SFI researchers receive grant for technological evolution study

The National Science Foundation has awarded SFI collaborators $380,000 over three years to study the evolution of technological performance. The project begins Jan. 1, 2008. SFI faculty member Doyne Farmer is principal investigator on the project. Co-PIs are SFI faculty members W. Brian Arthur, Doug Erwin, and Walter Powell and postdoctoral fellow Jessika Trancik. The grant is supported by NSF’s “Science of Science and Innovation Policy” program.

A better understanding of how technological progress can help society make better choices, says Doyne. The project will focus on innovations in the energy sector. The project’s primary outcome will be construction of an empirically based model of technological evolution that will examine new technologies in the context of an ecology of related technologies. Several large data sets will be analyzed.

The work will draw on previous literature regarding technological progress, the rate of performance improvement for technologies, and learning curves. Performance of an individual technology can be measured in a number of ways. Computers, for example, have tended to get faster and cheaper to produce over time. Such performance improvements typically, but not universally, follow a standard power law curve that spans industries and technology types. But history includes some notable exceptions, often attributed to outside factors or market dynamics.

Trancik has suggested that the rate of technological progress, for example, is influenced by the unit scale of the technology; radical innovations may occur more quickly on a small unit scale. The SFI project will examine progress in the context of a multitude of technologies in a market system, each at varying stages of maturity, performance, and investment – and seeks to understand how each technology’s progress is influenced by the others. “We want to know whether we can count on the performance curves for a given technology, and perhaps develop more reliable models,” he says.

Previous studies of renewable energy technology evolution by W. Brian Arthur have characterized an effect called “lock-in,” in which investment in a prior technology can blunt the acceptance of a new technology, even if the newcomer is superior. The interdisciplinary SFI project team includes economics, engineering, physics, biology, and sociology considerations. The approach will combine empirical data analysis, theoretical work, and simulation.

Doyne says the group hopes an improved model of technology evolution will be useful for making performance forecasts for individual technologies and for suggesting investment strategies for both public and private investors in the energy sector – in particular for low-carbon-emission energy technologies and strategies for mitigating climate change.

“The environment is a particularly pressing issue right now because we as a society are going to be making a massive investment in it in the coming decades,” Doyne says. Technological evolution also is the subject of SFI’s community lecture, “Technology Creating Technology,” by Brian Arthur, scheduled for Nov. 14.

A better understanding of how technology matures can help society make better choices.

DOYNE FARMER

Welcome to the new SFI Update
We have revised the Update to bring you deeper and richer information about the Institute and its people. We hope you enjoy the new format. Please send comments and suggestions to Ginger Richardson at gr@santafe.edu or John German at sfupdate@santafe.edu.

RESEARCH NEWS

SFI researchers receive grant for technological evolution study

The National Science Foundation has approved NSF’s five-year renewal of SFI’s integrative core grant, entitled “The Sciences of Complexity.” The award, $4,250,000 over five years, will provide partial support for SFI’s workshops and working groups, visitor and postdoc programs, and SFI’s complex systems summer schools, as well as indirect cost support for facilities and administrative costs.

“This grant is extremely important for SFI, not only for the needed research and education funds, but because it provides important external validation of SFI’s work by scientific peer review,” says Institute Vice President Chris Wood. He says the peer review process for the proposal was intense. In comparison to the usual single review panel and four to six written reviews typically received by center grants even with much larger budgets, this grant was reviewed by five different review panels and received 29 written reviews, reflecting its broad relevance to the domains of five different NSF directorates.

The proposal’s success was due to compelling scientific contributions from more than 40 SFI faculty members and their collaborators worldwide, he says. Another recently approved NSF grant, in support of work on technological innovation, is described at left.

ON & OFFS

For SFI’s schedule of workshops, lectures, and colloquia: http://www.santafe.edu/events/index.php

COMINGS & GOINGS

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

GRANT HIGHLIGHTS

NSF approves Institute’s ‘core grant’

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**Behavior Discussion Group explores range of human behaviors**

A series of informal discussions organized by SFI faculty member Sam Bowles addresses new research on human behaviors. The Behavior Discussion Group met two or three times a week during the summer, drawing 15 to 20 participants, says Sam.

*"The meetings are free-wheeling and range from papers almost ready for publication to the light bulb that went off in somebody's head last week," he says.*

Some highlights so far:

**Trust and cooperation**
Former SFI international fellow Juan-Camilo Cardenas (Universidad de Los Andes, Bogota) used games to gauge trust, cooperation, risk, and risk pooling in social groups in six Latin American cities. Cardenas found that social distance inhibited trust between participants.

**Valuing money**
SFI external faculty member Rob Axtell (Center for Social Complexity, George Mason University) described hyperbolic discounting—the seemingly irrational ways people value current money relative to future money—and commented on some of its societal consequences.

**Inferential cooperation among the poor**
Rohini Somanathan (University of Delhi) described women's economic self-help groups and small loan lenders in India. She presented data on group composition and attrition rates, education levels, and group social heterogeneity.

**The biology of economic risk-taking**
Anna Dreber (Harvard University Center for Evolutionary Dynamics) presented research on physiological and biological factors that appear to account for economic risk-taking, and suggested that individuals' economic preferences may be acquired in utero.

**Social segregation and racial inequality**
Rajiv Sethi (Columbia University) presented joint work with Sam Bowles and Glenn Loury (Brown University) exploring the conditions under which economic, educational, and other inequalities between groups can persist indefinitely even if the discriminatory practices that initially accounted for the group differences are removed.

**Games as culture**
Jenna Bednar and SFI faculty member Scott Page (both of the University of Michigan's political science department) found that game players adopt different strategies for some games when they played them in concert with other games. They asked whether these learned behaviors could be classified as culture.

**Collective delusions**
SFI postdoctoral fellow Charles Efferson discussed an experimental protocol he is crafting in which subjects might produce misinformation and promulgate mistaken beliefs in the face of counter-vailing evidence, without insertion of misinformation by confederates.

*The Behavior Discussion Group series will be coordinated by SFI postdoctoral fellow Dan Hruschka, and will continue throughout the year.*

**IMPACT**

*"They gave me great personal freedom to think out of the box while creating WikiScanner," he writes.*

This fall Virgil began at Caltech as a graduate student in Computation and Neural Systems. For more information: [http://virgil.jpl/](http://virgil.jpl/)
External faculty member Nina Fedoroff, newly appointed science and technology adviser to Secretary of State Condoleezza Rice, was interviewed in the Aug. 16 issue of Nature. “Some of her well-known opinions could cause friction,” the article said. Fedoroff, who is in favor of genetically modified crops and opposed to corn ethanol production, said: “People need to understand that if you grow maize for ethanol, you drive up the price of the maize. Now the World Food Programme can buy less and feed fewer people. Ethanol from maize is not going to solve the world’s energy problems, it is going to exacerbate them.” Work by Geoffrey West and SFI faculty members James Brown and Brian Enquist to quantify scaling laws in biology were featured on public radio’s Smart City (Aug. 2) and National Public Radio’s “Kneuwich on Science” (Aug. 18). Smart City says SFI is “producing important new insights on how cities grow, why they fade, and what we can do about it.” NPR’s Kneuwich says, “Though big and little creatures took very different, below the surface there is a surprising unity. Three scientists at the Santa Fe Institute…discovered that heartbeats vary in a precise mathematical way…Here is the heart of it: Nature goes easy on larger creatures so they don’t wear out too quickly.”

http://www.smartcityaudio.com/smartradio/lecture.cfm?artistID=955

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The Aug. 11 Times Online (U.K.) reviews Jeffrey Kluger’s book SIMPLE EXIST: The Simple Rules of a Complex World: “Simplicity is a travel through the science of complexity and simplicity, much of it based on work carried out at the Santa Fe Institute in New Mexico — a hotbed of blue sky thinking where scientists from across the disciplines swap ideas about physics, biology, computing, social sciences and much more…SFI spends a lot of time trying to model such systems mathematically.”

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**Project GUTS**

‘Growing Up Thinking Scientifically’ under way in Santa Fe schools

Middle schoolers interested in science, technology, engineering, and math are getting a special opportunity thanks to an SFI program offered through Santa Fe public schools.

Project GUTS – Growing Up Thinking Scientifically – is a summer and after-school educational program that encourages students to look at the world beyond their everyday levels of awareness, ask questions, and develop solutions through scientific inquiry. The program is free and open to any student entering the seventh or eighth grade who wants to engage in scientific inquiry by investigating topics of interest to their local communities – called place-based inquiry. Some 52 middle school students participated this summer, and five high school students participated as student mentors.

The program was conceived by SFI educator Irene Lee in the late ’90s after a stint as organizing manager for SFI’s Swarm Program and her participation in an Adventures in Modeling (AIM) workshop offered by SFI Science Board member Eric Klopfer of MIT. Like AIM, Project GUTS includes a focus on modeling and simulation of complex systems using the computer modeling program StarLogo.

“I was struck by the intuitiveness of programming in StarLogo and found my niche working with middle and high school teachers and their students,” Irene says.

Project GUTS partners with the Super- computing Challenge, which is aimed at high school students, and, Irene says, “We encourage our middle school students to continue on to the Challenge once they reach high school.”

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**Inside SFI**

**People**

Nina Fedoroff receives National Medal of Science, takes State Department post

SFI faculty member Nina Fedoroff in July was selected to be Secretary of State Condoleezza Rice’s new science and technology adviser.

Less than two weeks before the announcement of her appointment, Nina was at the White House to receive a 2006 National Medal of Science from President Bush. She is the third person to hold the State Department position, created in 2000 to serve as the department’s chief scientist and principal liaison with the national and international scientific and engineering communities.

Her duties also include enhancing the department’s science and technology literacy, increasing the number of scientists and engineers working in Washington and missions abroad, and providing advice on current and emerging science and technology issues as they affect foreign policy.

Nina, a leading geneticist and molecular biologist, is the Willaman Professor of Life Sciences and Evan Pugh Professor in the Biology Department and the Huck Institutes of the Life Sciences at Pennsylvania State University.

She is a member of SFI’s science steering committee.

CREDITS

Editorial Staff
John German
Ginger Richardson
Della Ulibarri

Contributors
Jenna Beck
Howard Kercheval

Design and Production
Pivot Design, Inc.

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