SANTA FE INSTITUTE

May / June 2012

UPDATE

IN THIS ISSUE

George Cowan passes away at 92

George Cowan, SFI's founding president and a central figure in the history of transdisciplinary science, passed away at his home on April 20 at the age of 92.

"George Cowan's death is a huge loss to us all," said SFI President Jerry Sabloff. "He was a wonderful person with a visionary understanding of the nature and role of science in the world today. He will be greatly missed by everyone associated with the Santa Fe Institute." (See "Goodbye George" below)

Cowan was a scientist, academic, businessman, and philanthropist. From 1982 to 1984 he was the central figure in founding the Institute. Although he preferred to conduct research, he accepted the invitation to be SFI's first president, a position in which he served from 1984 to 1991. He continued to serve on the Institute's Board of Trustees until his death.

Cowan received a B.S. from Worcester Polytechnic Institute in 1941. He did graduate studies at Princeton, where he worked under future Nobel laureate Eugene Wigner, whose investigation of uranium confirmed the feasibility of the Fermi pile.

He continued his nuclear research with the Manhattan Project at the University of Chicago, Oak Ridge, Columbia University, and Los Alamos. Because he was transferred to various locations as a technological troubleshooter for the effort (a result, he joked, of his being unmarried), he was among the very few people with knowledge of the separate components of the bomb, kept apart for security reasons.

He joined the Carnegie Institute of Technology in 1946. He earned a Ph.D. from the Mellon College of Science in 1950.

Weeks after his arrival at Los Alamos National Laboratory in 1949, he directed the detection of radioactive fallout from samples collected near the Russian border indicating the Soviets were in possession of a nuclear bomb. He later served on the Bethe Panel that convinced government decision makers the radiochemistry detected represented weapons uses rather than peaceful pursuits.

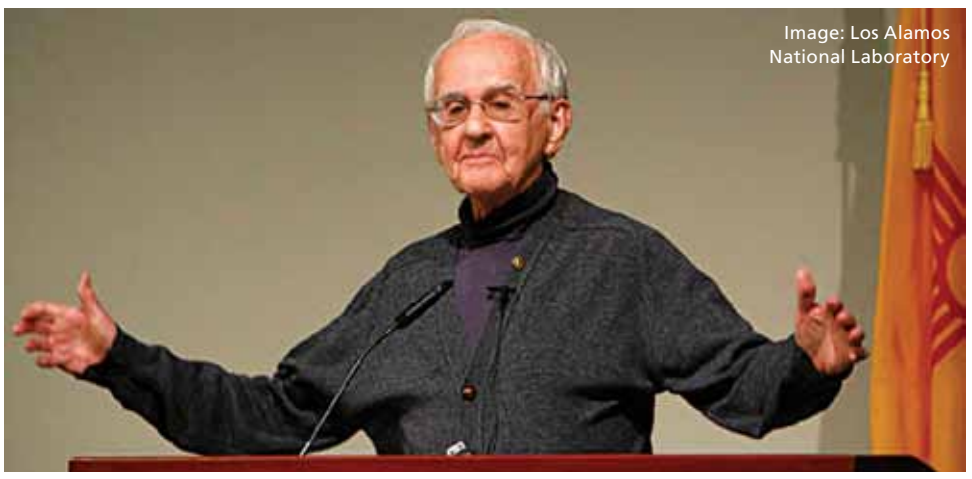


Image: Los Alamos National Laboratory

He worked at Los Alamos National Laboratory from 1949 to 1988, serving as a scientist, as a director of chemistry, as associate laboratory director of research, and as a senior laboratory fellow.

> "A researcher and smasher of atoms who also founded a bank and supported opera."
>
> ***– New York Times***

He was appointed to the White House Science Council during the Reagan administration. While serving in this capacity and facing problems involving interconnected aspects of science, policy, economics, environment, and more, he became an outspoken critic of scientific fragmentation in academia and government and a proponent of the intentional cross-fertilization of many fields – an idea that grew into SFI's transdisciplinary focus. He was among the first to advocate the quantitative study of complex adaptive systems.

He received the Enrico Fermi Award, the New Mexico Academy of Science Distinguished Scientist Award, the Robert H. Goddard Award, the E.O. Lawrence Award, and the Los Alamos National Laboratory Medal. In 1997 he was elected a fellow of the American Academy of Arts and Sciences.

As a scientist, Cowan studied nonlinear dynamics, using mathematical equations to predict the behavior of complex systems. He had a particularly strong commitment to one such complex system, the human brain, and the effects of early childhood experience on human brain development. He helped formulate and lead a major study using brain imaging techniques to investigate children's brain and behavioral development.

Cowan was a founding director of Los Alamos National Bank and was its chairman for 30 years. He was a patron of the arts and was an early board member of the Santa Fe Opera.

George's wife of 65 years, Helen "Satch" Cowan, passed away in August 2011. ■

Goodbye George: A father figure with a 'pioneer's eye'


Image: Walter Fontana

SFI invited those who knew George Cowan to share their memories of him on the Institute's website. Here are selected excerpts. Read them all, or submit your own, at **www.santafe.edu.**

"George told me about growing up during the Great Depression in Worcester, Massachusetts. [At his father's grocery store] George had the job of making baloney sandwiches for [the men] who were out of money and hungry…That was when George was twelve…He never stopped making those sandwiches." **– Sam Bowles**

"In his years of presidency he shaped SFI and made it what it is now: a great flag on the landscape of complexity research. We shall miss him but SFI remains as his heritage."
– Peter Schuster

"[Los Alamos National Bank] made it possible for two generations of non-US scientists to establish themselves in Northern New Mexico without a US credit history."
– Steen Rasmussen

"George was that rare father figure who raised us kids with strict standards and sometimes tough criticism, but also generous pockets, unquestioning moral and intellectual support, a pioneer's eye and taste, and most of all the hope that we would keep trying to be bad and break the rules and do things different from what had been done before."
– Erica Jen

RESEARCH NEWS

Turning vicious cycles virtuous

Movie makers and fiction writers have long depicted the disruption and fall of civilizations. But in a few works of fiction, like the classic "Foundation" series by Isaac Asimov, scientists develop models to help predict and avoid societal calamities.

SFI Professor Luis Bettencourt has been awarded $500,000 by the Army Research Office to do something akin to Asimov's models, but as a very real technique to meet humankind's contemporary challenges of environmental change, energy demand, infectious disease, and violence.

What brings such an idea out of science fiction and into the realm of genuine research, Luis says, is the rapid expansion

> more on page 4

RESEARCH NEWS

Better abstraction for real networks

For SFI Professor Cris Moore, current network theory is too abstract.

"All of us in the field know in our hearts that real networks are much, much richer than the way network theorists typically deal with them," he says.

He is co-hosting a workshop at SFI May 17-19, "Power Grids as Complex Networks: Formulating Problems for Useful Science and Science Based Engineering," to explore how network mathematicians can make better sense of electrical power networks.

While power networks offer particular challenges, Cris hopes lessons from the

> more on page 4

SFI IN THE NEWS

In March in the *Wall Street Journal, Forbes, Wired*, NPR, and other media, Jonah Lehrer, author of *Imagine*, a new book about creativity, cites SFI research suggesting that creativity is one natural outcome of urban living. But, the research points out, it comes at a cost – including expenses for energy use as well as an insatiable taste for "new things."

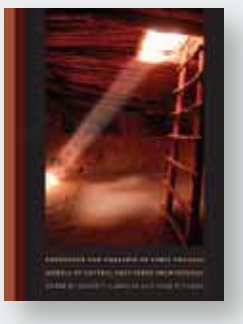
An essay in *OpEd News* on March 11 asks which economic perspective will inform U.S. financial reform, and traces the history of economic theory, including SFI's founding and its role in the advent of "complexity economics."

In April, the *Huffington Post* and MSNBC covered publication of a study by SFI Omidyar Fellow Rogier Braakman and External Professor Eric Smith tracing the six methods of carbon fixation seen in modern life back to a single ancestral form.

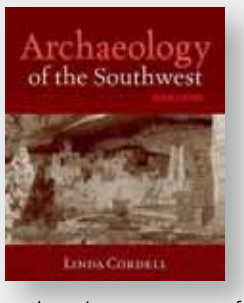
The *Santa Fe New Mexican* and KSFR's Santa Fe Radio Café covered the "Science On Screen" series in Santa Fe, a joint collaboration of the Center for Contemporary Arts and SFI during which Institute scientists screen their favorite films and offer eye-opening perspectives from their own research and the world of science.

In the *Huffington Post* on April 17, SFI External Professors Dan Rockmore and David Krakauer imagine a vastly different university of the future – decentralized, infused with information technologies, and rich in transdisciplinary, collaborative scholarship.

BOOK NEWS



Emergence and Collapse of Early Villages: Models of Central Mesa Verde Archaeology, co-edited by SFI External Professor Tim Kohler (Washington State University) and Mark Varien, compares results of agent-based modeling with the archaeological record, and examines how climate change, population size, interpersonal conflict, resource depletion, and changing social organization might have contributed to dramatic shifts in ancestral Puebloan habitation of the Mesa Verde region from 600 to 1280 A.D.



Archaeology of the Southwest, Third Edition, by SFI External Professor Linda Cordell (School for Advanced Research) and Maxine McBrinn, provides a comprehensive summary of the major themes and topics central to modern interpretation and practice on the topic, and offers readers the latest in current research, debates, and topical syntheses, as well as increased coverage of Paleoindian and Archaic periods and the Casas Grandes phenomenon. For advanced undergraduate and graduate courses, researchers, and general readers.

Nonlinearities

From the editor

George Cowan left us April 20. I didn't know him well, but I know enough about him to understand that he is one of the giants on whose shoulders we at SFI stand. There is hardly a philanthropic, scientific, or business organization in northern New Mexico that wasn't touched by him in a significant way. If you can, spend a few minutes reading the memories posted by his SFI friends at www.santafe.edu. A great man. And thank you, George, for all of this.

Here is the final paragraph of George's *New York Times* obituary, which appeared online on April 24 and in print on April 26, and which I like very much: "[Edward Teller and George Cowan] had been part of a regular poker game at Los Alamos. Dr. Cowan said he particularly liked to play with Dr. Teller 'because he had a tendency to draw to inside straights' — generally a losing hand."

Congratulations to Doyne Farmer (see page 4). I do know Doyne, and his work epitomizes what's useful about complex systems science. We can never fill his shoes, but hopefully we'll be able to fill the void with something new.

One thing I've learned in 20 plus years of science writing is that the ratio of repressed high school English teachers in any population is greater than you might think. You grammarians out there probably noted, in fact, how I used the word "hopefully" as a sentential adverb above. Save your gotcha for another day. As of April 17 the Associated Press Stylebook says this is an acceptable use (though the *New York Times* is holding its ground). It's the latest in the battle between English-language prescriptivists and descriptivists. You can probably guess where I fall. I'm also adamant about serial commas, but don't get me started.

Speaking of opinions, SFI Professor Cris Moore has some strong ones. He's also a mathematician who is fun to talk with… about math. One of his views is that network theory isn't often applied effectively to real networks. The power grids workshop he and External Professor Raissa D'Souza are co-hosting at SFI this month might begin to address this gap (see page 1).

Finally, the new title of this editor's column is "Nonlinearities." As always, I'm taking suggestions, ideas, gotchas, encouragement, musings — even bizarre expressions of lunacy (you know who you are). ■

– John German, jdg@santafe.edu

RESEARCH NEWS

Finding the roots and early branches on the tree of life

In a new paper, SFI Omidyar Fellow Rogier Braakman and External Professor D. Eric Smith map the development of life-sustaining chemistry to the history of early life and trace six methods of carbon fixation back to a single ancestral form.

Carbon fixation – life's mechanism for making carbon dioxide biologically useful – forms the biggest bridge between Earth's nonliving chemistry and its living biosphere. All contemporary organisms that fix carbon do so in one of six ways. These six mechanisms have overlaps, but it was previously unclear which of the six types came first, and how their development interweaved with environmental and biological changes.

The authors used a method that creates "trees" of evolutionary relatedness based on genetic sequences and metabolic traits. From this, they were able to reconstruct the complete early evolutionary history of biological carbon fixation, relating all ways in which life today performs this function.

The earliest form of carbon fixation achieved a special kind of built-in robustness – not seen in modern cells – by layering multiple carbon-fixing mechanisms, they say. This redundancy allowed early life to compensate for a lack of refined control over its internal chemistry, and formed a template for the later splits that created the earliest major branches in the tree of life.

The first major life-form split, for example, came with the earliest appearance of oxygen on Earth, causing the ancestors of blue-green algae and most other bacteria to separate from the branch that includes Archaea, which, outside of bacteria, are the other major early group of single-celled microorganisms.

"It seems likely that the earliest cells were rickety assemblies whose parts were constantly malfunctioning and breaking down," says Eric. "How can any metabolism be sustained with such shaky support? The key is concurrent and constant redundancy."

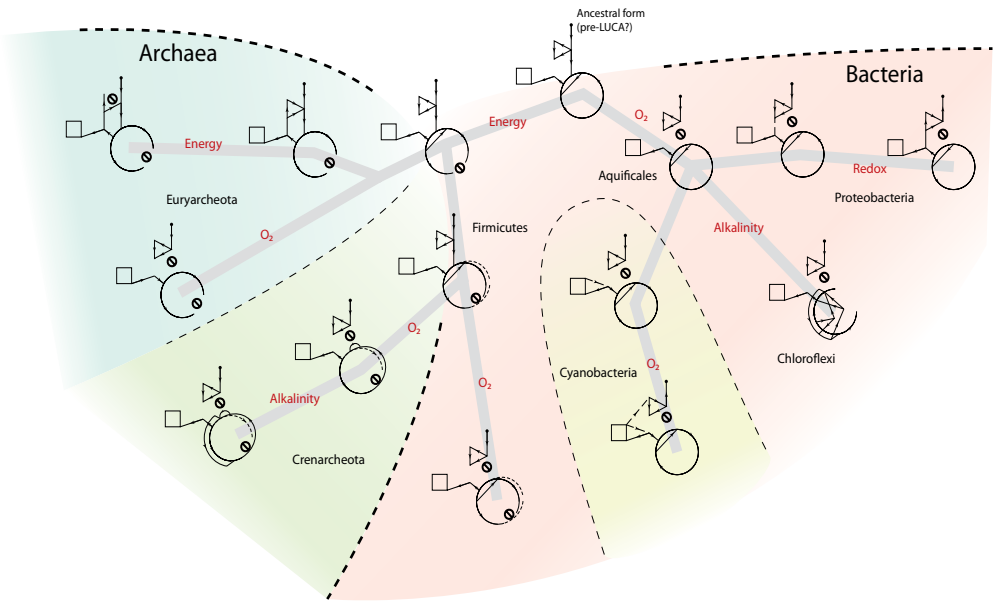
Once early cells had more refined enzymes and membranes, allowing greater control over metabolic chemistry, environmental driving forces directed life's unfolding. These forces included changes in oxygen level and alkalinity, as well as minimization of the amount of energy (in the form of ATP) used to create biomass.

In other words, they say, the environment drove major divergences in predictable ways – in contrast to the widely held belief that chance dominated evolutionary innovation, and that rewinding and replaying the evolutionary tape would lead to an irreconcilably different tree of life.

"Mapping cell function onto genetic history gives us a clear picture of the physiology that led to the major foundational divergences of evolution," says Rogier. "This highlights the central role of basic chemistry and physics in driving early evolution."

With the ancestral form uncovered and evolutionary drivers pinned to branching points in the tree, the researchers now want to make the study more mathematically formal and further analyze the early evolution of metabolism.

Their study was published April 18 in *PLoS Computational Biology.* ■



Phylometabolic tree of carbon fixation. Each small black network represents a carbon-fixation pathway, and the tree describes the evolutionary process that connects them. In red text are identified environmental driving forces. Through integrating phylogenetics with metabolic constraints, phylometabolic analysis allows a clear description down to the root of the tree (top center), and shows how carbon-fixation structured the deep history of life on Earth.

RESEARCH NEWS

May working group to explore the atomic bomb's legacy

VIP observers lit up by the light of an atomic bomb during Operation Greenhouse, Enewetak Atoll, 1951.

The effort to develop the first atomic bomb united the greatest physics and engineering talent of a generation. The achievement not only had broad implications for humanity, it also shaped the way modern science is conducted and funded.

An SFI working group, "Legacies of the Manhattan Project: A Case Study in the Consequences of Conflict," May 12-13 at SFI, will examine new information about the project, review original records, and mine the memories of project participants to present a local case study from this important period in scientific history.

Topics include the Manhattan Project's scientific legacy, including its influence on setting scientific agendas and subsequent developments in physics and complex systems modeling; the project's political legacy, including the Cold War and the politics of funding scientific research; and its philosophical and cultural legacies.

"We have no agenda other than to look at the issue," says Ellen Bradbury-Reid, who is co-organizing the event with SFI External Professor Linda Cordell. "The panelists are not here to present papers or push any agendas. They're coming together to discuss the issue and answer questions."

Several SFI researchers are examining conflict in human and animal societies. The Manhattan Project and subsequent arms race has emerged as a case study for understanding conflict management and the implications of conflict as a mechanism for evolutionary change.

Participants in the meeting include Harold Agnew, former director of Los Alamos; SFI External Professor Jessica Flack; Gregg Herken, author and Cold War political expert; Nobel laureate and SFI Distinguished Fellow Murray Gell-Mann; Ellen Bradbury-Reid, Manhattan Project historian; and Gino Segre, nuclear physicist and author of several books on the history of science.

Follow this meeting live on Twitter at **#bomblegacy** or at **www.nucleardiner.com.** ■

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

Follow SFI online at **www.santafe.edu**

ACHIEVEMENTS

The Betsy and Jesse Fink Foundation has awarded SFI Professor Jennifer Dunne a $25,000 grant to support research into using ecological networks to understand environmental change. The award, in part, will fund a working group at SFI later this year.

The National Center for Women & Information Technology has given SFI Project GUTS Principal Investigator Irene Lee its Award for Aspirations in Computing Educator Award. The annual award is for educators that have demonstrated a commitment to encouraging young women's interests in computing.

SFI External Professor Joseph Traub (Columbia University) is among the key pioneers of the information age providing oral histories for the Computer History Museum in Mountain View, Calif. His interviewer was Dr. Prakhakar Raghavan, head of Yahoo! Labs. The interview is available online at **www.computerhistory.org.**

SFI Online

Multimedia content available at ***www.santafe.edu***

Video: SFI Miller Scholar Rebecca Newberger Goldstein considers intuition as an essential part of our moral and philosophical thinking. Source: SFI 2012 Community Lecture

Video: SFI Omidyar Fellow Scott Ortman asks whether human society is the result of human agency. Source: SFI Big Questions video

Audio: SFI External Professor Tim Kohler describes how archeologists are using computer modeling to learn why the Puebloans left southwest Colorado in the late 1200's. Source: Colorado Public Radio

Video: SFI Professor Jennifer Dunne asks how networks can help us understand the role humans play in ecosystems. Source: SFI Big Questions video

Video: SFI President Jerry Sabloff and Faculty Chair Doug Erwin describe how and why SFI asks Big Questions. Source: SFI Big Questions video

Video: Author Brian Christian shares his experiences as a "confederate" in an annual man vs. computer "Turing Test," offering insights on ways computers are reshaping what it means to be human. Source: SFI 2012 Community Lecture

John Miller (right of center) and REU students conduct an impromptu experiment in SFI's kitchen.

EDUCATION

Summer programs: 'Intense and profound science'

Many complexity scholars first experience SFI through the Institute's summer education programs, just as SFI Summer School Programs Manager John Paul Gonzales did almost four years ago.

"The SFI summer programs offer the most intense and profound science education experiences that I can imagine," he says.

John Paul's first exposure came through a chance encounter with the Complex Systems Summer School in 2008. "I walked to the back of the room, and [External Professor] Liz Bradley was talking about applications of chaos theory," he recalls. "It was such a fascinating way of looking at the world that I wanted to learn more."

The CSSS is a four-week program that introduces graduate students and postdoctoral fellows to a range of topics in complex systems science, including chaos theory, computation, and networks.

John Paul Gonzales

"It's like drinking from the fire hose," he says, "but it allows people to see the connections between fields. Once someone goes through the CSSS, they can pick up anywhere in the SFI world."

This year's CSSS is June 3-30 at St. John's College in Santa Fe.

SFI's **Graduate Workshop in Computational Social Science, Modeling, and Complexity** offers students from economics and the social sciences a range of computational techniques they use to answer social dynamics questions of their own design. This summer, participants also will work together to answer a question posed by SFI's Business Network.

The 2012 graduate workshop and the inaugural advanced graduate workshop for program alumni (see article below) take place June 17-30 at St. John's.

SFI's **Research Experiences for Undergraduates** pairs young scientists with SFI faculty mentors. Participants are encouraged to investigate complex social systems through a research project they design with their mentors.

John Paul says the program is "a taste of what it is to be an SFI postdoc. Students from around the country experience SFI's culture and what Santa Fe has to offer for a few months, and then we send them back to their home institutions with big ideas."

The 2012 REU program runs June 4-August 10; participants live at St. John's and pursue their research at SFI.

For high school students enrolled in SFI's **Complexity and Modeling Program (CAMP),** "summer camp" will be a transformative experience. Based on previous school for students in the Santa Fe area, SFI's CAMP now offers young scholars from around the nation a chance to learn complexity science from SFI scientists. Participants will attend lectures on the fundamentals of chaos and complexity, gather ecological field data, receive training in computer modeling, and pursue independent research projects. CAMP runs July 8-23 at George Mason University (GMU) in Fairfax, Virgina.

GUTS y Girls, an offshoot of SFI's successful Growing Up Thinking Scientifically (GUTS) program, in 2012 will run a two-week summer program that puts New Mexico middle school girls in touch with female mentors in science, technology, engineering, and mathematics.

"The great thing about the GUTS y Girls summer workshop is it allows girls to intensify their understanding of computer science in a really supportive environment that's a lot of fun," says SFI GUTS y Girls program coordinator Kathryn Ugoretz. "It gives them strong female mentors, and it's a way for them to really deepen their understanding of what we work on throughout the year."

The GUTS y Girls summer program will run in two sessions, June 4-15 at New Mexico State University in Las Cruces, and June 18-29 at the Santa Fe Complex.

Again this summer, the Institute is reaching out to future scientists through their science teachers. In a teacher development workshop titled **"Understanding the Origins of Life: From Geochemistry to the Genetic Code,"** high school teachers of biology, chemistry, and geology will learn about emerging theories concerning the chemical and physical origins of life. They will be trained to use agent-based modeling programs and offered course units on topics covered in the workshop. The workshop will be held June 25-29 at the GMU Fairfax campus.

For working professionals who want to incorporate complexity science into their understanding of the global financial crisis, the Institute is offering a three-day symposium **"The Science of Complexity: Understanding the Global Financial Crisis."** The symposium, a collaboration between SFI and the Krasnow Institute for Advanced Study, will be held May 16-18 at GMU's Arlington, Virginia campus. ■

'An atmosphere where the students live their science'

For 18 years, the Institute has seeded the young field of computational social science with alumni of its Graduate Workshop in Computational Social Science Modeling and Complexity. Summer 2012 marks the first time SFI will offer an advanced workshop for past participants who wish to further develop their research.

The advanced group will spend two weeks in Santa Fe, where they will share living quarters and pursue computational techniques to investigate complex social questions. By housing the students together, coordinators John Miller and Scott Page (both SFI External Professors) hope to encourage "an atmosphere where the students live their science," John says.

One participant plans to investigate whether the rules and social structures of institutions can influence people's behaviors even after the institutions themselves have died out. Another will model influence processes that have appeared in political science literature in recent years. A third will examine cooperation and strife between ethnic groups, using data from a network of Zambian roads that have brought Chinese immigrants in contact with native populations.

"We gather a high quality group of students and create a supportive research environment where this amazing group of colleagues is working hard on novel scientific ideas all the time," John says. "The social sciences have seen a rapid assimilation of the core ideas of complexity and computational modeling, often driven by contributions from our former students." ■

EDUCATION

Delle Foundation to fund children's museum exhibit

A hands-on exhibit for children that focuses on many of the complex systems addressed by SFI scientists is in the initial planning stage at the Santa Fe Children's Museum.

The Delle Foundation, an independent charitable organization previously spearheaded by SFI's late founding president George Cowan, has awarded a two-year, $150,000 grant to the Santa Fe Children's Museum to work with SFI scientists and the New Mexico Department of Cultural Affairs to create an exhibit and learning lab for children ages 9-12. Students at New Mexico Highlands University will help design the first exhibit, scheduled to open at the museum in 2013.

"The learning lab and exhibit project will be a gem in New Mexico and raise the profile of the Santa Fe Children's Museum on the national level," says Anna Marie Tutera Manriquez, the Museum's outgoing executive director who applied for the grant.

George Cowan and SFI Trustee Bill Enloe will be honored at the Museum's annual gala on May 19. ■

DONOR PROFILE

Jerry Murdock: Modeling society's problems

Education in the 19th and 20th centuries was good at teaching people to approach a problem in a linear fashion. SFI Trustee Jerry Murdock believes the survival of our culture in the 21st century depends on teaching leaders and decision-makers to model complex problems.

He supports the Institute because SFI researchers have created tools that could help improve the environment, our economy, and the functioning of democracy – if world leaders will learn to use them.

"Most of our leaders are not trained to conceptualize these problems, let alone solve them," he says. "SFI's transdisciplinary work is the model for how leaders and science can cross boundaries to solve the relevant and significant issues of our day."

"I have no interest in funding science in general," he says. "But I have tremendous interest in funding science that addresses the most pressing challenges we have in our society today."

Murdock and SFI President Jerry Sabloff have formed a group to study archaeo-astronomy and seek to understand how early astronomical science can provide new insights into ancient civilizations. He is especially interested in the integration of astronomy within ancient Mayan culture. ■

INSIDE SFI

Doyne Farmer to INET@Oxford

SFI Professor J. Doyne Farmer has been chosen to lead the complexity economics program at INET@Oxford, a collaboration between the James Martin School for the 21st Century at Oxford University and the Institute for New Economic Thinking (INET).

INET founder George Soros announced the creation of the major new interdisciplinary center April 12 during the INET annual conference in Berlin.

"Fresh thinking in economics is urgently needed to mitigate many global challenges, not least systemic financial crises, the creation of sustainable jobs and employment, and the wide-ranging challenges of development," said Soros.

Doyne, a physicist who has pioneered and led complexity economics research at SFI since the late 1980s, will lead an interdisciplinary group of scholars applying insights from complex systems theory, network theory, and evolutionary theory to economic issues. The program is among a half-dozen research areas to be studied at the center. Doyne also will hold a professorship in Oxford's Department of Mathematics.

"SFI is very sad to lose Doyne to Oxford given his great contributions to the Institute over many years, but we are delighted for him that he is embarking on such an exciting opportunity with the new INET institute at Oxford," says SFI President Jerry Sabloff. "We are pleased that he will continue his association with SFI as an External Professor." ■

May / June 2012

UPDATE

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> *Virtuous cycles* continued from page 1

in the last decade of our ability to measure human and social behaviors across many levels of organizations.

"There has been relatively little progress in turning these increasing volumes of data into predictive scientific knowledge that can be used to intervene and avoid deeper problems," he says. "Among the critical issues that can be studied relate to the robustness (or lack thereof) of large human social organizations, such as cities and nations, and to resource and environmental stress, and how these factors interact with internal dynamical and organizational structures, including the potential for decay and collapse."

Although plenty of work has been done to try to capture the internal dynamics of organizations, such as firms or governments, and to model their decision structures, these models apply at best to a single level of organization and typically fail to predict accurately, or to be sensitive to, dynamics and inputs at different scales. Luis wants to address these issues by building a theory based on empirical data about human social organizations across scales from firms to nations.

"It's really about understanding the nature of these processes and learning how to interfere in them," he says. "If you understand the nature of problems, specifically in terms of their potential for instability in positive or negative directions, you have a means to tilt the process to a benign outcome." ■

> *Real networks* continued from page 1

workshop might apply more generally, yielding insights for creating more reasonable abstractions of other highly dynamic networks, such as food webs.

The power grid is an "excellent choice" for advancing the field of network science, he says, because making mathematical models of power grids offers challenges beyond those of other dynamic networks.

Power network failures, for example, tend not to transmit from power station to power station in the same way that, say, infectious diseases spread from person to person. Instead, the failure of one power station or transmission line places a burden on alternate stations and transmission lines even if they are not directly connected.

Power-system engineers are experts at the regional level, Cris says, but what's missing is a scientific understanding of what regional power grids have in common and how those grids interact both with other power grids and other networks, including other utilities, the Internet, and transportation systems.

"The goal of the workshop is to bring together network theorists with people who really understand these rich dynamics and go beyond engineering to science – to understand which variables and structures really matter at the large scale."

Workshop co-organizers are External Professor Raissa D'Souza (UC Davis), engineering and public policy scholar Paul Hines (University of Vermont), mathematical physicist Misha Chertkov, and applied mathematician Aric Hagberg (both of Los Alamos National Laboratory).

"We invited a mixture of network theorists, electrical engineers, and power-systems engineers," says Cris, as well as people from the optimization community interested in solving resource-allocation problems for improving power-grid robustness, including its ability to incorporate renewable sources, and reducing its vulnerability to attack. Some 25-30 participants are expected in total, with the schedule set to allow time for discussion and for forging new collaborations. ■

Upcoming events

SFI Community Lecture, "The Information: How we came to be deluged by Tweets," May 16, 7:30 p.m., James A. Little Theater. The story of information began in a time profoundly unlike our own, when every thought and utterance vanished as soon as it was born. From the invention of scripts and alphabets to the long-misunderstood talking drums of Africa, author James Gleick tells the story of information technologies that have changed the very nature of human consciousness. He provides portraits of key figures contributing to information as our era's defining quality, and takes us straight to the frontiers of information theory today. Gleick's latest book is *The Information*. SFI's 2012 Community Lecture series is sponsored by Los Alamos National Bank. Additional support for this lecture is provided by Joy and Phil LeCuyer.

SFI-CCA Science on Screen series, "Groundhog Day with Murray Gell-Mann," May 17, 7:00 p.m., Center for Contemporary Arts. In this final screening in the 2012 "Science On Screen" series, SFI Distinguished Fellow Murray Gell-Mann gives this classic déjà vu comedy a novel spin: Can Bill Murray help us understand the essence of scientific practice? Gell-Mann and screenwriter Danny Rubin discuss one of cinema's most enjoyable mind-bending films. Generously Sponsored by Ringo and the Tanoroadgang.

SFI Community Lecture, "Why we come to the aid of our friends: An evolutionary puzzle," June 27, 7:30 p.m., James A. Little Theater. Friends sacrifice for one another without apparent concern for consequences or reciprocation. Such unconditional acts of selflessness provide an important buffer against hardship, both for individuals and for human societies. But they also pose an evolutionary puzzle. How does humankind benefit from unconditional aid when false friends and exploiters abound? Dan Hruschka searches for clues in the origins of human friendship – how it develops, how it varies across cultures, and how it compares to social ties in other species. Hruschka, a former SFI Omidyar Fellow, is an assistant professor of anthropology at Arizona State University and author of *Friendship: Development, Ecology, and Evolution of a Relationship*. The 2012 Community Lecture series is sponsored by Los Alamos National Bank. This lecture is sponsored in memory of Kate Klein, from the Kate Klein Fund at the Santa Fe Community Foundation. ■