SANTA FE INSTITUTE

September / October 2015

UPDATE

Actress Caitlin McShea and SFI President David Krakauer read from Cormac McCarthy's *The Passenger* during an August 5 Lannan Foundation event in Santa Fe. (Credit: Don Usner)

New Pres David Krakauer balances science, art, and chaos

David Krakauer's first month as SFI's president featured a number of high profile appearances in Santa Fe, along with a declared commitment to scientific risk taking.

"Risk is difficult to define, but clearly taking a risk has something to do with an elevated probability of failure," he says in an online video greeting to SFI's community. "For us, risk means exploring untested ideas, and entering into research territories that haven't yet been explored – with all the implications of exploration in unexplored territories." Watch his six-minute video greeting at http://goo.gl/HILxt9.

Rejecting the institutional proclivity for laborious, antiseptic mission statements, he is developing a new and concise statement of SFI's purpose in ongoing discussions with SFI's faculty, staff, and trustees. "SFI is a rather unique research institute whose mission is to try to understand order in an evolving, chaotic world," he says. "To do that, you have to bring together an extraordinarily diverse array of researchers, with complementary ideas and skills and tools. It's the only way to approach some of the most difficult problems our society faces today."

The new statement's exact wording is still in flux – and it will likely change again – but it currently reads: "Searching for order in the complexity of evolving worlds."

As his first public appearance as president, Krakauer MC'ed a special Lannan Foundation art-meets-science event at Santa Fe's Lensic Theater the evening of August 5.

The event featured a conversation between Krakauer and visual artist James Drake, with Drake's drawings projected on a large screen behind them. Their conversation was interspersed with passages from Cormac McCarthy's new novel *The Passenger*, read by Krakauer and actress Caitlin McShea playing the parts of two of the novel's characters. All was accompanied by an original score composed by Cormac McCarthy's 17-year-old son John Francis McCarthy.

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RESEARCH NEWS

Piecing the puzzle of self assembly

Suppose you buy a jigsaw puzzle, take it home, and shake it for a long time. You wouldn't expect the puzzle to assemble itself, yet that's exactly what proteins and other self-assembling biological materials do all the time.

Amino acids in the body assemble themselves into proteins, and capsids, the protective shells surrounding viruses, build themselves out of proteins.

"Biology is full of examples of this kind of thing," says SFI Omidyar Fellow Yoav Kallus, who is co-organizing an SFI workshop on so-called kinetic networks, the myriad, intersecting pathways a system could take to go from raw materials to finished product.

At the meeting, scientists from several fields will seek to better understand how self-assembling materials do what they do.

The main challenge, Kallus explains, is complexity. A virus capsid might have 60 subunits. If you imagine all the ways you could build the same Lego house out of the same 60 bricks, you'll get a sense of the problem's scale – and why traditional approaches to studying kinetic networks won't help.

A major goal of the workshop is simply to share ideas on how to confront that complexity,

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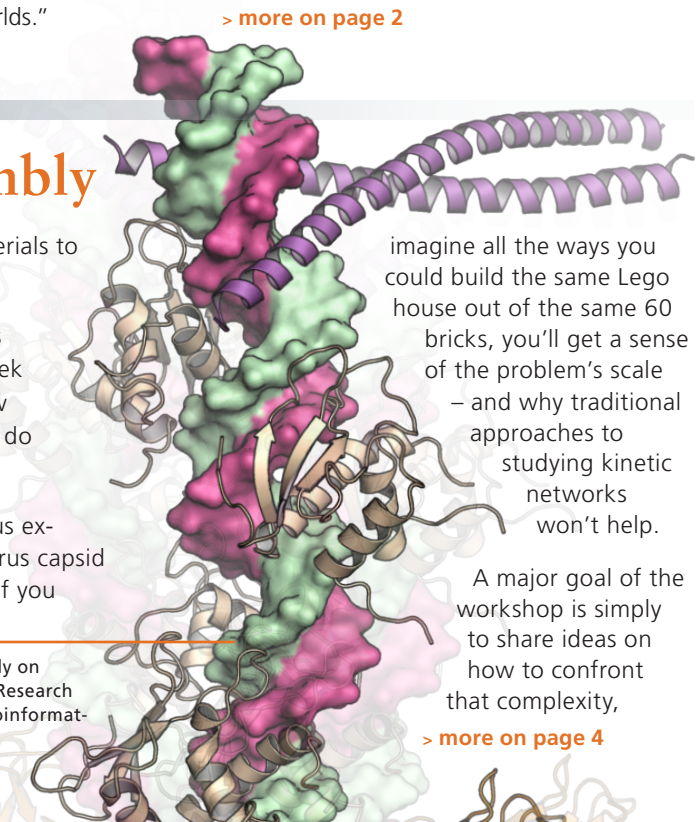


Enhanceosome protein assembly on double-stranded DNA (Image: Research Collaboratory for Structural Bioinformatics Protein Data Bank)

IN THIS ISSUE

RESEARCH NEWS

Innovation as search on a landscape of possibles

Innovation (here defined as a lasting novelty or invention) might be understood as a search process in a space of combinatorial possibilities. This month at SFI, a hand-picked group of engineers, biologists, economists, and innovation experts will explore how to transform this notion into formal – even predictive – models.

The mid-October working group is sponsored by the Arizona State University-SFI Center for Biosocial Complex Systems and is funded by the National Science Foundation.

It builds on an SFI workshop last fall that explored the drivers of invention and the challenges of building a theory of innovation, including how to identify and measure novelty.

"With universal problems, such as innovation, we need a broad interdisciplinary discussion to grasp the fundamental nature of the problem so that we can (hopefully) arrive at deep theoretical insights," says SFI External Professor Manfred Laubichler, who is co-organizing the meeting with SFI collaborator Jose Lobo. "And we need those [insights] to have real-world impacts."

A few participants have taken steps, using data on patented inventions or cell metabolic pathways to build empirical search spaces. The hope is that a general framework for innovation might arise from similarities the participants and others observe in their separate search spaces.

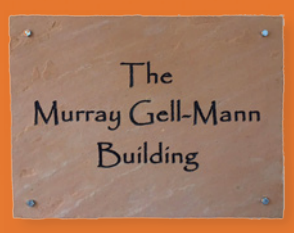
Lobo points to Darwin's Theory of Evolution as a potential framework. If we can begin to build a similarly general Theory of Innovation, he says, "it will help us explain how things emerge and thrive."

Some think the very nature of innovation obviates prediction. Still, certain features of companies and societies make them more inventive and innovative than others, Lobo says. Whether such a theory is possible will be much discussed, but "all agree, in the absence of a good theory, we won't be able to make predictions," he says. ■

Nonlinearities

From the editor

Two new engraved-stone signs greet visitors to SFI. To the left of the entryway to our main building is a recognition of the Institute's most accomplished scientist, Murray Gell-Mann. Several of Murray's friends and colleagues spoke during an August 10 building dedication ceremony. At its conclusion, the 86-year-old honoree made a few brief remarks, which he read deadpan and with impeccable comedic timing, to the delight of the 100 or so people in attendance. I can't do it justice, so please watch the six-minute highlights video at http://bit.ly/1LOYbNG.



The second engraving, to the right of the doorway, is an anonymous gift– it's an inscription that (reportedly) greeted students at an entrance to Plato's Academy. If you read Greek – like a surprising number of SFI passersby – or you are a student of the classics, you need no translation. If you don't read Greek, it translates roughly to: "Let None But Geometers Enter Here." As several freakishly well-read SFIers have pointed out, however, its original intent was probably more inclusive. Its modern analog might be "Mathematics Spoken Here." Indeed.

August was punctuated by bittersweet remembrances of two of the giants on whose shoulders we stand. On August 9 we learned of the passing of John Holland, perhaps the seminal figure in mathematically conceptualizing genetic algorithms – ideas that led to methods in optimization, search, and evolutionary computation. His career and passions followed a trajectory that more or less paralleled this idea: "The proper role of computer science is the study of computation writ large across all of nature."

Two weeks later, on August 24, we lost Joseph Traub, whose algorithmic thinking immeasurably influenced the field of computer science during its formative period, and who played the leading role in developing the field of computational complexity.

I can't adequately summarize either man's contributions here, but both were integral members of our community since the beginning, and both were known for their passionate, playful intellects. Our website includes eulogies to both, along with memories submitted by dozens of their friends and colleagues. I leave you with this poem written by Holland protégé Chris Langton:

John the Father

John Holland's gone
And we have lost
Another one
Of those who crossed
This with that
And moved the world.

But do not dwell
too long in grief!
Let me tell you
My belief:
Though he himself has crossed the portal,
John Holland's schema are immortal!

– John German, jdg@santafe.edu

SFI IN THE NEWS

SFI's Sam Bowles commented in an August 17 *New Scientist* article on the evolutionary implications of recently found evidence for Stone Age mass torture.

An August 15 *Newsweek* article covered the recent Lannan Foundation-SFI art-meets-science event featuring artist James Drake, author Cormac McCarthy, composer John Francis McCarthy, and SFI President David Krakauer.

Yahoo! Finance on August 13 drew from SFI research on company mortality to consider Google's recent corporate restructure.

SFI External Professor Dan Rockmore and President David Krakauer moved beyond the Turing test in a provocative essay in the August 10 *Chronicle of Higher Education*.

WIRED featured SFI External Professor Raissa D'Souza's work on explosive network phenomena on August 1.

A new economic synthesis was foretold in a July 21 *New Scientist* feature that quoted and described the work of a number of SFI faculty and collaborators.

CERN's experimental observation of "pentaquark" particles reinforced SFI Distinguished Fellow Murray Gell-Mann's theory of matter, noted *Time, BBC News*, and dozens of other national and international publications in mid July.

On June 30, *The New York Times, MSN*, and other publications covered research by SFI Omidyar Fellows Ben Althouse and Sam Scarpino suggesting that vaccinated persons without symptoms of whooping cough are likely major contributors to the world pertussis epidemic.

Slate on June 18 and *New Scientist* on July 3 featured a study on the "random walk" of professional sports scoring by SFI External Professor Aaron Clauset and SFI Professor Sid Redner. ■

RESEARCH NEWS

Does social isolation foil or fuel epidemics?

Conventional wisdom holds that the more people keep to their own social groups, the less likely a small disease outbreak will turn into an epidemic. In a recent paper in *PNAS*, however, SFI researchers Laurent Hébert-Dufresne and Ben Althouse show that this long-held tenet of public health might just be wrong, and the consequences could reach far beyond epidemiology.

At the heart of the new study are two effects that have received a lot of attention in recent years – social clustering and co-infection, in which one disease can change the infection dynamics of another. But the two effects hadn't been studied together, and that, the researchers say, turns out to be a major oversight.

"We thought we understood how clustering works," says Hébert-Dufresne, "but it behaves exactly opposite of what we thought once interactions are added in. Our intuition was totally wrong."

Ordinarily clustering limits outbreaks. Kids in one preschool get each other sick, for example, but those kids don't see kids from other preschools as often, so they tend not to spread the disease very far. Co-infection often works the other way. Once someone is sick with, say, pneumonia, they're more likely to come down with the flu, lowering the bar for an epidemic of both diseases.

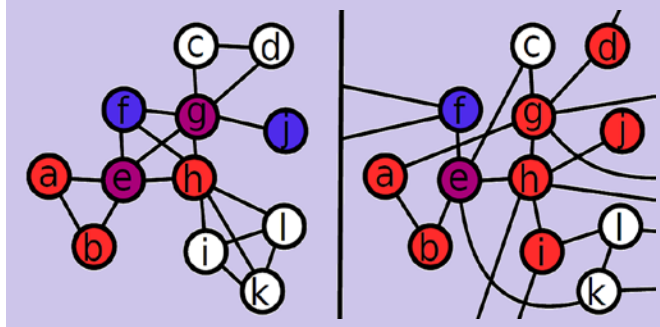
But put the effects together, the pair says, and you get something that is more – and different – than the sum of its parts.

To arrive at their results, the pair modeled social contacts as a set of overlaying groups, showing that groups can act as traps for epidemic outbreaks *and* as incubators for co-infections. By calculating the tradeoff between both effects, they found that the interactions between diseases like pneumonia and the flu help keep each other going within a social group long enough that one of them is more likely to break out into other social clusters. That outbreak then becomes a foothold for the other, and both diseases "can catch fire," Alhouse says.

The end result is a larger, more rapidly developing epidemic.

The consequences for public health are obvious. But the insights hold equally important consequences for complex systems researchers, who often think in epidemiological terms. Two ideas, for example, might interact so that both spread more rapidly than they would on their own.

"We hope to take this work in new and different directions in epidemiology, social science, and networks research," Althouse says. "There's great potential." ■



Researchers assigned individuals to multiple social groups (left) and used a randomized network for comparison (right). Red and blue nodes represent those infected with a single disease, and purple nodes are co-infected individuals. (Image: Hébert-Dufresne, Althouse)

RESEARCH NEWS

Recognizing the guises of wildness

For most people the word "wild" invokes an untamed wilderness or perhaps a feral animal. In mathematics and computational complexity, the term refers to a specific, thorny phenomenon that arises in problems related to classification – such as classifying matrices, differential equations, or types of symmetry.

Such problems don't have a straightforward solution, if they have any solution at all, so wildness is sometimes regarded as the frontier at best, or as the end of the road at worst.

The phenomenon has traditionally been confined to geometry and representation theory, but it appears in other areas, too, including physics and computer science. A better understanding of wildness in its many guises might help push these fields forward.

That's why SFI Omidyar Fellow Josh Grochow, SFI Professor Cris Moore, Vlatko Vedral (Oxford and the National University of Singapore), and Jerzy Weyman (University of Connecticut) have organized a workshop, Wildness in Computer Science, Physics, and Mathematics. They're inviting researchers to share wild problems from their own fields, hoping an interdisciplinary conversation will spur new ideas and avenues of investigation.

Quantum entanglement offers an example: Entangled particles, connected at the quantum level, cannot be described independently, so classifying the patterns in which particles can be entangled is a wild problem. Understanding those patterns might inspire advances in quantum computing and encryption.

Grochow organized the workshop after wildness showed up repeatedly in his research at the intersection of computer science and mathematics. "All these problems I was thinking about, in geometric complexity theory and in a few problems in computer science, had this one hard nugget of wildness," he says. "The fact that we don't understand wildness is a barrier standing in the way of progress in all these areas." ■

> *Krakauer's first month* continued from page 1

Krakauer says he joined these elements because he saw an "unbelievable resemblance" between Drake's drawings and McCarthy's themes – such as madness, genius, and mathematical truth.

In part because the event was the first public glimpse of McCarthy's yet-unpublished novel, it inspired international media coverage; *Newsweek's* Jack Martinez wrote that the presentation "was not your average coffee shop book reading…A reading like this could only have taken place at the Santa Fe Institute."

"It was an experiment, and I don't know if it succeeded or failed, but we did it," Krakauer said after the event.

Days later, on August 10, Krakauer was the lead-off speaker during a ceremony at SFI to dedicate and rename the Institute's main building the "Murray Gell-Mann Building."

"It means a great deal to me to be two weeks on the job, and to be essentially commemorating the contributions of someone I've gotten to know who is not only one of the greatest physicists or our time, but also one of the greatest minds of our time," he said.

Half a dozen friends and colleagues of Gell-Mann – a Nobel laureate and one of SFI's founders – also spoke at the event. Watch video highlights of the event at bit.ly/1LOYbNG.

Interviews with the local press geneated a month-long media buzz in August. Following an

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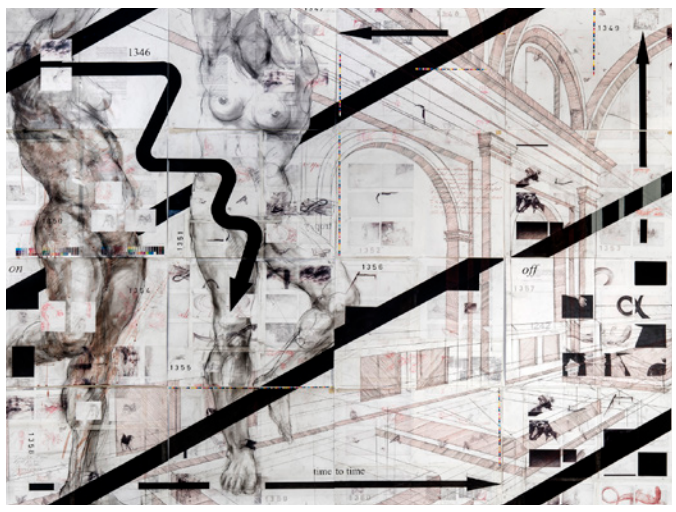

James Drake's "Time to Time" (charcoal, pencil, and ink) juxtaposes anatomy, architecture, and mathematics. (Courtesy: James Drake)

RESEARCH NEWS

Working group: Are the secrets to life to be found in info theory?

We are immersed in life here on Earth, but life isn't found on the Moon. Nor has it arisen, so far as we know, anywhere else in the solar system. Why do some physical environments precipitate life, and why don't others?

SFI researchers hope to find clues during a working group at SFI this month.

On some level, it's obvious why nothing lives on the Moon: It's a cold, waterless place without much of an atmosphere. A deeper answer is that our biosphere manages to take in energy from sunlight and use it to build and maintain life.

But that answer leads to a still deeper question, according to the meeting's organizers, SFI Professor David Wolpert and Omidyar Fellow alum James O'Dwyer: If the Earth really does use sunlight to convert a disorderly lump of mass and energy into organized living things, why can't the Moon, Earth's nearest neighbor, do something similar using different mechanisms?

The answer, Wolpert says, might lie in information theory. In addition to being central to modern biologists' understanding of evolution, information theory overlaps heavily with thermodynamics, the area of physics concerned with how the different kinds of internal energy of a system (such as heat and stored chemical energy) might be affected by the outside world. This suggests information theory might provide "a common language we could use to gain traction and find the conditions for life," Wolpert says.

An important question is which biological mechanisms are inevitable and which aren't, O'Dwyer says. "We have hints from ecological patterns that not everything is possible," he says, and understanding what is and isn't possible will help scientists develop a viable, information-inspired theory of life.

The pair doesn't expect to find the answers right away. "Science as a whole is, in a sense, growing into this problem," Wolpert says, just now finding the right language, honing its questions, and pushing toward an answer to one of its greatest remaining puzzles – the origins and very nature of life. ■

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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*.

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PEOPLE

Caterina De Bacco

The physics of optimizing networks

When Caterina De Bacco joins SFI this fall as a postdoctoral fellow, she'll be bringing the perspective of a statistical physicist to a critical challenge: ensuring that the networks we depend on are working as efficiently as possible.

De Bacco, who earned her PhD from the Université Paris Sud, has applied her field of study to understanding complex networks and optimizing traffic on communication networks. She's keenly aware that there is still much for both computer scientists and physicists to do in solving important network issues.

"The work we have done on the edge-disjoint path problem has revealed better results than other state-of-the-art algorithms on benchmarks proposed by computer scientists," notes De Bacco. "This positive result motivates me to pursue this line of research, especially considering the fact that statistical physics has started only recently to study these problems, [leaving] many questions still open for answers."

At the Institute, she will be working with SFI Professor Cris Moore to explore inference problems, such as determining the origin of an epidemic given the state (or subset of the state). ■

ACHIEVEMENTS

James O'Dwyer

SFI Omidyar Fellow alum James O'Dwyer has been selected by the Simons Foundation as a 2015 Simons Investigator for his innovative work bringing new ideas from statistical physics to bear on the analysis of ecological problems.

Scott Ortman

SFI Omidyar Fellow alums Scott Ortman and James O'Dwyer and SFI External Professor Van Savage have been awarded three separate 2015 Scholar Awards from the James S. McDonnell Foundation, all in the Complex Systems category. ■

> ***Krakauer's first month*** **continued from page 2**

August 19 freeform lunch discussion at SFI with more than a dozen reporters, Roger Snodgrass of the *Los Alamos Daily News* wrote that Krakauer possesses "a playful otter-like intellect and restless energy" and is "already maneuvering to shake things up."

The *Albuquerque Journal's* Jackie Jadrnak quipped: "What can we expect from a guy who says stupidity is the world's number one problem?...He's looking to spread the scientific gospel of reason and evidence to the general public, and [he] has come up with some proposals for how the Santa Fe Institute might do that."

Among the proposals Krakauer announced are an alternative to the university model he terms "the multiversity" – essentially SFI would partner with half a dozen top universities to handpick four or five outstanding graduate students from each school per year. SFI faculty would collaborate with and mentor them, and bring them to SFI for a series of multidisciplinary summer schools. Ultimately the students would earn certificates in complexity from SFI that complement their degrees.

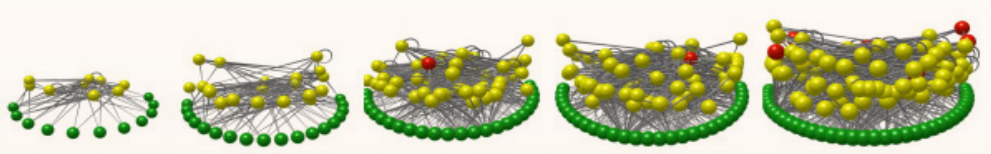
Krakauer also announced his intent to sponsor two major annual prizes in complexity – one for making a significant contribution to advancing the field of complex systems, the other for having a significant impact in applying complex systems science to a tangible, real-world problem.

He also wants to sponsor a festival in Santa Fe that brings together creative thinkers around a multidisciplinary theme, perhaps interplanetary travel and how one would accomplish it – "all the aspects of what it would take to sustain human life in an enclosed environment," he says. "The interplanetary aspect is a conceit. It's really just code for complexity."

"We have a fixation on single variables," said Krakauer, explaining that people, especially policy makers, need to broaden their thinking to consider all the factors that can simultaneously interact in creating or solving the issues we face. "I want rationality to diffuse into the world." ■

Krakauer spoke during an August 10 ceremony at SFI during which the Institute's main building was named after SFI Distinguished Fellow Murray Gell-Mann.

RESEARCH NEWS BRIEFS



Diagrams of example food web networks from each of the five spatial scales studied (quadrant, transect, site, locale, and archipelago, from left to right). Spheres represent taxa and lines between them represent directional feeding links. (Image: Dunne et al.)

How our understanding of food web structure changes with spatial scale

In an August 18 paper in the journal *Ecology and Evolution*, SFI VP for Science Jennifer Dunne and colleagues ask whether our understanding of how food webs are organized changes with the spatial dimension at which we observe them. The researchers analyzed network properties of intertidal food webs at five spatial scales, from .25 square meters to the entire Sanak Archipelago in the Aleutian Islands of Alaska. Their analysis reveals that many network properties are as expected at different scales given the increased numbers of species and links that are sampled in larger areas.

2014 SFI meeting central to national creativity report

A new report from the National Endowment for the Arts (NEA) provides perspective on current and future avenues for creativity research, basing its findings on an SFI working group held in July 2014. Among its conclusions: Creativity research requires more partnerships among neurobiologists, artists, psychologists, and educators; the field needs neuroscientific validation of existing tools to assess creativity in individuals; and brain research is a young field, which makes this the perfect time to invest in creativity research. SFI VP for Science Jennifer Dunne co-organized the working group with Bill O'Brien and Sunil Iyengar of the NEA.

Coarse-grained evolutionary trees reveal patterns of microbial diversification

In what is likely the first study to use both coarse-graining from physics and Λ-coalescents from mathematical modeling, SFI Omidyar Fellow alum James O'Dwyer and his collaborators sort sequence data into a new kind of microbial family tree that reveals distinct evolutionary patterns – sudden bursts of diversification that might shed light on the evolutionary dynamics of harmful microbe species and on general evolutionary processes. Their results were published July 7 in *PNAS*. ■

BUSINESS NETWORK NEWS

U.K. topical meeting considers the ecology of the investment industry

In an age of increasing worldwide financial interdependencies and consequent systemic risk, the time is probably right for questioning the structure, incentives, and constraints of the investment industry and how its components interact as part of the system.

During a recent topical meeting in London, Reinventing the Investment Industry, SFI Business Network members considered the ecology of the asset management industry.

"The investment industry is similar to other large social, political, and economic systems," says SFI VP Chris Wood. "It has developed and evolved organically over time with very few top-down controls and without a clear, generally agreed-on end state."

Co-organized and hosted by the global professional services firm Towers Watson, the September 1 meeting brought leaders of the financial industry, public officials, and other business experts together with complex systems scientists.

Ecology, and specifically ecological networks, turns out to be an apt analog for the investment industry – a network of constituents, including end savers, asset owners, investment managers, service providers, governments, and regulators, each with its own set of goals, incentives, regulations, and constraints that need not be aligned with those of the other constituents.

A key issue is the health of the system from the perspective of end savers, investors, and pension holders. These questions led Wood to invite co-organizer Tim Hodgson to summarize recent efforts by Towers Watson's Thinking Ahead Institute during last year's SFI Symposium on economics from a complex systems perspective.

Wood says the meeting, like all Business Network gatherings, reflected the intersection of SFI's and the Network members' expertise and interests. ■

MY STORY

People of SFI

Beth Kiyosaki
Hospitality Assistant
Santa Fe Institute

I coordinate the Institute's afternoon tea, which provides a chance for faculty, staff, and visitors to catch up and sometimes converse about big questions. Last year, some or our visiting fellows were talking about mapping poor neighborhoods in sprawling metropolitan areas like Johannesburg to provide better infrastructure for its inhabitants. I was raised on the Hawaiian Islands, and I wonder and worry about the feasibility of sustaining a teeming population on such a tiny footprint. My ongoing "knotty koan" is this: As we learn more about the cold, vast universe, how likely is it that we will sustain excellence in the quality of our lives on Earth, and what are the chances of finding a replacement planet as we hurtle towards overpopulation of this one?

DONOR PROFILE

Compounding his interest in SFI

From the moment Elliot Turner attended his first SFI event, a 2012 Business Network meeting called Risk: The Human Factor, he knew he'd found his intellectual home.

"It was one of the most thoughtful, engaging events I've ever gone to," says Turner, Managing Director at RGA Investment Advisors. "I ended up mulling over everything I'd learned for the next couple of weeks, and from then on, I was hooked."

Since then, Turner has attended the Business Network's conference annually, participated in a number of SFI breakfasts, and completed SFI's online Introduction to Complexity course. He says the Institute's multidisciplinary approach has transformed the way he approaches investing, and it plays a prominent role in his influential "Compounding My Interests" blog.

"My work is at the intersection of humanities and math, and I think it's more important to use the numbers to weave a narrative, as opposed to using a narrative to weave the numbers," Turner says. "I can now approach my work in a much more scientific way than a typical humanities thinker would."

An investment advisor, Turner offers insights to anyone considering contributing to SFI. "On multiple levels, an investment in SFI contributes to great returns," he says. "The more you expose yourself to big ideas and people who are smarter than yourself, the better you'll ultimately become. It's a two-fold investment in terms of improving society and improving yourself, and I think there's a positive feedback loop between the two." ■

INSIDE SFI

Charity Navigator awards SFI top rating

SFI has earned the highest possible rating from the independent charity evaluator Charity Navigator, recognizing the Institute's governance, fiscal management, and commitment to accountability and transparency.

The ratings "certify that SFI manages its operations and addresses its mission in the most responsible and transparent manner in an increasingly complex fiscal environment," says SFI VP for Advancement Nancy Deutsch. "This attests to existing donors and prospective supporters that we are worthy of their investment in us. We are very proud of this recognition."

Half of the metrics in Charity Navigator's ratings methodology focus on governance, ethical practices, and openness. These "Accountability & Transparency" metrics reveal which charities adhere to best practices that minimize the chance of unethical activities and whether a charity freely shares basic information about its organization with donors and other stakeholders.

Tim Gamory, COO of Charity Navigator, says just one in four nonprofits evaluated by Charity Navigator earns its four-star rating.

SFI also meets the highest standard for transparency and accountability for the charity evaluator GuideStar. ■

> *Self assembly* continued from page 1

Kallus says. "Researchers who have been studying kinetic networks of particular systems have reached a lot of insights and developed a lot of techniques that could be useful to researchers looking at kinetic networks in other fields," he says.

Participants also will discuss heuristics and computational methods for designing unusual materials and machines, such as DNA-reaction-based computers.

"The dream application," Kallus says, "is to be able to fabricate designer materials with tailored properties using the right mix of building blocks." ■

EDUCATION NEWS

NSF-funded program to prep teachers

This summer SFI's Learning Lab was awarded a nearly $3 million National Science Foundation grant to develop and study a new professional development program for U.S. middle school teachers.

Science education is under increasing pressure to stay current with modern scientific practices. As a result, states are adopting the new Next Generation Science Standards, which require science teachers to incorporate computational thinking, modeling, and simulation into their curricula. Many teachers, however, are not yet prepared to provide this education, says Irene Lee, Director of SFI's Learning Lab.

The NSF award funds a new program, Teachers with GUTS, that builds on a long history of SFI work by Lee and others to promote computational thinking by students and teachers, and in classrooms. (GUTS stands for Growing Up Thinking Scientifically, a reference to SFI's longstanding Project GUTS program for middle school students.)

The award is the largest grant the Learning Lab has received. It provides a significant opportunity for research and iterative development over the next four years to meet the need for professional development in computer science, says Lee.

Teachers with GUTS focuses on identifying the best ways to reach different teachers, whether through online learning communities or in-person professional development.

"We see in the next five years a huge increase in the number of teachers who will be asking for this kind of preparation," says Lee. "At the end, we'll hopefully know the best preparation for them and how we can leverage an online professional development network to expand learning opportunities for science teachers." ■

Upcoming community events

SFI Community Lecture, Wednesday, October 14, 7:30 p.m., James A. Little Theater (1060 Cerrillos Road) – Questioning the Science of Gender Difference. For decades, science has told us that biology defines gender differences. But what if scientists – and popular culture – have got it wrong? Cordelia Fine probes the literature, from studies in prestigious scientific journals to the latest assertions of "Mars and Venus" author John Gray, to challenge assertions that attribute gender-based differences to hardwired biology. Exploring how cultural beliefs about the sexes subtly influence the way research is done, interpreted, and presented, Fine provides a fresh perspective on gender and on society's long-held, and possibly mistaken, beliefs.

Cordelia Fine is an academic psychologist and writer whose most recent book, *Delusions of Gender: The Real Science Behind Sex Differences*, was named a Book of the Year by *The Guardian* and *The Washington Post*. Fine is an ARC Future Fellow in Psychological Sciences and an associate professor at the Melbourne Business School at the University of Melbourne.

SFI's 2015 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 @SFIlive or #genderdelusions.

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UPDATE
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