



Update

March 2008



Engraving by Paul Revere (June 1774) titled "America Swallowing the Bitter Draught" illustrates the aftermath of the Boston Tea Party and the closing of the port. (Image: U.S. National Archives)

RESEARCH NEWS

Can science inform history?

An SFI meeting on Honolulu in March is bringing together researchers – physicists and historians alike – who think they can rewrite history books.

Many historians believe the historical chronicle, with its linear chain of causal events, "is the essence of history and always will be," says SFI Professor David Krakauer. "Others are beginning to see more of a structure to it."

David, who is co-organizing the presentations, says the primary question is whether historians might benefit from the language and principles of complexity science, much as the fields of ecology and economics have.

The project is part of a longstanding interest in history and complexity at SFI that includes the work of SFI External Professor John Padgett (University of Chicago), SFI External Professor Doug White (UC Irvine), SFI Trustee Robert McCormick Adams (Smithsonian, UC

San Diego), and SFI External Professor Henry Wright (University of Michigan).

But imposing a scientific framework on history is difficult, says David. History is narrative – by necessity a subjective interpretation of events and personalities, characterized by particularity rather than regularity.

Sciences, on the other hand, aggregate repeated observations of regularity into laws. Thus, the future of the solar system can be predicted with relative accuracy with knowledge of the locations of planets today and the application of Newton's laws, he says.

In this sense, David says, Newton is one of the greatest historians who ever lived, as he was able to recount the past and predict the future with equal accuracy.

At the March meeting David and colleagues plan to address the gap between science and history from a

variety of perspectives and approaches. Four major SFI donors are attending the meeting.

As one approach, the tools of complexity science could, in effect, quantify randomness and regularity in historical events.

Another approach would address the subjectivity of historical narrative – in other words, how historians today determine which events are historical or significant and which are not – using the tools and principles of coarse graining from physics. At one end of the spectrum, individuals and personalities are historically significant; at the other end, history captures only large-scale movements or population-wide trends.

"What counts as an historical event? What are the variables? These are important questions for history," he says.

> more on page 2

IN THIS ISSUE

- > Lit Bits 2
- > Counterinsurgency 2
- > SFI at AAAS 2
- > SFI In the News 3
- > Theme week 3
- > Disease prediction 3
- > NSF exhibit 3
- > Traffic jams 3
- > Genes in conflict 4

Reception, dinner complement April 14 Gorbachev lecture

The Institute expects a large community turnout at events associated with former Soviet President and Nobel Peace Prize winner Mikhail Gorbachev's April 14 public lecture in Santa Fe, says Shannon Larsen, SFI Executive Director for Development and Corporate Relations.

The lecture, "Gorbachev on Leadership: From the End of the Cold War to the Growing Environmental Crisis," benefits SFI and will be held at the Lensic Santa Fe's Performing Arts Center starting at 6 p.m. New Mexico Governor Bill Richardson will introduce Gorbachev.

Tickets are \$35, \$50, \$100, and \$200 and are available at the Lensic box office.



Mikhail Gorbachev

Long-time SFI friend Gerald Peters arranged Gorbachev's visit and the Peters Family Art Foundation is underwriting the cost of the lecture. Peters also is hosting a cocktail party and dinner at the Rio Chama Steakhouse. Gorbachev will participate in both functions.

Admission to the 5 p.m. cocktail party is \$500 per person, limited to 100 people. Corporate sponsors are invited to the 8 p.m. dinner.

For more information, contact Shannon Larsen or visit www.santafe.edu/events

LIT BITS

Topological vulnerability of the European power grid under errors and attacks; Rosas-Casals, M.; Valverde, S.; Solé, Ricard [SFI External Professor]; *International Journal of Bifurcation and Chaos* 17 (7), July 2007, pp. 2465-2475

A statistical analysis of the three-fold evolution of genomic compression through frame overlaps in prokaryotes; Lillo, Fabrizio [SFI External Professor]; Krakauer, David [SFI Professor]; *Biology Direct* 2, Sept. 18, 2007, pp. 1-22

Inverted and mirror repeats in model nucleotide sequences; Lillo, Fabrizio [SFI External Professor]; Spano, M.; *Physical Review E* 76 (4 pt 1), October 2007, pp. 1056-1067

Generalized Box-Muller method for generating q-Gaussian random deviates; Thistleton, W.J.; Marsh, J.A.; Nelson, K.; Tsallis, Constantino

[SFI External Professor]; *IEEE Transactions on Information Theory* 53 (12), December 2007, pp. 4805-4810

Other-regarding preferences in a non-human primate: Common marmosets provision food altruistically; Burkart, J.M.; Fehr, E.; Efferson, Charles [SFI Postdoctoral Fellow]; van Schaik, C.P.; *Proceedings of the National Academy of Sciences* 104 (50), Dec. 11, 2007, pp. 19762-19766

Damage spreading and criticality in finite random dynamical networks; Rohlf, Thimo [SFI Postdoctoral Fellow]; Gulbahce, N.; Teuscher, C.; *Physical Review Letters* 99 (24), Dec. 14, 2007, pp. 308-311

Robustness of the second law of thermodynamics under generalizations of the maximum entropy

method; Abe, S.; Thurner, Stefan [SFI External Professor]; *EPL* 81 (1), 2008, pp. 18-21

Conformists and mavericks: The empirics of frequency-dependent cultural transmission; Efferson, Charles [SFI Postdoctoral Fellow]; Lalive, R.; Richerson, P.J.; McElreath, R.; Lubell, M.; *Evolution and Human Behavior* 29 (1), January 2008, pp. 56-64

Robustness and evolvability: A paradox resolved; Wagner, Andreas [SFI External Professor]; *Proceedings of the Royal Society B-Biological Sciences* 275 (1630), Jan. 7, 2008, pp. 91-100

Shifting patterns: Malaria dynamics and rainfall variability in an African highland; Pascual, Mercedes [SFI External Professor]; Cazelles, B.; Bouma, M.; Chaves, L.; Koelle, K.; *Proceedings*

of the Royal Society B-Biological Sciences 275 (1631), Jan. 22, 2008, pp.123-132

Languages evolve in punctuational bursts; Atkinson, Q.D.; Meade, A.; Venditti, C.; Greenhill, S.J.; Pagel, Mark [SFI External Professor]; *SCIENCE* 319 (5863), Feb. 1, 2008, p. 588

The evolution of developmental patterning under genetic duplication constraints; Fuentes, Miguel Angel [SFI Postdoctoral Fellow]; Krakauer, David [SFI Professor]; *Journal of the Royal Society Interface* 5 (19), Feb. 6, 2008, pp. 237-245

An interdisciplinary overview of a Mesopotamian city and its hinterlands (preprint); Adams, Robert McCormick [SFI Trustee]; *Cuneiform Digital Library Journal*, March 25, 2008, <http://cdli.ucla.edu/pubs/cdlj.html>

IMPACT

SFI researchers speak at AAAS meeting

Three researchers affiliated with the Institute spoke at the annual meeting of the American Association for the Advancement of Science (AAAS) in Boston in mid February. The theme of this year's meeting was "Science and Technology from a Global Perspective."

■ SFI External Professor Nina Fedoroff (Advisor to the Secretary of State, U.S. Department of State, and Penn State University) delivered a plenary lecture on Feb. 16 entitled, "Making the World Flat: Science and Technology in the Developing World."

■ SFI Professor Sam Bowles (University of Sienna) spoke Feb. 15 on "Moral Judgment: Evolutionary and Psychological Perspectives."

■ SFI Professor Doug Erwin (Smithsonian Institution) spoke Feb. 18 on "Major Transformations in Evolution: The State of the Art and Public Understanding." ■

ON & OFFS

For SFI's schedule of workshops, lectures, and colloquia: www.santafe.edu/events

COMINGS & GOINGS

For a schedule of SFI visitors: www.santafe.edu/events/calendar-visitors-week.php

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RESEARCH NEWS

Counterinsurgency under the glass of scientific inquiry

A panel discussion at SFI on March 20 will examine the limitations and the value of counterinsurgency as a tool for mitigating political violence in war-torn countries. The discussion, open to the public, is scheduled for 7:30 p.m. at the SFI campus.

SFI Professor Elisabeth Wood (Yale University) is co-organizing the event along with colleagues Daniel Branch (University of Exeter) and Stathis Kalyvas (Yale).

Elisabeth says a discussion of counterinsurgency is a follow-on to her years of research on insurgency and political violence in South Africa, Sri Lanka, and various Latin American countries.

Employing tools of game theory and comparative analysis, her research has identified a causal pathway leading to democracy through insurgency and led to conclusions about the factors underlying the emergence of insurgencies and indicators associated with lasting peace settlements.

"I am troubled by the way historical examples of counterinsurgency have been misunderstood," she says. "Often the best scholarship on those cases does not support popular interpretations."

She believes revisiting classic cases will lead to better understandings of counterinsurgency.

Discussion participants were selected to provide a blend of scholarly perspectives from both the political science and history fields.

Kalyvas, for example, whose work focuses on the microdynamics of civil war, brings a detailed knowledge of counterinsurgency in Greece, Algeria, and Vietnam. Branch, a historian, has studied the role of African collaboration with the British counterinsurgency effort during the Mau Mau rebellion during the 1950s.

Panelists Stephen C. Biddle of the Council on Foreign Relations and Ahmed Hashim of the Navy War College are experts on counterinsurgency in Iraq.

Elisabeth says empirical studies of insurgency and counterinsurgency reveal a number of stylized facts that could be illuminated by SFI's research approaches – type analysis such as social network analysis, epidemiological models, and microfoundations of human social behavior, for example.

"Patterns of violence and participation in insurgency and counterinsurgency are very complex phenomena," she says. "In conflict we observe diffusion, tipping points, proximity effects, path dependency, and complex causal pathways." ■

Counterinsurgency panel discussion
Thursday, March 20,
7:30 p.m., SFI



Vote counting in El Salvador (Image: Mark Carrato, USAID)

> History and science continued from page 1

"A good historian compresses the past into a minimum number of causal variables, and the influence of time scales and individuals is largely a function of the degree of coarse graining you select. But this selection is subjective. We have no non-human way of determining the appropriate level of coarse graining for history."

Many historians reject the notion that history can be quantified, David says. But he questions why some history-related fields have made the transformation into the sciences – fields like cosmology, paleontology, and archaeology – while scholarly history remains firmly rooted in the humanities.

"Historians have always been interested in intersections and recurrences of events. Counterfactual histories begin to



An anti-Communist North Korean just released from a POW camp shouts for joy (1953-1954). (Image: U.S. National Archives)

broaden probabilities and statistics," he says. "But historians generally have not sought rules and regularities."

"Will history books become more like math books?" he asks. "I have a suspicion there will be some of that."

David and a small group of researchers began thinking about a common language of science and history at a 2005 meeting at SFI organized by David and John Gaddis (Yale University), author of *The Landscape of History*.

The March meeting, co-organized by Gaddis and Ken Pomeranz (UC Irvine), touches on big history, the theory of conflict, and economic and ecological history. ■

SFI IN THE NEWS

The February *Harvard Business Review's* annual snapshot of emerging business ideas, "Breakthrough Ideas for 2008," includes an article by SFI Trustee and Science Steering Committee Member Michael Mauboussin (Legg Mason Capital Management, Inc.) titled "What good are experts?" "As computing power grows and networks unleash the wisdom of crowds, the unique value of experts in making predictions and solving problems is steadily narrowing." Computers now routinely solve complex, rules-based problems, such as credit scoring, that once were the domain of experts. Likewise, the collective wisdom of people often proves to be better than experts at addressing probabilistic problems, such as predicting stock market behavior. Still, Mauboussin says, recent research suggests "there is a sweet spot where

experts still have a unique edge...For now, individual experts or small expert teams within companies still have an edge in the realm of rules-based, high-freedom problems such as innovation, strategy development, and troubleshooting." <http://harvardbusinessonline.hbsp.harvard.edu>

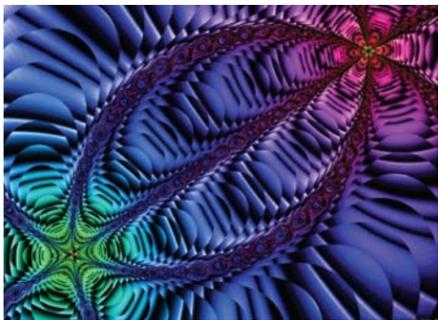
The Feb. 14 issue of *U.S. News & World Report* published a Q&A with Richard Florida, professor of business and creativity at the University of Toronto and author of the bestselling book *The Rise of the Creative Class*. In the interview, Florida argues that recent studies of population data strongly suggest that opportunity, innovation, and money increasingly coalesce in metropolitan areas. Later he mentions SFI: "Innovative people cluster together

When we do that we increase each other's productivity. A group of researchers at the Santa Fe Institute call it an 'urban metabolism.' As our cities grow they get faster and faster, better and better, more and more innovative. Some don't, and they die. That's why economic activity spikes, because of these conglomerations of energy and talent." www.usnews.com/articles/news/national/2008/02/14/qa-richard-florida.html

Voice of America online on Feb. 10 calls Cormac McCarthy, "one of the most important American writers alive today...When Cormac McCarthy is not writing, he likes to spend time at the Santa Fe Institute in New Mexico. This organization gathers researchers and scientists from around the world to work on important

issues such as economics, technology, and the environment. Cormac McCarthy says he has always been interested in the way things work. And, he says talking with researchers at the Institute helps him to think." **Audio available at** www.voanews.com/specialenglish/2008-02-10-voa2.cfm

"No Country for Old Men," the film adaptation of Cormac McCarthy's novel by that name, was named best picture at the 80th annual Academy Awards ceremony on February 24. The movie's creators, Joel and Ethan Coen, also won Oscars for directing and screenplay adaptation for the movie. Cormac was seated with the Coen brothers during the telecast.



"Transmission," fractal art by Sven Geier (<http://sgeier.net/>)

BUSINESS NETWORK NEWS

Theme week dwells on organizational dynamics

A small but engaged group of SFI Business Network members participated in a unique weeklong meeting Jan. 28-Feb. 1 at SFI. The program provided members more time to interact and discuss than is typically afforded in one-day Business Network meetings.

Executive Director for Development and Corporate Relations Shannon Larsen says the Business Network Theme Week is an added benefit for members that provides the opportunity to hear about scientific work from SFI researchers and spend more time exploring and discussing how the scientific topics relate to business.

The approach and the topic, "Organizational Dynamics," grew out of member

> [more on page 4](#)

RESEARCH NEWS

Disease prediction through mathematics

Sometimes the most effective weapon against disease might not be a drug or vaccine, but a bit of well-turned mathematics. A small working group met at SFI in late February with the goal of improving the mathematical models used to understand, manage, and prevent infectious disease epidemics.

The participants at the meeting, titled "From Network Structure to Epidemiological Prediction," sifted through data from eight independent epidemiological studies of HIV-AIDS in several human populations using various data-gathering methods.

Their aims in this initial meeting were to identify both the commonalities and differences among the data sets and infer the major factors behind the spread of infection through the study populations' diverse social networks.

The project was made possible by a grant from SFI Trustee Bill Sick and his wife Stephanie. The meeting was organized by SFI External Professor Lauren Meyers, an associate professor of integrative biology at the University of Texas at Austin.

In attendance were Richard Rothenberg, a preventive medicine physician at Georgia State University's Institute of Public Health, UC San Diego post-doctoral fellow Erik Volz, and private database consultant Stephen Muth.

The project team's next step, says

Lauren, will be to spend the next few months applying the insights they came up with toward generating better predictive models of disease-spread dynamics. By viewing diverse populations through the lens of network models, she says, we may discover more effective strategies for controlling outbreaks.

The group plans to meet one more time this summer to discuss how their results can be generalized to other populations and diseases and applied to real-world health practice. ■



Researchers studied several populations in which HIV-AIDS are prevalent. (Image: Zimbabwean orphans, USAID)

IMPACT

NSF atrium exhibit by SFI describes origins of life research

A new SFI-developed exhibit unveiled recently in the atrium of the NSF building in Arlington, VA, offers new theories about life's origin by researchers at SFI.

The exhibit, opened Feb. 13, addresses the kinds and origins of molecules that participated in the genesis of life and the pathways that led from pre-biotic inorganic chemistry and geochemistry to the biochemistry of life some 3.8 billion years ago.

It is based largely on research by SFI Science Board Chair Emeritus Harold Morowitz, SFI Professor Eric Smith,

and colleagues from five collaborating institutions. The researchers represent astronomy, geology, geochemistry, biochemistry, genetics, and other fields.

The exhibit – which includes video demonstrations and an interactive, computer-based "origin of life" experiment – was produced for SFI by media arts students at New Mexico Highlands University through a partnership with the New Mexico Department of Cultural Affairs.

For more information, www.nsf.gov/news/news_summ.jsp?cntn_id=111125. ■

RESEARCH NEWS

Traffic jammed? Close some roads to minimize commute snarls

Your commute may be 30 percent longer because of other people's selfishness. Ironically, having fewer roads might be part of the solution.



That's the upshot of recent work by SFI Postdoctoral Fellow Michael Gastner.

As part of his research, Michael imagined a world with a benevolent dictator who chooses everyone's routes to minimize the total commute time of the whole group. No longer would too many cars pile onto the same road, grinding traffic to a crawl. Instead, when a road was nearing its design capacity, the dictator would send some cars on alternate routes, spreading the traffic around to keep the cars moving quickly.

Michael modeled the major road networks in New York, Boston, and

London. He found that although his imagined benevolent dictator might lengthen commute times for a few cars, the approach could speed overall travel time by as much as 30 percent.

Technology might someday serve as a benevolent dictator, or at least as a benevolent advisor, he says. But that would require coordinating information about everyone's travel plans, an intimidating task. So Michael looked for an alternate solution.

Network theory shows that sometimes, networks function more efficiently with fewer connections. So he decided to see if that applied to actual road net-

works. Indeed, he found roads in each city whose use seemed to slow overall traffic patterns.

"It's strange, but sometimes you can close roads and improve everyone's travel times," he says. "Since we found it in all three cities, this is presumably a much more frequent phenomenon than is intuitively expected."

Michael presented the most recent work during SFI's "Physics of Society" workshop in January. ■

> **Theme week**
continued from page 3

suggestions at the annual meeting in November.

“The feedback we received very clearly was that our Business Network members don’t always want the researchers to change the level of what they’re presenting, and they want more time to drill down and discuss the ideas being presented.”

Nine Business Network members participated in the first Theme Week.

“This group asked for the pure science from the researchers,” she says. “It takes a sophisticated group to be able to listen and absorb the scientific talks

and translate for themselves what it means to their companies.”

SFI Postdoctoral Fellow Dan Hruschka kicked off the meeting with an overview of ideas to be presented during the week. University of Connecticut professor of evolutionary ecology and biology Peter Turchin reviewed several lessons on dynamic organizations from history.

In a talk titled “How Information and Energy Exchange Shape Organisms and Societies,” University of New Mexico assistant professor of computer science Melanie Moses applied thinking from biology and sociology to business dynamics.

SFI External Professor George Gumerman led an afternoon tour of Bandelier

National Monument and discussed social organization and cooperation in ancient Anasazi society.

SFI President and Distinguished Professor Geoffrey West presented SFI’s recent work in scaling laws and cities.

Several Network members presented as well. For a complete list of presenters and topics, see www.santafe.edu/events/workshops/index.php/Organizational_Dynamics_Theme_Week

Shannon says the event exceeded her expectations and the feedback from members was positive.

Said Philip Moyer, global security architect with Deloitte Touche Tohmatsu:

“The techniques and conclusions clearly applied to business issues. The opportunity to interact directly, for a relatively long period of time, with other business network members was a fabulous and productive opportunity...I’m looking forward to the next opportunity to visit, interact, and learn.”

Shannon says she hopes to continue the conversation through SFI’s online community, CASITA. A second Theme Week is being planned for September on visualization in complex networks. Representatives from Business Network member Innovation Labs, which specializes in facilitating group exploration of complex ideas, will lead breakout sessions to help take the conversations to the next level, she says. ■

IMPACT

Upcoming Institute public lecture focuses on genes in conflict

All too often people do dumb things. We vow to diet but eat cake. We watch TV instead of going for a run. We fall into addictions.

SFI Professor Jon Wilkins thinks he might know why: Our problem isn’t psychological, but biological. Our genes, encoded with information about whether they came from our father or our mother, are at war.

“The genes that you got from your mom are trying to get you to do different things from the genes that you got from your dad,” Jon says, “and the overall brain doesn’t function as well as it should as a result. Many human

frailties can be explained by this genetic arms race within us.”

Jon will present his work, titled “Devil or Angel: Genetic Conflicts in Brain and Behavior,” at an SFI Public Lecture on March 19 at 7:30 pm at the James A. Little Theater, New Mexico School for the Deaf.

His is among a series of SFI Public Lectures planned for the coming months. Others include:

■ April 14, former Soviet President and Nobel Prize winner Mikhail Gorbachev will present “Gorbachev on Leadership: From the End of the Cold

Devil or Angel, Wednesday, March 19, 7:30 p.m.
James A. Little Theater, New Mexico School for the Deaf
For more information, www.santafe.edu/events

War to the Growing Environmental Crisis,” Lencic Santa Fe’s Performing Arts Center, 6 p.m. (See story on page 1)

■ April 23, Seth Lloyd of the Massachusetts Institute of Technology will present “Programming the Universe” at 7:30 p.m. at the Armory for the Arts (1050 Old Santa Fe Trail). His talk will explore how the universe itself is a giant computer and the implications for quan-

tum physics, our understanding of free will, and the ultimate future of life itself.

■ May 14, Peter Norvig, Director of Research at Google, will present “Practice Makes Perfect: How Billions of Examples Lead to Better Models of Language, Pictures, and Other Things,” at 7:30 p.m. at the Armory for the Arts. He will describe how computers learn to do more tasks simply from looking at examples, without relying on programming. ■



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