it...I think there's a lot of worry about tenure. I'm a very productive and hard working person, and I could

only write one paper the year I had my baby.

Do you have any sage advice for women embarking on a career in science, or who already have tenure in a field where women are underrepresented?

Something that I have not been so very good at is defending my right to be here, aggressively defending my position. If you have a view and you're in a meeting, I think it's important to make that view known, make sure that you're heard, and that your ideas are recognized. Women need to watch out for each other, to make sure that they get appropriate credit.

You have a son who's now 24 and a UCSB graduate. How did you mix motherhood with the demands of a tenured faculty position?

I had many years with no recreation! You have to love your work, because you have to give up something, and most often it's your personal time—but it is do-able. It's very, very difficult, but it's worth it. I think you just do it and you never have a thought about giving up other important parts of your life. You have a right to have children, but you can't be blind—you're not going to have a lot of free time. Motherhood has tremendous rewards and research has tremendous rewards. I believe you can have it all, or at least almost all. I'm proof that it's possible, but the next generation should be able to improve on my model.

A photograph of a cougar walking through a rocky, brushy landscape. The cougar is the central focus, moving from the upper right towards the lower left. Its fur is a mix of brown and tan, and its eyes are looking directly at the camera. The ground is covered with dry leaves, twigs, and patches of green grass. Large, light-colored rocks are scattered throughout the scene, particularly in the foreground and middle ground. The lighting is bright, suggesting a sunny day, with shadows cast across the rocks and vegetation.

Where the Wild Things Are...

As cities and towns expand, they creep ever farther into fields, forests and deserts that are home to a multitude of animals and plants. As these wild places are replaced by buildings, parking lots and highways, the species that live there are squeezed into ever-smaller habitats. But if there are still suitable connections between those areas — for example, a lush urban park, a golf course that includes stands of native trees, or even a railway line flanked with grasses— animals and plants can move from one habitat to

These corridors, as ecologists call them, allow animals to travel in search of food and mates and to escape habitat changes or catastrophes like forest fires. They also allow animals and plants to replenish dwindling populations, and to colonize new areas. That keeps the whole population healthy, with a robust gene pool that's more resilient to disease and environmental changes. On the other hand, if an area of habitat gets cut off by urban sprawl, animals that can't fly or make their way through yards and parking lots and across roads have nowhere to go. They can easily be decimated by disease or wiped out when trees are cut down or wildfire strikes. Over time, an isolated population can become inbred, making it even less resilient to diseases, habitat changes and natural disasters.

Because many of the world's wild areas have been fragmented by development, it's crucial to preserve and restore connections between the remaining habitat areas, ecologists say, and that's now a top priority in conservation planning.

With so many species in peril and so many pressures on their habitats, ecologists, government agencies and conservation groups must make tough decisions about where to spend the limited funds available to protect habitats. They have to figure out which corridors are the most important so they can be preserved or restored.

"We're always going to have limited resources and we've got to be able to figure out where to spend our money," says Brad McRae, a postdoctoral fellow at UCSB's National Center for Ecological Analysis and Synthesis (NCEAS).

McRae has developed a new way of thinking about and modeling landscape connectivity that reveals the most crucial linkages between habitats and predicts how animals move through them, and hence how landscape affects gene flow. He's used the approach to model the movement of mountain lions in Southern California, greater sage-grouse in the intermountain West, and jaguars in South America.

With help from UCSB computer scientists, McRae has produced detailed models of wildlife movement across areas as big as whole continents. His work will

help protect rare species that are losing their habitats to development, and his technique is catching on with researchers and planners around the world.

McRae's new approach grew out of his earlier work in electrical engineering. His bachelor's degree, from Clarkson University, was in electrical and computer engineering, and he worked as an engineering intern at Texas Instruments before taking a job as an electrical and computer engineer at NCR Corporation, a technology company in Ithaca, New York. It was in the mid-90s that he changed his focus to ecology. He completed a Masters of Science, with a thesis on effects of landscape composition on songbird populations, at the University of Wisconsin-Madison and then a doctorate in Forest Science at Northern Arizona University, with a thesis on gene flow between mountain lion populations. McRae came to NCEAS in 2005, and is one of about 3,500 researchers who have spent time at the renowned center, which was established in 1995 with funding from the National Science Foundation.

McRae began pondering the similarities in how animals and plants move through fragmented landscapes, and how electrical currents flow through circuits. In a circuit, current will travel through any path available from one node to another. If there are multiple routes available, more current will flow.

In McRae's analogy, animals and plants are the equivalent of electrical current, and they'll take advantage of whatever pathways are available to travel between habitat areas, which are like nodes in a circuit. If there are many connections—corridors, that is—they will move more easily. When animals

encounter a barrier like a road, their movement is reduced, just as less electrical current travels through materials with high resistance, like silicon. In some cases, a barrier may stop movement altogether: a major highway may thwart the travel plans of animals that try to scamper across it, just as electricity can't travel through rubber.

Electrical engineers have equations to describe how electricity moves through a circuit. McRae decided to use those equations—circuit theory—to model animal and plant movement over large, complex landscapes.



JPL engineer Matt Dickey took the photograph opposite from the bridge at the center of this photo, between the parking lot and the main campus at Jet Propulsion Laboratory, in La Cañada (near Pasadena), CA. The creek bed in which the mountain lion is crouched is a good example of the corridors through urban sprawl identified in McRae's studies.

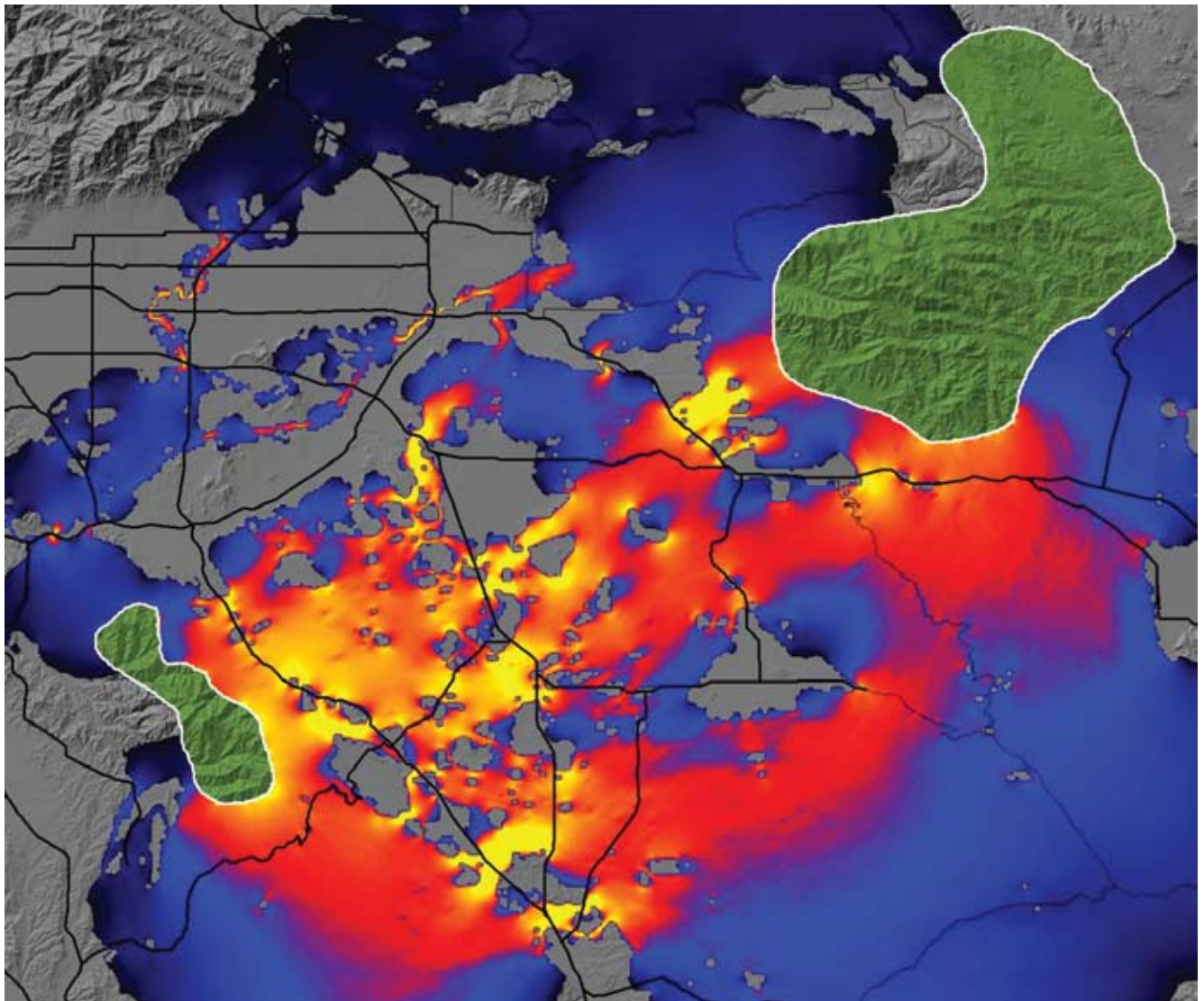
McRae tested the idea using data on two threatened species: big leaf mahogany, a tropical tree that grows in parts of Central America, and wolverines, the largest land-dwelling members of the weasel family, which roam widely in western and far northern North America.

Genetic connectivity for these species had already been studied using conventional approaches, but McRae revisited the data, applying circuit theory to the problem. He found that for both species, his technique worked better using landscape and genetic data than standard methods, and he published his work in the highly respected *Proceedings of the National Academy of Sciences* last year.

In McRae's model, landscapes are represented as conductive surfaces, and features like forests, roads, and grassland have differing degrees of resistance to animal or plant movement. To perform an analysis, McRae must first break down a large landscape into smaller cells, so that he can analyze how species move between those cells, and consequently through the landscape as a whole.

Using his new approach, McRae found that the shape of habitats can dramatically affect how animals and plants move around and breed—a factor that couldn't be taken into account using conventional models of movement—and that barriers to movement don't have as big an influence as had been assumed in standard models. Unlike conventional approaches, the circuit theory technique allows all the possible pathways through a landscape to be analyzed at the same time. "With one single computation," McRae says, "you can consider every possible corridor, every possible linkage in the landscape."

Over the last couple of years, McRae collaborated with Brett Dickson at Northern Arizona University and wildlife biologist Rick Hopkins of Live Oak Associates to use circuit theory to examine how mountain lions move through Southern California. There are populations of mountain lions in mountain ranges in the region, but relentless urban sprawl has created plenty of barriers for the animals: choked six-lane highways, condo complexes and shopping malls.



Habitat connectivity in Southern California: Warmer colors show areas important for mountain lion movement between mountain ranges. Yellow indicates "pinch points," or areas where connectivity is most vulnerable to being cut off by development.

“We set out to figure out which areas between those mountain ranges are most crucial for connectivity,” McRae says. “Where are those critical areas, those pinch points?” If those connections are lost to development he says, mountain lion populations could become dangerously isolated.

McRae has produced maps of mountain lion movement in Southern California which will be submitted for publication soon. In those maps, areas where connectivity is not threatened are indicated in blue, and red is used for places that are critical for maintaining movement. If these pinch points were to be cut off altogether, whole populations of mountain lions could be cut off from each other, McRae says, leaving them genetically isolated and vulnerable to disease, habitat destruction and natural disasters. He’s identified a crucial linkage between lion habitats in the San Bernardino and San Jacinto mountains, but to move between those two areas, mountain lions must cross Interstate 10, one of the region’s busiest highways.

McRae initially did the work using the popular programming language MATLAB, and it took several days to run his models. “I had very slow, clunky code because I’m not a very good programmer,” McRae said. He “struggled” with the code for years before attending a talk at NCEAS by Viral Shah, then a doctoral candidate working with John Gilbert, a professor of computer science at UCSB, who is trying to make powerful parallel computing techniques “available to people who don’t have experience in high performance computing,” Gilbert says.

Shah, who now works for Interactive Supercomputing and is a visiting scientist in Gilbert’s lab, set to work to try to make McRae’s task less onerous and his computations much quicker. McRae says Shah’s work transformed his “clunky MATLAB code that took 3 days to run into something that takes a few minutes,” using an 8-core processor at NCEAS. “All of a sudden it’s just whizzing,” McRae says. “It’s just a few hundred lines of code,” he adds, “but it accomplishes a great deal.”

McRae says Shah’s work transformed his “clunky MATLAB code that took 3 days to run into something that takes a few minutes,” using an 8-core processor at NCEAS.




Shah then set up McRae’s code to run in Star-P, a parallel computing environment developed by Shah and Gilbert together with Steve Reinhardt of Interactive Supercomputing Inc. Star-P allows users to work in a familiar programming language like MATLAB, while Star-P translates the codes so they can be run effectively on multiple parallel processors.

“The trick was to stay in an environment that Brad was familiar with,” Shah says.

Shah’s contribution has allowed McRae to produce models of wildlife movement across larger areas, and to produce more detailed and accurate results by dividing landscapes into many smaller cells than he could using traditional computing methods. Because McRae can run his models so much faster, he can also refine them much more quickly.

McRae now wants to use his technique to model habitat connectivity for groups of species, such as forest carnivores, since it’s generally more practical to try to conserve suites of species in an ecosystem rather than single animals.

Scientists and conservationists have long argued that connections need to be preserved and restored to save species. With McRae’s new method of modeling habitat, they should have a much stronger case and a better idea of where to put the limited funds available for such efforts.

“It gives us an objective way to quantify the benefits of protecting those habitats,” McRae says. 

Brad McRae’s Home Page: www.nceas.ucsb.edu/~mcr

Using Circuit Theory To Design Connected Landscapes: www.nceas.ucsb.edu/~mcr/design.html

National Center for Ecological Analysis and Synthesis: www.nceas.ucsb.edu

Viral Shah’s Home Page: allthingshpc.nfshost.com/drupal

John Gilbert’s Home Page: www.cs.ucsb.edu/~gilbert

National Science Foundation: www.nsf.gov

Los Angeles Times coverage of the mountain lion at JPL: www.latimes.com/news/local/la-me-cougar26jan26,0,323028.story

SPREADING THE WORD, STAYING THE COURSE

Recruiting students in engineering and the sciences is highly competitive, and the pool of qualified applicants is limited. It takes creativity and commitment to expand that pool, and to retain those students once they're admitted. Here's how UCSB tackles the challenge...

Face it: Math and science are not the easiest subjects. They're tough in middle and high school, and their difficulty takes a quantum leap in the college years. Engineering combines the two—even more challenging for most students. UC Santa Barbara is sending a different message to kids who may not think of themselves as potential scientists or engineers: Don't sell yourself short. You may be a future engineer and not yet know it. Science may be your strong suit. Set your sights on a career in these areas, and we'll help you get there.

That message is embodied in an alphabet soup of UCSB programs—CAMP, EPSEM INSET, LEAPS, MESA, PREM, SIMS and others—that reach out to students from a wide range of backgrounds and seek to give them a pathway to success in college and beyond.

Some of this effort is explicitly directed at minority students. CAMP (California Alliance for Minority Participation in Science, Engineering, and Mathematics) and PREM (Partnership for Research and Education in Material Science) are two such programs. Others, such as MESA (Mathematics Engineering Science Achievement) have a somewhat wider target group—students who come from families with no history of attending college.

MESA Pitches Science and Math

MESA is one of the oldest and largest recruiting and outreach programs in California higher education. Founded in 1970 and run out of the UC President's office, it is active at six UC campuses, 11 Cal State University locations, 30 community colleges and about 300 middle and high schools. It has more than 180 industry partners—including big names such as Google, Microsoft, and Hewlett-Packard—and is a model for similar programs in seven other states. At UCSB, MESA activities run the gamut of recruitment and retention. At 24 schools in Santa Barbara and Ventura Counties, MESA provides academic enrichment, training in study skills, guest speakers, field trips, SAT/PSAT training, and other activities aimed



at getting more students ready for college. For MESA students who go on to study engineering at UCSB, the program provides tutoring, support services and career networking.

Bob Cota, a mechanical engineer, spent 30 years in private industry before coming to UCSB nine years ago to be director of the MESA Center. He notes that UCSB has taken a lead role in developing the statewide MESA summer algebra academies. It is one of four institutions in California that join with Johns Hopkins University to offer an intensive five-week “What is engineering?” residential summer course for about two dozen 11th and 12th grade students. Cota calls this “an extremely tough, very good program” that “gives students a better perspective on what to expect at the college level, and also tells them what they need to do to prepare.”

MESA's profile on the UCSB campus is highest each year at the Science and Technology/MESA day, held in March. About 1,000 students come to UCSB for science and engineering competitions, tours of campus labs and libraries, and a chance to meet with UCSB faculty and students. They get quite a show. At the 2005 event, for instance, they talked via video link with astronaut (and UCSB alum) Leroy Chiao, in orbit at the International Space Station.

LEAPS—a Two-Way Education

MESA does its work with a staff of five, including two field operators working full-time in the area schools. Another outreach program, Let's Explore Applied Physical Science (LEAPS), relies on UCSB graduate and undergraduate students to help eighth-graders get on track toward college-level science. Seven graduate students in engineering and the sciences are designated each year as LEAPS Fellows, receiving stipends from the National Science Foundation. Six of them work two mornings a week with teachers in middle school



UCSB's Message:

Don't sell yourself short.

You may be a future engineer and not yet know it.

Science may be your strong suit.

Set your sights on a career in these areas, and we'll help you get there.



science courses, focused mainly on helping students do inquiry-based labs. The seventh leads 10 undergrad LEAPS Fellows in conducting after-school programs. The target student population is similar to that of MESA.

UCSB Professor of Physics Elisabeth Gwinn, who has headed LEAPS since its start in 2002, says the program is a two-way education. The eighth-graders learn how to do science, while the UCSB students learn something about teaching—both from their own interaction with students and from working with experienced local teachers. Gwinn says the fellows learn quite a bit of science, too. Explaining the basics of chemistry, physics and astronomy to middle-schoolers forces graduate students to fill gaps in their own knowledge. Fellows “know a lot about narrow fields going in,” she says, “and they leave with a broad knowledge of the sciences.”

Promoting Literacy at CNSI

UCSB’s outreach effort also extends to community colleges, where programs work to recruit students to summer internships that introduce them to the university. EPSEM (Expanding Pathways to Science, Engineering and Math) and INSET (Interns in Nanoscience and Engineering), both funded by the National Science Foundation, are two of these.

Leading EPSEM and INSET is the California NanoSystems Institute (CNSI), jointly run by UCSB and UCLA. Its director of education, Fiona Goodchild, sees its mission as fundamentally one of “promoting literacy in science and engineering.” CNSI’s other outreach initiatives include the Apprentice Researchers program, which has engaged local high school juniors in campus research groups since 1991, and shorter-term projects such as the current “Too Small to See-2” nanotechnology exhibit. Designed for children ages 8 to 13, the exhibit at CNSI’s Elings Hall continues through May 31 of this year, teaching through hands-on activities how scientists use electron microscopes, molecular models, and computer graphics to understand the structure and properties of nanomaterials.



At UCSB’s Materials Research Laboratory (MRL), educational outreach is a core activity, equal in importance to research. “It is written into the mission of the center,” says MRL’s education director, research scientist Dotti Pak. “The faculty see it as part of their responsibility, and their mission as well.” MRL initiatives are aimed at teachers, undergraduates, community college students and K-12 students, with several programs (including CAMP and PREM) aimed at minority students or predominantly minority schools.

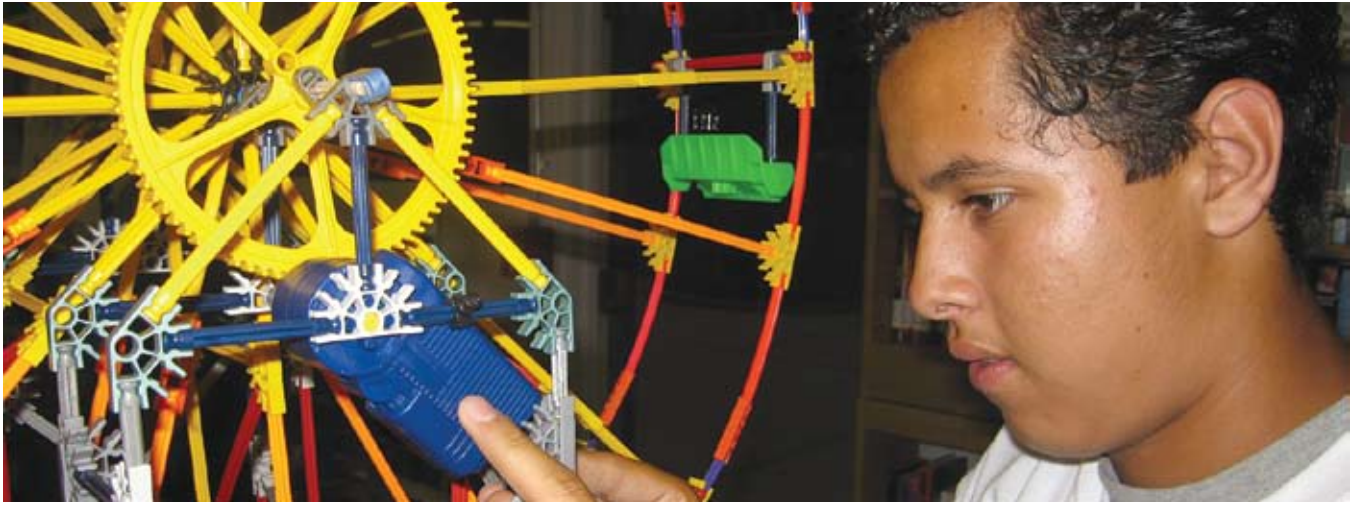
Teaching with “Buckyballs”

MRL works closely with MESA in its local outreach, focusing its efforts on schools in the MESA program and, with MESA, running the summer algebra academy. But MRL initiatives have their own distinct flavor, thanks to the involvement of faculty members such as Ram Seshadri, an associate professor of Materials. Seshadri has built an educational program, mainly for eighth graders, around models of molecules called buckminsterfullerenes, or buckyballs (their spherical structure of carbon atoms resembles that of R. Buckminster Fuller’s geodesic domes). Using a kit with which students can make scale-model buckyballs of their own, Seshadri’s program opens their minds to the wonders of nanoscience. As Pak explains,

“We talk to the kids about scale—what’s the scale of a nanometer relative to things they know—and the relationship between structure and properties of a material.”

The effort does not stop once students are admitted to UCSB. It enters a new phase—helping students stay the course—that can be just as challenging as anything that comes before. The sustaining effort targets community college transfer students as well as freshmen, and it starts in earnest before these students begin their UCSB classes.

The annual EPSEM Summer Institute, for instance, brings prospective transfer students to Santa Barbara for two weeks of interaction with UCSB faculty via lab projects, mentoring and social activities. Goodchild says students who get through the period of “transfer shock” do well. “If you talk to faculty, they often remember outstanding transfer students,” she says. “Transfers usually know why they’re here, whereas



many of the freshmen have not yet have figured out their priorities.”

EPSEM also sponsors the Summer Institute for Math and Science (SIMS), engaging about two dozen high-school graduates in two weeks of intensive instruction in mathematics, chemistry, writing, and lab skills, to prepare them for university-level work.

Students as Pioneers

As is the case in many other outreach programs, the students going through UCSB’s summer programs tend to be pioneers in their families or communities—the first to go to college. Most tend to come from minority groups, though a substantial share are non-Hispanic whites, of the 107 students in the 2007 EPSEM summer program, 61% were minority. Their stories can be dramatic. UCSB Mathematics Professor Ken Millett, who has long worked with the SIMS program, recalls that “one fellow a few years back was homeless; his family lived in a car in Los Angeles.” People getting to college against such odds “have a huge capacity for success,” he says.

That particular student ultimately transferred from UCSB to a Cal State University campus. Millett recalls, “For him, living in the dormitories was very traumatic. In his situation, UCSB was more than he could handle.” But if the success rate of SIMS students isn’t 100%, it ranks favorably with that of UCSB students as a whole. From 1998 through 2005, according to figures from CNSI, 85% of SIMS students graduated in six years or less, compared to 76% for the full student body. Their average grade point average was 2.94 (just short of a straight “B”), compared to a GPA of 2.92 for all UCSB engineering undergrads and 2.98 for undergraduates in general.

For the 75 to 80 MESA students enrolled in Engineering at UCSB, there are services such as tutoring and contact with alumni who have gone on to jobs with firms such as Boeing, Chevron and Raytheon. Cota, the MESA director, says this side of the program gets less generous funding than the K-12 recruitment side. Still, he says, it has achieved retention rates of 75% or better, “and that’s significant in a field such as engineering.”

The success of outreach and recruiting programs is tricky to measure, especially when their objective is not necessarily to get kids to go to UCSB. As Millett puts it, “I’m a faculty member at UCSB, and my first priority and objective would be for students to come to UCSB, do well, and go on to have a fabulous life.” But he says he is happy if they go to other colleges on their way to success.

Likewise, K-12 outreach programs such as MESA measure their success not by the number of students who go to a particular college, but by the number who meet the standards for any UC campus, or for other four-year schools. On that score, MESA points to statewide numbers showing that its minority high school graduates have a high rate of eligibility for admission to UC—29%, in the latest report well above the statewide rate of 6.2% for African Americans and 6.5% for Latinos. “We have accomplished a lot with regard to increasing the number of students who prepare and are able to matriculate to a four-year campus,” Cota says.



Building Better Buildings

Buildings consume 39% of the total energy we use in the U.S., and 71% of all our electricity. Producing that energy generates almost half (48%) of our total carbon emissions. If we're going to seriously address the linked energy and climate change crises, buildings clearly offer tremendous potential for reducing our demand for energy and its concomitant carbon emissions.



A group of researchers at UC Santa Barbara is looking to play a major part in that reduction. Professors Bud Homsy, Igor Mezic, Jeff Moehlis, João Hespanha, and Rich Wolski are leading research efforts into integrated building design, in which active control of indoor airflows could greatly improve the ventilation and efficiency of heating and cooling in buildings.

Current technologies—existing hardware combined with energy-efficiency modeling tools and algorithms, such as the Department of Energy’s “EnergyPlus”—offer energy savings of 10% to 30% when applied to the retrofit of extant buildings and the design of new ones. Far greater savings can be achieved, however, with modern analysis and control tools based on dynamical systems and control theory, when these tools are used to optimize the performance of the building as a fully integrated system.

Large buildings equipped with heating, ventilation and air conditioning (HVAC), data centers, and a myriad of sensors and wireless communication devices are complex systems whose operation includes multi-physics and multi-scale effects. Building systems are dynamically uncertain with respect to both the energy load and the environment, with dramatic changes in the number of occupants in the building, their energy demand, and ambient weather conditions.

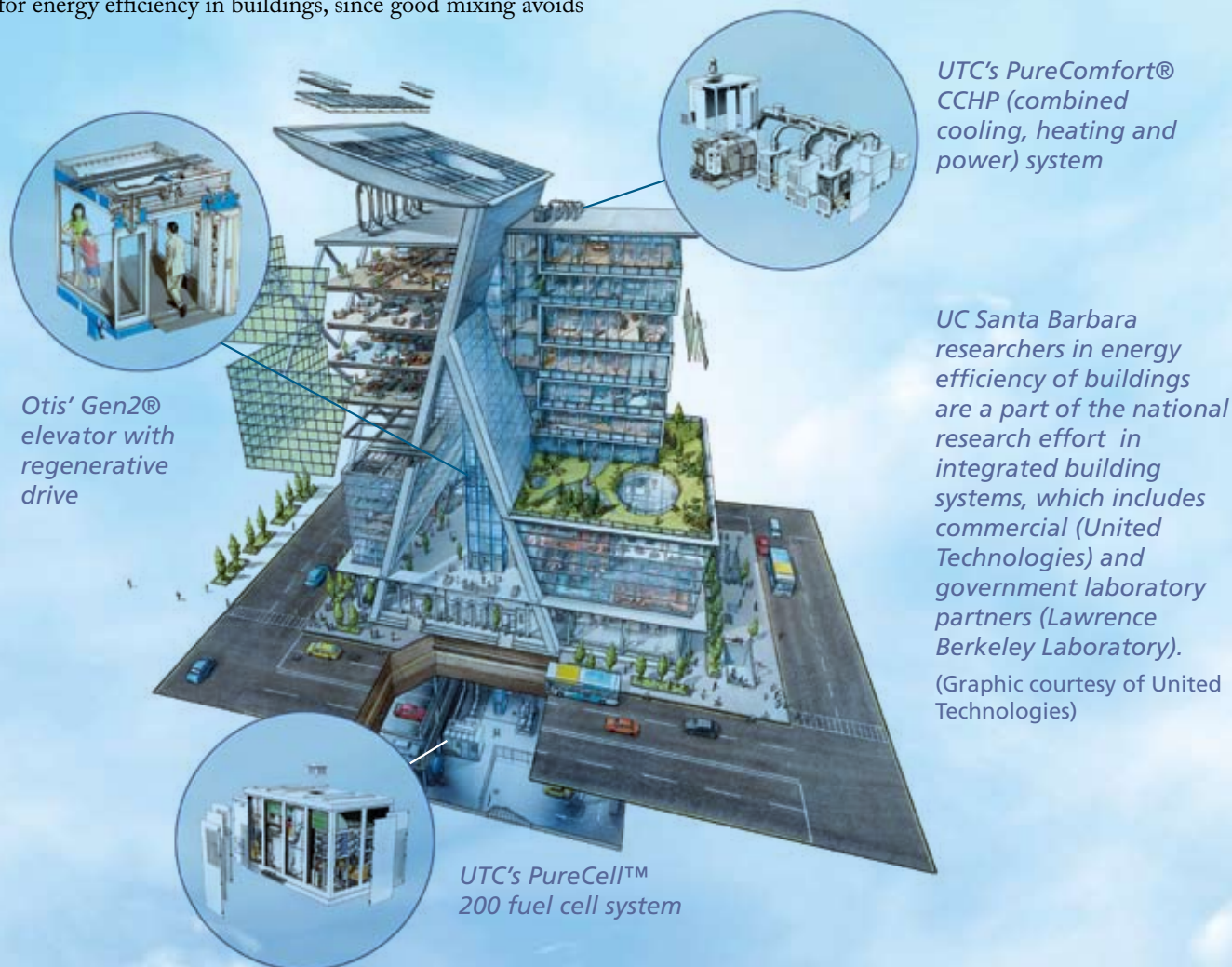
A smart building containing an array of sensors and an integrated, optimized control system could dynamically adjust lighting and HVAC flows based on actual, real-time presence rather than scheduled occupancy. Energy and money are not wasted on cooling and lighting empty rooms. Mixing of airflows is a particularly important topic for energy efficiency in buildings, since good mixing avoids

the wasteful temperature stratification which occurs, for example, when hot air rises to the ceiling and cold air falls to the floor.

Recent research in Mezic’s laboratory has established modeling techniques that enable design of efficient mixing in a variety of ambient conditions—the airflow can be directed to cool or heat the occupants much more efficiently. By combining sensor networks, active ventilation, adjustable lighting, and adjustable windows and doors into integrated and optimized compound systems, much higher quality living and working environments are possible, with 50% greater energy efficiency than current systems offer.

Data centers are an important, special case, whether as occupants of dedicated areas in general-use buildings or as single-purpose data center buildings. In data centers, there are few people but large heat loads from high power-density server arrays. Data center growth is causing the energy density of buildings to grow at a rate that is expected to be proportional to internet and server demand—and that demand is expected to double in the next few years.

Efficient energy use in data centers, far more than in typical office spaces and commercial buildings, requires especially efficient ways of redistributing cooling energy. Data centers present special and unique challenges, due to the coupling between the computer use and cooling systems. Mezic and Rich Wolski are spearheading an effort by faculty in UCSB’s Mechanical Engineering and Computer Science departments, developing new approaches and solutions for this special class of buildings.



UTC's PureComfort® CCHP (combined cooling, heating and power) system

UC Santa Barbara researchers in energy efficiency of buildings are a part of the national research effort in integrated building systems, which includes commercial (United Technologies) and government laboratory partners (Lawrence Berkeley Laboratory). (Graphic courtesy of United Technologies)

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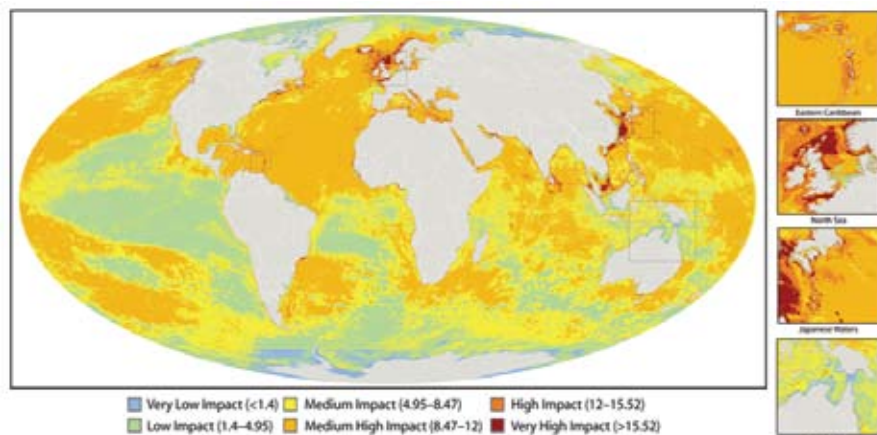
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News and Events from Engineering and the Sciences at UC Santa Barbara



More than 40 percent of the world's oceans are heavily affected by human activities, and few if any areas remain untouched.

That is the conclusion reached by the first global-scale study of human influence on marine ecosystems. By overlaying maps of 17 different activities such as fishing, climate change, and pollution, researchers at UC Santa Barbara's National Center for Ecological Analysis and Synthesis (NCEAS) have produced a



composite map of the toll that humans have exacted on the seas. The work involved 19 scientists from a broad range of universities, NGOs, and government agencies. It was published in the Feb. 15 issue of *Science* and presented February 14 at the American Association for the Advancement of Science (AAAS) meeting in Boston, MA.

The study synthesized global data on human impacts to marine ecosystems such as coral reefs, seagrass beds, continental shelves, and the deep ocean. Past studies have focused largely on single activities or single ecosystems in isolation, and rarely at the global scale. In this study, the scientists were able to look at the summed influence of human activities across the entire ocean.

"This project allows us to finally start

to see the big picture of how humans are affecting the oceans," said lead author Ben Halpern, assistant research scientist at NCEAS. "Our results show that when these and other individual impacts are summed up, the big picture looks much worse than I imagine most people expected. It was certainly a surprise to me."

"This research is a critically needed synthesis of the impact of human activity on ocean ecosystems," said David Garrison, biological oceanography program director at NSF. "The effort is likely to be a model for assessing these impacts at local and regional scales."

The study reports that the most heavily affected waters in the world include large areas of the North Sea, the South and East China Seas, the Caribbean

Sea, the east coast of North America, the Mediterranean Sea, the Red Sea, the Persian Gulf, the Bering Sea, and several regions in the western Pacific. The least affected areas are largely near the poles.

"Unfortunately, as polar ice sheets disappear with warming global climate and human activities spread into these areas, there is a great risk of rapid degradation of these relatively pristine ecosystems," said Carrie Kappel, a principal investigator on the project and a post-doctoral researcher at NCEAS.

Importantly, human influence on the ocean varies dramatically across various ecosystems. The most heavily affected areas include coral reefs, seagrass beds, mangroves, rocky reefs and shelves, and seamounts. The least impacted

ecosystems are soft-bottom areas and open-ocean surface waters.

"My hope is that our results serve as a wake-up call to better manage and protect our oceans rather than a reason to give up," Halpern said. "Humans will always use the oceans for recreation, extraction of resources, and for commercial activity such as shipping. This is a good thing. Our goal, and really our necessity, is to do this in a sustainable way so that our oceans remain in a healthy state and continue to provide us the resources we need and want."

A new Institute for Energy Efficiency has been established at UC Santa Barbara.

The UCSB institute is under the direction of Professor John Bowers of the Electrical and Computer Engineering Department, and will involve approximately 50 faculty members from multiple disciplines on the campus.

"We're already spending more than \$10 million a year on energy efficiency research at UCSB," stated Bowers at the launch announcement. "The Institute will provide a unifying and very synergistic environment for our work, which is being conducted in many different departments and centers on our campus." Bowers went on to note, "As an institute, we will triple our research funding over the next three years, which will dramatically accelerate the development and



commercialization of key energy-saving technologies. This increased funding will also attract and support additional leading thinkers in energy efficiency."

The areas of technology on which the UCSB Institute for Energy Efficiency will focus initially include:

- Lighting and Displays
- Computing and Networks
- Energy Conversion, Transmission, and Storage
- Dynamics of Energy Efficiency
- Transportation Materials

UCSB is an acknowledged leader each of these fields. In addition to its multiple research initiatives, the Institute will sponsor international conferences and symposia, and will host residencies for visiting scholars in energy efficiency.

Initial “seed money” support for the Institute was provided by Jeff Henley, Dan Burnham, John Marren, Fredric Steck, and Phil White, all prominent UCSB donors who will be active in the Institute’s ambitious fundraising efforts. Long-term plans for the Institute include a broad range of programs and relationships with government agencies, foundations, individuals, and corporations

www.iee.ucsb.edu



Venture Acceleration Initiative launches to support campus startups.

A new program to accelerate and streamline the creation of spin-off businesses from the world-class research at UC Santa Barbara has been launched. UCSB’s Venture Acceleration Initiative (VAI) program supports new ventures through a highly integrated approach to the complex process of moving technology from the lab bench to commercialization. The initiative will benefit not only faculty

entrepreneurs and their investors, but will also provide a significant boost to the local and regional economies as the nascent businesses take shape and grow.

An in-house entrepreneurship consulting service—to assist with market analysis and validation, business model definition, and strategy development—is complimented by a strong network of potential stakeholders with interests in various stages of the start-up process. This provides crucial access for the emerging ventures to the business community. Seed funding, bridging the gap between research funding and venture capital, is particularly critical for technology-based start-ups, and VAI provides access to a growing and diverse investor network; the program is also looking toward the eventual development of a university-based seed fund.

VAI is itself an example of the success of a new UC-wide fellowship program run through the Industry-University Cooperative Research Program (IUCRP). The fellowship program, now in its second year, places and supports talented and business savvy scientists on individual UC campuses, tasked with the creation or expansion of innovative new programs that are designed to better integrate the university with the California economy.

Dr. Don Oparah, the founding director of VAI, emphasized the importance of partnership to the success of the new initiative, stating, “Working closely with the external business world, the local community and other key stakeholders across the state and beyond is an essential part of our strategy for delivering on the vision and promise of VAI.”

www.vai.ucsb.edu

Physicist and Engineer David Awschalom Awarded Top Faculty Honor

David Awschalom, an internationally recognized researcher who is a professor of physics and of electrical and computer engineering at UC Santa Barbara, has been awarded the highest honor the faculty of UCSB can bestow: Awschalom has been named Faculty Research Lecturer for 2008.



In announcing the award, the UCSB Academic Senate said Awschalom “has made remarkable contributions to our campus in the fields of physics and engineering.”

Awschalom is director of the Center for Spintronics and Quantum Computation and associate director of the California NanoSystems Institute, a collaborative endeavor between UCSB and UCLA. Awschalom’s research group explores magnetic and electron spin dynamics within a variety of semiconductor-based nanoscale systems. His fundamental discoveries are opening the door to new opportunities for research and technology in the emerging fields of semiconductor spintronics and quantum computation.

The Faculty Research Lectureship was established in 1955; Awschalom is the 53rd recipient of the honor. His Faculty Research Lecture will be on campus and free and open to the public. The date has not yet been determined.

Last year’s recipient of the prestigious honor, Steven K. Fisher, a neurobiologist, presented the award to Awschalom at a meeting of the

Academic Senate's Faculty Legislature. Fisher said the award's selection committee picked Awschalom "for a combination of outstanding research contributions, scholarship, scientific leadership, broad contributions to enriching the intellectual stature of UCSB, and for his outstanding role as a teacher and mentor."

Since coming to UCSB in 1991, Awschalom has mentored 59 postdoctoral fellows and graduate students, 15 of who now hold positions in academe. "It is hard to imagine a clearer picture of scientific and academic leadership than that presented by the career of Professor Awschalom," said Fisher.

In acknowledging receipt of the honor, Awschalom said: "I am extremely surprised and deeply honored to receive this award. This level of appreciation from my colleagues across the campus means a great deal to me."

CNR Rao Awarded Nikkei

Asia Prize. Chintamani Nagesa Ramachandra (CNR) Rao, Distinguished Visiting Professor of Materials at UC Santa Barbara, has been awarded the prestigious 'Nikkei Asia Prize' for Science, Technology and Innovation. The award is being given by Nihon Keizai Shimbun, Inc (Nikkei), publisher of Japan's leading business newspaper, in recognition of



his "distinguished contribution to chemical spectroscopy, molecular spectra and chemistry of advanced materials." The Nikkei Asia Prizes are awarded annually to recognize outstanding achievements that improve the quality of life in Asia and contribute to regional stability. In addition to Rao's Science, Technology and Innovation category, prizes are given in the categories of Culture and Regional Growth.

Rao is a world renowned authority in chemistry and materials. He is the Linus Pauling Research Professor and Honorary President of the Jawaharlal Nehru Centre for Advanced Scientific Research at the Indian Institute of Science in Bangalore, India. He is a Fellow of the Royal Society of London, as well as the Indian Academy of Sciences, and the Indian National Science Academy. He is a Foreign Associate of the National Academy of Sciences and a Founding Fellow of the Third World Academy of Sciences.

Rao's contributions to the field of solid state chemistry and materials are remarkable for their enormous diversity, their originality, and their extraordinary prolificity. He has published more than 1,000 research papers and edited or written 35 books in a career spanning more than 40 years. His current research interests are mainly in phenomena and properties exhibited by transition metal oxide systems, including high temperature superconductivity, colossal magnetoresistance and metal-insulation transitions. His work on transition metaloxides has led to basic understanding of novel phenomena and of the relationship between materials properties and the structural chemistry of these materials. He has been a Distinguished Visiting Professor in UCSB's Materials Department since 1995.

The Nikkei Asia Prize will be formally conferred on Rao in Tokyo on May 21.

Cascini Awarded Sloan Fellowship

Paolo Cascini, assistant professor of mathematics at UC Santa Barbara, has won a prestigious Sloan Research Fellowship from the Alfred P. Sloan Foundation.

Cascini is one of 118 young scientists, mathematicians, and economists to be awarded the fellowship this year. Seventeen of the awards went to UC researchers; University of California faculty members received more Alfred P. Sloan Research Fellowships than any other university this year.

Fellows can use their two-year, \$50,000 grants to pursue whatever lines of inquiry are of most interest to them. Funds are awarded directly to the Fellow's institution and may be used by the Fellow for such purposes as equipment, technical assistance, professional travel, trainee support, or any other activity directly related to the Fellow's research.

Cascini won the award for his research in algebraic geometry, in particular the minimal model program. In the past two decades algebraic geometry has played a central role in mathematics due to its many applications in different fields.

Cascini is originally from Italy, where he received his bachelor's degree in mathematics at the University of Florence, in 2000. In 2002, he earned his master's degree at the Courant Institute of Mathematical Sciences at New York University, where he went on to receive his Ph.D. in 2004. From 2004 to 2007, Cascini was a visiting assistant professor of mathematics at UCSB. In 2007, he became an assistant professor at UCSB.

Overall, the New York-based Sloan Foundation awarded \$5.9 million in fellowships to faculty members at 64 colleges and universities in the United States and Canada who are conducting research in physics, chemistry, molecular biology, computer science, economics, mathematics and neuroscience.

The Sloan Research Fellowships, which support the work of exceptional young researchers early in their academic careers, have been awarded since 1955. Since then, 35 Sloan Research Fellows have gone on to win the Nobel Prize in their fields and 14 have received the Fields Medal, the top honor in mathematics.

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News and Events from Engineering and the Sciences at UC Santa Barbara



Johnsons Endow Fellowship for Outstanding Graduate Students in Chemistry and Biochemistry.

UC Santa Barbara alumnus M. Ross Johnson and his wife, Charlotte, have given UCSB \$500,000 to establish an endowed fellowship fund for the recruitment and support of outstanding graduate students in the Department of Chemistry and Biochemistry.

Johnson, who earned a doctorate in organic chemistry from UCSB, is an internationally recognized medicinal chemist and pharmaceutical and biotechnology entrepreneur. He is co-founder and president of Parion Services, a pharmaceutical company in North Carolina.

The Johnsons established the graduate fellowship to honor his doctoral advisor, UCSB Professor Emeritus Bruce Rickborn. Rickborn is a renowned organic chemist and a devoted teacher. During his 39-year career at UCSB, more than 30 graduate students obtained doctoral degrees under his direction. Rickborn considers his work with graduate students as his most important contribution to science.

"Professor Rickborn played a great role in my success and the success of many other UCSB students as well," said Ross Johnson. "We could think of no better way to honor him than to establish a fellowship in his name that would attract future generations of top students to UCSB. It is our way of giving back to the community and honoring a truly deserving mentor."

Alec Wodtke, chair of UCSB's Chemistry and Biochemistry Department, said: "Ross Johnson has shown both wisdom and generosity in providing a permanent fund to support

the development of young people's careers in science. This is a wonderful tribute to his scientific mentor Bruce Rickborn. It is a double dose of heartwarming goodness!"

Rickborn said he was touched by the couple's generosity. "Ross Johnson was among our earliest Ph.D.s, and he continues to enjoy a very successful and entrepreneurial career as an organic chemist," said Rickborn. "I am moved and honored that he insisted that I be included in the name of the fellowship, and delighted that he has chosen to remember his UCSB days with this important support."



Written and reported by staff writers and editors, and by staff from the Office of Public Affairs.



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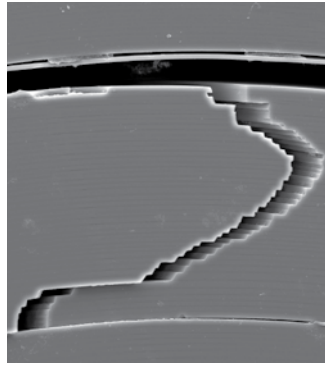
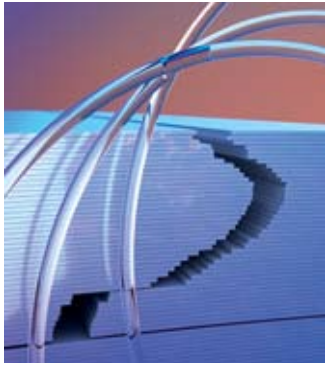


engineering.ucsb.edu/insights2008

For questions, contact Andrew Elliott at 805.893.5497 or elliott@engineering.ucsb.edu.

What is this?

Answer from page 23



The image in the foreground is a graphical representation of the 3 meter long glassy anchor spicule from the deep sea sponge, *Monorhaphis chuni*, highlighting its transparency and remarkable flexibility. The background image illustrates its micro-architecture which consists of layers of silica separated by thin organic inter-layers measuring less than 50nm thick. Following loading, fracture of this laminated structure involves cracking of the constituent silica and crack deflection through the intervening proteinaceous layers, leading to the stair-step pattern in the image. Crack deflection mitigates the high stress concentration that would otherwise be present at the crack tip, resulting in high spicule strength and toughness. This design strategy thus prevents the structure from failing catastrophically as one would expect for a non-laminated glass rod (note the fracture similarities between the spicule and the brick street following the 1906 San Francisco earthquake). It is hoped that by understanding structure-function relationships in these materials, that design lessons can be learned that will ultimately guide the development of more damage-tolerant synthetic structural glasses for a wide range of applications.



Bear Photo Company

Effects of Laminate Architecture on Fracture Resistance of Sponge Biosilica: Lessons from Nature
A. Miserez, J. C. Weaver, P. J. Thurner, J. Aizenberg, Y. Dauphin, P. Fratzl, D. E. Morse, F. W. Zok
Advanced Functional Materials 2008 (in press)

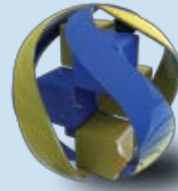
Note from the editor

As the College of Engineering's "fresh-caught" communications manager, I've inherited a strong, lively publication from Barbara Gray, our former Editor in Chief. It's my intention to build on the solid foundation Barbara created, and I welcome your input on content, design, or any other aspect of *Convergence* on which you care to comment.

You'll notice a couple of additions to our masthead: We've added writers Anna Davison and Gail Gallessich. Anna has a science background herself, having trained as a biologist before deciding she'd rather write about science than do it. She attended the Science Writing Program at UC Santa Cruz, and now writes for several other well-respected science magazines as well as for *Convergence*. Gail is the science writer in the UCSB Office of Public Affairs. Virtually every issue of *Convergence* contains her work, and we want to give her the recognition she's earned.

TR

CONVERGENCE



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If you have comments or questions about this publication, contact Tony Rairden at trairden@engineering.ucsb.edu.

To effect a change of address, please send e-mail to marie@engineering.ucsb.edu or send your name and old and new addresses to Marie Howell, Marketing Coordinator, Engineering and the Sciences, UC Santa Barbara, Santa Barbara, CA 93106-5130.

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