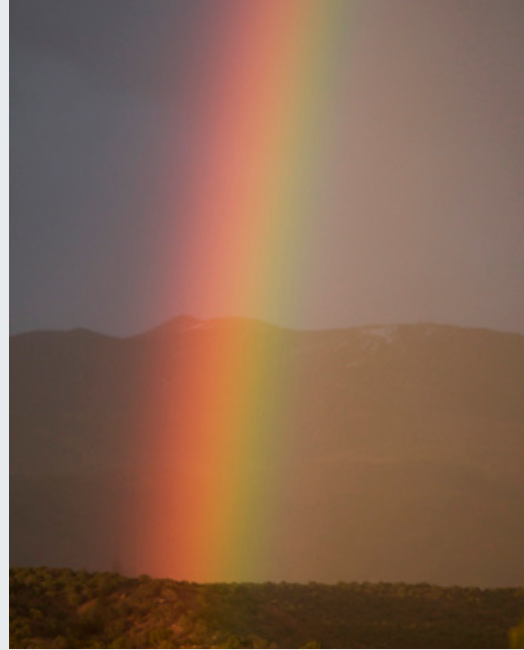




September / October 2014

UPDATE



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RESEARCH NEWS

What underlies all innovation?

While it's all but accepted that novelty and innovation are defining characteristics of many a complex system – from biology to economics – the deeper question is: Where does novelty come from? What gives rise to new ideas, new behaviors, new processes, new structures?

An October workshop at SFI, "Origins of Novelty in Biological, Social, and Technological Systems: Towards a General Theory of Innovation," asks those questions of some of the top experts in fields ranging from archaeology and search theory to ecology and technology. The meeting is co-organized by SFI Chair of the Faculty Jennifer Dunne, Jose Lobo (ASU), and External Professors Andreas Wagner and Manfred Laubichler.

"It was time to bring together a number of groups of SFI researchers working on innovation in different kinds of complex

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RESEARCH NEWS

How insect farming and human farming are, or aren't, alike

Some insects create highly organized social systems; ant and termite colonies, with their elaborate systems for foraging and gathering, are among the most well known.

A late-August workshop at SFI, "Convergent Evolution of Agriculture in Insects and Humans," asked what sort of evolutionary food-gathering crossovers, if any, might exist between human farmers and, say, leaf-cutting ants or ambrosia beetles.

SFI External Professor Peter Peregrine, the workshop's host, says the group's first order of business was to ask "whether humans and insects both practice 'agriculture' or whether they are really such different forms of food production that

> **more on page 3**



SFI External Professor David Krakauer reviews "The Evolution of Complexity and Intelligence on Earth" project.

Workshop reviews progress on four major SFI projects

SFI hosted a two-day review in late August of research projects supported by the three-year, \$5 million John Templeton Foundation grant, "The Principles of Complexity," that began in fall 2011.

The grant's goals were to pursue fundamental understandings of the regularities in complex biological and social systems and to generate new concepts and quantitative methods of general scientific and social value. It supported three major SFI research projects and one major education project.

"This grant has been hugely important to science at SFI," says SFI President Jerry Sabloff. "It has allowed us to begin to take full advantage of the influx of new data available in multiple fields, and it has allowed our researchers to make important new connections between fields. Together, this has led

to significant advances in our theoretical understanding of a variety of complex systems."

Complex early societies

Sabloff co-leads the "Universal Patterns in the Emergence of Complex Societies" project with former Omidyar Postdoctoral Fellow Laura Fortunato. As part of the project, SFI researchers are developing a database of archaeological survey data to explore the timelines for the evolution of social complexity across many cultures and geographies, and seeking to identify the critical factors that led to the rise of early states.

"In recent years, there really has been a dearth of broad, cross-cultural studies of the rise of early states," said Sabloff. "We need to develop a general theory to explain why

states arose in some regions and to explain why they did not in other areas."

SFI's Eric Rupley summarized his takeaway from the project: "What we're seeing is a great deal of regional integration occurring before the state is built up. This suggests that there are underlying social processes that lead up to the growth of the state over a period of time, before a primary urban center becomes the 'big place' where people go."

Team members include Jerry Sabloff, Laura Fortunato, Paula Sabloff, Anne Kandler, Scott Ortman, Tim Kohler, Stefani Crabtree, Charles Perreault, Eric Rupley, and Paul Hooper; in addition, the project relied on the advice of Peter Peregrine, Chip Stanish, and Henry Wright and the research support of a host of interns, assistants, and volunteers.

> **more on page 2**

INSIDE SFI

Ceremony to honor Murray Gell-Mann with Helmholtz Medal



SFI Distinguished Fellow Murray Gell-Mann will receive the prestigious Helmholtz Medal during a special ceremony on Thursday, September 25, at the Institute. The award recognizes Gell-Mann's foundational contributions to particle physics.

The Helmholtz Medal is the highest honor of the Berlin-Brandenburg Academy of Sciences and Humanities (BBAW) and continues

the longstanding scientific tradition of the Prussian Academy of Sciences. Established in June 1892, the Medal has recognized such physicists as Robert Bunsen and Lord Kelvin and, more recently, former SFI researcher Manfred Eigen and 2012 Nobel Prize recipient John C. Polanyi.

In 1969 Gell-Mann was awarded the Nobel Prize in physics for his discoveries concerning the classification of elementary particles and their interactions. Among his contributions was the "Eightfold Way," a scheme for ordering subatomic particles onto geometric shapes, which opened the door to the theoretical prediction of undiscovered particles and their properties.

Gell-Mann's scheme, later confirmed experimentally, led to the quantum field theory of quarks and gluons and seems to account for all subatomic particles and their strong interactions.

The invitation-only ceremony will feature an introduction and welcome from SFI President Jerry Sabloff, followed by words of recognition from Gell-Mann's friends and SFI colleagues Jim Hartle and Geoffrey West.

BBAW's Vice President Klaus Lucas, who is traveling from Germany, will present the award. Participation in this event is by invitation only. ■



On August 17, the *Santa Fe New Mexican* featured SFI Learning Lab Director Irene Lee and the nonprofit code.org’s plans to bring SFI’s Project GUTS after-school curriculum to science classrooms across the country beginning this school year.

In the July 28 *Santa Fe New Mexican*, SFI Omidyar Fellow Eric Libby ponders how the study of organisms that straddle the gap between single- and multi-cellularity can challenge our basic assumptions about organisms and evolution.

The July 18 *Bangor Daily News* reported that more than 900 students completed “Introduction to Dynamical Systems and Chaos” taught by College of the Atlantic professor

David Feldman, part of SFI’s Complexity Explorer online course series.

“Hanging out at the Santa Fe Institute is like being at a brain spa,” writes weather.com’s David Kushner in a July 17 feature describing the Institute, its research, and its people in the context of a recent workshop at which experts gathered to explore climate and sustainability.

In a July 16 Q&A in *Libre Mercado* (Spain), SFI Trustee John Chisholm extolls the value of online education and complex systems approaches and says the Institute has “profoundly” influenced his thinking about the economy.

Nonlinearities From the editor

It’s difficult to know how integral certain people are to a group until they are gone. Only then do you become aware of the social gravity they exerted on the system. So it is with Laura Ware, a longtime SFI staff member who retired on August 29.

All who know Laura consider her a friend. She offered hundreds of SFI visitors a place at her dinner table. Her curiosity button is stuck permanently in the ON position. Her appreciation for the natural world inspires many. Through her lens, she documented much of the Institute’s history, and with a great deal of visual aplomb. The two photos at the top of page one are of Laura (and Harold Morowitz) and by Laura (rainbow).

I will miss Laura’s relentlessly positive outlook, her willingness to help, her deep knowledge of everything SFI...and her razor-sharp editor’s eye. She’s one person I know will succeed at retirement. We’ll see you on the trails, Laura, and on the slopes, in the gulches, on the bluffs, and in the glow of many glorious sunsets.

One day in January 2010, now-SFI postdoc Christa Brelsford, an avid rock climber, was in Haiti volunteering on a literacy project. When the building started shaking, she bolted for the exit rather than devise a plan. Those seconds saved her life.

On the way to the exit, the stairwell fell around her. Her life was saved by an iron railing that folded over her, protecting her from the weight of the collapsing building. But her leg was crushed. A harrowing tale of bravery, smarts, and luck followed.

She was lucky her companions had access to a motorcycle and were able to carry her through the destruction to a nearby U.N. mission. She was lucky to be an American and to be selected for U.S. military evacuation. She was smart and brave enough not to allow herself to lose consciousness or hope. Thirty hours later she was in surgery in Miami, lucky to have the best medical care in the world. Tens of thousands of Haitians were not as lucky.

She has refused to be defined by her loss, choosing rather to be grateful for her remarkable fortune. She never asked herself whether she would climb again. This month Christa travels to Spain to compete in the Paraclimbing World Championship. I urge you to read her inspirational story on our website and to follow her progress on our Facebook page. ■

– John German, jdg@santafe.edu

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The SFI *Update* is published by the Institute six times a year to keep its community informed. Please send comments or questions to John German at jdg@santafe.edu.



Follow SFI online at www.santafe.edu

Upcoming community events

SFI Community Lecture, Wednesday, October 15, 7:30 p.m., James A. Little Theater (1060 Cerrillos Road) – I get all the news I need from the sports section. Sports players (or teams) are often described as being hot or cold, implying there is something inherently “streaky” about an athlete’s performance that extrapolates to the next try. Using data from ten seasons of professional basketball and more than a century of major league baseball, physicist Sid Redner argues that scoring is a memoryless random process – suggesting that the notion of a scoring streak is a fallacy and that win/loss records in professional baseball teams are similarly memoryless. Finally, he shows that our favorite pastime is getting progressively more competitive – no more dynasties or perennial losers.

SFI’s 2014 Community Lectures are made possible through the generous support of Thornburg Investment Management. Lectures are free and open to the public, but seating is limited. To watch a lecture as it happens, visit SFI’s YouTube page; participate in the discussion live on Twitter at #sfi_live. ■

RESEARCH NEWS

What’s better than penicillin for syphilis

Syphilis is on the rise again; nearly 16,000 cases were reported in the U.S. in 2012.

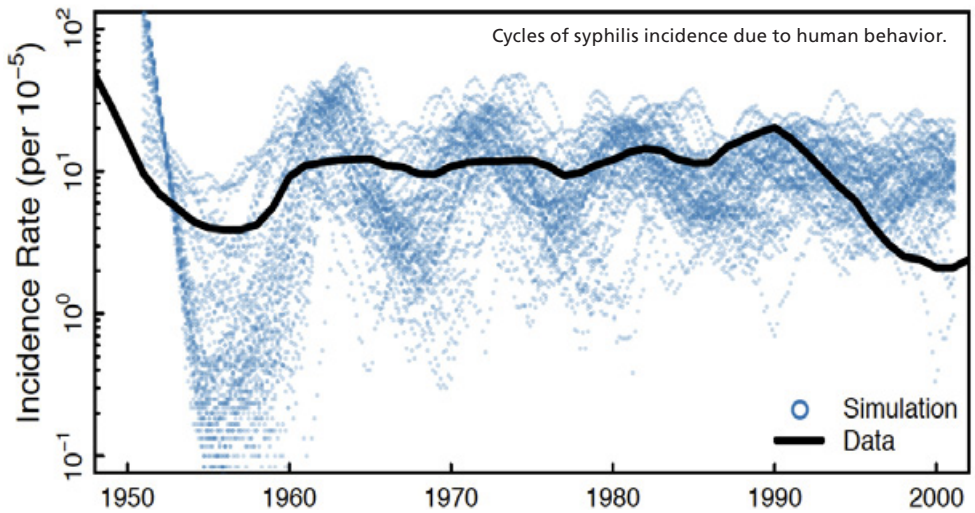
Public health officials looking to stem the tide should consider focusing more attention on patterns of sexual behavior, according to SFI Omidyar Fellow Ben Althouse and SFI Postdoctoral Fellow Laurent Hébert-Dufresne in a paper published August 6 in the *Journal of the Royal Society Interface*.

The two came to that conclusion while exploring the cycles of syphilis infection since the early 1960s. In the past, researchers assumed

can spread rapidly through a network of sexual partners, but when people find out their sexual partners have the disease they’ll stop having sex with the infected. That network disconnect, on a wide scale, helps stem the tide of infection, but once the outbreak subsides, people reconnect and a new outbreak can begin.

Having figured out that simple social behavior could be driving observed syphilis cycles, the researchers turned their attention to how to stop them.

By simulating syphilis epidemics on a computer,



immunity drove those cycles. “The thought was, an epidemic sweeps through, people become immune, the incidence goes down,” and then people become susceptible once again, Althouse says. But there’s little solid evidence that syphilis immunity is long lasting enough to account for the dips.

If not cycles of immunity, what was behind the pattern? The answer, Althouse and Hébert-Dufresne say, lies in human behavior and social networks.

At the onset of a syphilis outbreak, the disease

they found that education and awareness campaigns were often a better choice than widespread treatment for mitigating an epidemic. Surprisingly their model suggests that campaigns are most effective at the height of an outbreak, when officials can focus on stopping the next outbreak before it starts.

Right now, “the front line is a shot of penicillin, which works very well,” Althouse says. But well-timed messaging aimed at stopping the disease’s spread could be even more effective, he says. ■

RESEARCH NEWS

Working group tackles public health complexity

Public health and health inequality are embedded in complex systems, and public health researchers stand to gain from a complex systems approach, according to co-organizers of an upcoming working group at SFI.

“Complex systems approaches are still new in public health, and they’re quite promising,” says Ross Hammond, especially when it comes to understanding demographic disparities in health outcomes – for example, why physical activity varies so much as a function of age and race.

Hammond, a Brookings Institution senior fellow and SFI External Professor, is co-organizing the late-September working group with University of Michigan professor emeritus George Kaplan.

The two-day gathering is the capstone meeting of the Network on Inequality, Complexity, and Health project, or NICH, a diverse collaboration of North American researchers from epidemiology, economics, computer science, human development, sociology, and other fields, co-founded by Kaplan.

NICH’s diversity is both a challenge and an opportunity, Hammond says. While the team is still working on how to successfully communicate the value of complex systems to different audiences, “for me what’s coming out of NICH are new partnerships, new colleagues, and a more honed sense of where the interesting questions may lie,” he says.

The invitation-only meeting will focus on finalizing a number of papers authored by NICH subteams, and on creating a final product summarizing NICH’s work.

“We’re trying to figure out how to have a lasting impact,” Hammond says. ■

> **Templeton review** continued from page 1

Complex life

SFI External Professors David Krakauer and Jessica Flack co-lead “The Evolution of Complexity and Intelligence on Earth” project, which seeks a rigorous way to understand the role information, energy, and environment play in biological complexity.

Flack said their approach views biological systems as being part of an information hierarchy in which components with partially aligned interests interact in multiple time and space scales. Information (often manifested in rough predictions biological systems make about their future environments) serves to couple these multi-scaled systems.

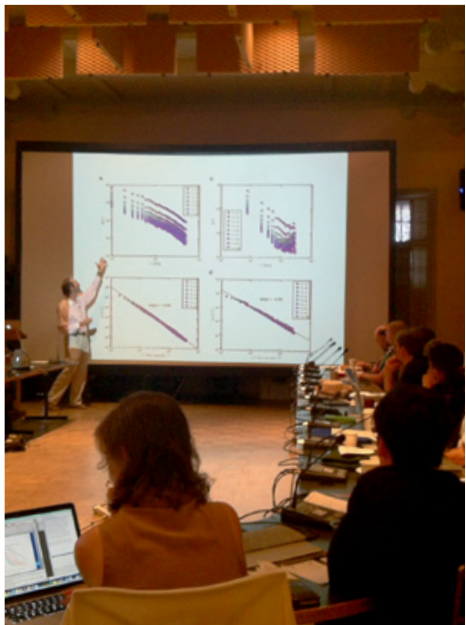
The team, Flack said, has begun to develop a

computational approach that relies on “effective theories” to make rough, course-grained connections between the microscopic behavior of the components of a biological system and the macroscopic “outputs” that arise from many components interacting in multiple time and space scales.

“We can then ask questions like ‘how tunable or controllable is the macroscopic behavior?’ and ‘can small perturbations at the microscale induce large-scale changes to the macro behavior of the system?’”

Team members include David Krakauer, Jessica Flack, Bryan Daniels, Philip Poon, Chris Ellison, Eddie Lee, Evandro Ferrada, and Peter Stadler.

> more on page 4





SFI External Professor and Science Board member Mercedes Pascual has been awarded the Ecological Society of America’s Robert H. MacArthur Award. The award, given every other year, recognizes a mid-career ecologist for “meritorious contributions to ecology with the expectation of continued outstanding ecological research.” Pascual is recognized for her contributions to the theory of food web structure; the ecology, spread, and evolution of infectious diseases; and the development and application of novel computational methods for relating climate to disease.



SFI External Professor Melanie Moses has been awarded the James S. McDonnell Foundation’s 21st Century Science Initiative in Studying Complex Systems – Scholar Award for 2014. She was selected for the award for “furthering the science of complex systems via the continued development of the theory and tools used in the study of complex research.” The award comes with a six year, \$450,000 grant, with which Moses says she plans to continue her research of how cooperative behavior emerges in complex systems. ■

SFI Online

Multimedia content available at www.santafe.edu

Video: Mathematician Steven Strogatz shows how math underpins our lives, from finding the perfect romantic partner to understanding how Google works. SFI 2014 Community Lecture

Video: SFI External Professor Seth Lloyd proffers a mode of time travel that is both theoretically possible and creatively irresistible. SFI 2014 Community Lecture

Video: SFI’s Luis Bettencourt and Geoffrey West are among the experts who weigh in on the question “What’s the number one thing we

could do to improve city life?” 2014 Aspen Ideas Festival interview by *The Atlantic - Cities*

Video: SFI External Professor Dan Rockmore is co-creator of a new documentary retelling the advent of the BASIC programming language 50 years ago at Dartmouth College. Dartmouth College video

Video: SFI Professor Luis Bettencourt says integrating the needs of people and governments is one key to the challenges of rapid urbanization. Aspen Ideas Festival panel discussion

Collective thinking as cognition

On one level, brains are just blobs of neurons; on another, they are the world’s most sophisticated computers. A recent meeting at SFI explored the possibility that societies, whether ant or human, are computers too.

“There’s a lot of research recently on describing cognition computationally,” says Bryan Daniels, a researcher at the University of Wisconsin’s Center for Complexity and Collective Computation, or C4. At the same time, scientists are looking more and more at the collective behavior of groups of organisms.

The late-July working group, “Collective Cognition: Quantifying Distributed Inference,” was organized by Daniels and fellow C4 researchers Chris Ellison, Philip Poon, and SFI External Professor Jessica Flack, who co-directs C4.

The meeting brought together research-

ers who study cognitive science, social networks, and animal societies to begin to identify connections in the still-emerging field.

One intriguing topic the group discussed was that cultures served as a kind of collective social computer: a culture accumulates information over the generations and transforms it into new ideas and new ways of life.

There were points of contention – what, for example, counts as collective cognition? – but by the end of the discussions the group had begun talking about a framework for future work, says Daniels.

“Much like the systems we’re studying, connecting with researchers who are developing similar ideas is leading to a broader understanding” of computation in the natural world, he says. ■

2014 REUs work shoulder to shoulder with complexity’s top minds

Some 650 U.S. research centers host NSF-sponsored Research Experiences for Undergraduates (REU) summer programs. Only one offers its participants a chance to work shoulder to shoulder with the leading thinkers in complex systems science.

Juniper Lovato, SFI Education Program Coordinator, says a key motive of the Institute’s REU program is to train the next generation of complexity scholars to one day take over as leading complexity scholars.

SFI 2014 REU Marcus Levine, who is double majoring in astrophysics and philosophy from Columbia University, says his stay at SFI has provided him a unique opportunity to immerse in a topic of his choice – analysis of the human microbiome, “ecosystems” in the human body that he believes haven’t received enough attention.

“It occurred to me that we really don’t have a good dataset for microbial interaction in the human body,” says Levine. “Something I’m trying to do is identify structures in these interaction networks.”

> **Innovation** continued from page 1

systems to see what progress is possible in developing a general theory,” says Dunne, who initiated the meeting.

The word *novelty* itself doesn’t really work for Wagner, the workshop’s host; it already has a very specific meaning in economics and evolutionary biology, he says.

But if the participants can settle on an

His SFI mentors included Professor David Wolpert, Omidyar Fellow Eric Libby, and former Omidyar Fellow James O’Dwyer.

For 2014 REU Emily Robertson, an economics major from Portland State University, the economy is a complex system, and she is interested in understanding how cooperative behavior emerges in large groups of people.

Her research so far has involved creating threshold models for collective action problems, in which individuals decide whether or not to participate in a collective action. She hopes her research will provide insight into individual decision making strategies in massive social gatherings like the Arab Spring protests of 2010-2011.

She worked alongside SFI External Professor John Miller.

“Research opportunities at larger schools can be limited, and most projects prefer students with prior experience,” she says. “I never would have received this amount of attention at Portland State.” ■

overarching theory that can be applied to various disciplines, he says, “then we’ll have somewhere to go. We’ll have made that step forward. Because theories unify knowledge.”

“Innovation is something that’s really central to human life,” he adds. “It’s intrinsically interesting to study it.” ■

Della Vigil’s straw appliqué wins 2014 Spanish Market honors

Della Vigil won the “Innovation Within Tradition” award at Santa Fe’s 63rd Annual Traditional Spanish Market in July, an internationally renowned art competition sponsored by the Spanish Colonial Arts Society of Santa Fe.

Her “Florecimiento de Amor” (Love Blossoming), a straw appliqué piece, was praised by judges for its “innovative introduction of modern characteristics to a traditional craft while demonstrating a clear connection to New Mexican artistic traditions.”



“Winning an award like this can really help elevate me as an artist,” Ulibarri says. “It was overwhelming, but it was good because people were interested in an art form that dates back hundreds of years.”

She is an administrative specialist in SFI’s Office of the Vice President for Science.

Straw appliqué is a method of inlaying a golden straw design onto wood and coating it with varnish, yielding a shimmering design with the look of gold but without the price tag. Many colonial-era villagers in Northern New Mexico used this method to decorate precious items with a golden finish. The



technique became widely regarded as “poor man’s gold.”

Vigil was first selected to participate in the Traditional Spanish Market in 2008 and has won past awards for her straw appliqué designs. Her work has been exhibited in The Museum of Spanish Colonial Art, sold at the Santuario de Chimayo gift shops, and commissioned by collectors. She teaches workshops on the art, and some of her students have won awards too.

For Vigil it is simply a labor of love.

“It’s a great way for me to unwind after a long day,” she says. “I’m fascinated by old things, and it is important to me to keep the traditions of my ancestors alive and pass them on to the next generation.”

For more information on the award and straw appliqué, visit the Spanish Colonial Arts Society website. ■

> **Insect farming** continued from page 1

comparing and contrasting them is not productive.”

If, in fact, something along the lines of convergent evolution (the development of similar features in species of different lineages) is happening, Peregrine says that opens questions about how various functional and developmental constraints led to food gathering and production.

“What if some of the effects of agriculture on insect societies help us understand what happened in human societies once agriculture was adopted,” says Peregrine, an archaeologist. “If we can identify some of the causes and consequences of human agriculture as being shared with insects, then I think that helps us to build broader

theories of cultural evolution based on well-established principles and processes of organic evolution.”

He also hopes to build lasting relationships between groups of researchers, such as biologists who have been bridging the gap between organic and cultural evolution and Peregrine’s fellow archaeologists.

“Food-getting strategies are a basic function of any organism and play a profound role in directing the course of evolution,” says Peregrine. “Understanding the evolution of a rare and unique food-getting strategy – in this case agriculture – might help us in refining or even in developing new approaches to understanding evolution.” ■



Thirty years of insights at the boundaries

In the three decades since its founding, the Santa Fe Institute has produced some remarkable and influential insights. From illuminating how cities and societies function and evolve, the Institute has become a beacon for those seeking answers to some of our most perplexing questions. You might say that insights are our stock in trade, produced to benefit society at large and guide the leaders who are making big decisions that impact future generations.

How have we managed to produce game-changing insights so consistently over three decades? We asked SFI Board Member and Pulitzer Prize-winning author Cormac McCarthy to tell us what makes SFI so special.

Having been an integral part of the SFI community for the last decade, Cormac

understands the Institute’s potential, and he applies a novelist’s keen observational skills to describe it. “Scientific work at SFI is always pushing creativity to its practical limits,” he says. “We always court a high risk of failure. Above all we have more fun than should be legal.” I can think of no better or more succinct way to describe the SFI community and approach.

Of our special community – and the thinkers we work to attract – Cormac notes, “We are beyond relentless in seeking out the best people in every discipline. We will get you here. No matter what. And we will give you the space and the resources that you need.” I know a significant number of scholars, including our Omidyar Postdoctoral Fellows, who would support that observation, many of whom have gone on

to create or join new centers of interdisciplinary study modeled after SFI.

Cormac’s insights spotlight SFI’s unique strengths: the diverse, big-thinking community we’ve built; a tolerance for risk that gives free reign to creativity and innovation (supported by solid science); and the joy and excitement that come from exploring our ever-changing universe. All of these qualities add up to the kinds of insights that will drive meaningful change in our world, and that’s work – and fun – we can all be proud of.

Warm regards,

Nancy Deutsch, Vice President for Advancement

New Science. New Horizons.

HONORING MURRAY GELL-MANN

In the 1950s and 60s, Murray Gell-Mann predicted the existence of subatomic particles he called “quarks.” His insight was so profound it gave rise to a whole new subfield of physics.

Decades later, in the early 1980s, as the concept of an institute for big ideas was beginning to come together, SFI’s co-founders asked Gell-Mann, the Nobel laureate in physics, for his insights about a new kind of center dedicated to a new kind of science.

Gell-Mann’s ideas, prestige, and connections were instrumental in attracting the brightest minds to Santa Fe. Today, as a Distinguished Fellow of the Institute, he continues to play a key role in defining SFI’s direction. Gell-Mann has always embraced big ideas, and SFI has proven to be the perfect home for his unique perspective.

As we celebrate 30 years of new science from the Santa Fe Institute, we are proud to honor Murray Gell-Mann’s vision with a special fund that supports SFI science. The fund will help ensure that Gell-Mann’s work – and the science he has come to personify – continues and thrives at SFI for generations to come.

Please make a gift to SFI today to honor the Santa Fe Institute’s most illustrious big thinker, Murray Gell-Mann.

Campaign news

To date, SFI’s 30th anniversary campaign – New Science. New Horizons. – has raised more than \$24.2 million toward our \$30 million goal.

Contact the Office of Advancement at 505.946.3678 to discuss how you can help us attain new horizons.

SFI@30

MY STORY

Cormac McCarthy
Author
Trustee, Santa Fe Institute

“The first MacArthur Fellowship meeting in Chicago was sort of like a television show. We were whisked away to a beautiful old house on the lake-shore in private limousines. There were just a handful of us and none of us really knew what the whole thing was about. Just that they were going to give us some money. We went down in the evening for cocktails and dinner and I made a bee-line for the physicists. Murray Gell-Mann and David Gross and John Schwartz and George Zweig and others. They included me in their group without question. Murray and I became friends and here I am.”

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UPDATE

SANTA FE INSTITUTE

> **Templeton review** continued from page 2

Complex socioeconomic systems

SFI Professors Geoffrey West and Luis Bettencourt co-lead “The Hidden Laws that Per-vade Complex Biological & Social Phenom-ena” project, which draws from biology and physics to understand human socioeconomic complexity.

“What we suggest is that the scaling relationships we are seeing are an outcome of the universality and integration of both social and infrastructural networks in space,” said West.

Bettencourt described recent research that explores how networks relate to urban geog-raphy and how increasingly dense social and infrastructural networks give rise to the ad-vantages of scale (a.k.a. scaling) cities create as they grow.

“If we’re all trying to solve the same simple human problem, such as how to survive on this patch of dirt, we will all have roughly the same information to work with,” he said. “But if we’re all trying to solve different prob-lems, our collective knowledge grows. This diversity of knowledge and its interaction is the dynamic in a city that causes increasing returns to scale.”

Former Omidyar Postdoctoral Fellow Scott Ortman, whose recent work with Bettencourt and colleagues suggests that archaeologi-cal data from early cities are a good fit to the scaling models for modern cities, noted that the language SFI uses to describe its cities work has evolved, from a focus a few years ago on describing urban scaling relationships observed in modern cities to “seeking a gen-eral theory of human social organization. For me, this is a stunning example of what SFI can do—bring these teams together and find broad generalities across systems.”

Team members include Luis Bettencourt, Geoffrey West, Jose Lobo, Deborah Strumsky, Clio Andris, Scott Ortman, Andres Gomez-Lievano, Marcus Hamilton, Markus Schlapfer, Hyejin Youn, and Madeleine Daepf.

SFI is in preliminary discussions with a major university press regarding a possible book se-ries summarizing the key research supported under this grant.

Complexity education

The Templeton grant also supported an edu-cation outreach project led by SFI McKin-non Family VP for Education and Institutional Outreach Ginger Richardson and External Professor Melanie Mitchell: creation of the Complexity Explorer (complexityexplorer.org), a central online repository for teaching and learning materials associated with the sci-ences of complexity.

Mitchell offered a tour of the site’s library of ideas, simulations, exercises, definitions, course curricula, syllabi, and other resources, then turned her attention to the center-piece of the Explorer: its massive open online courses (MOOCs) in complexity.

Four MOOCs have been offered so far, she said, with more than 24,000 total students enrolled and some encouraging statistics.

External Professor Liz Bradley spoke of her trepidation about teaching one of six Com-plexity Explorer MOOCs scheduled to begin this fall (“If I make a sign error, a thousand people are going to email me. That’s terrify-ing.”). David Feldman followed with his im-pressions of his own just-completed “Dynam-ics and Chaos” MOOC (“It was more difficult than I imagined. It was strangely satisfying. I’m thinking about the next one.”)

Mitchell described her vision for the future: a greater number of course offerings, much larger participation numbers, a (possible) cer-tificate program, MOOCs as prerequisites for summer schools at the Institute, and “flipped” university courses featuring online MOOC-like lectures as homework and interactive exercises and activities in the classroom.

“I’m even dreaming of Massive Open Online Science,” she said. “I’d like to see online com-munities doing scientific experiments.” ■