

enough to make your big breakthrough, and you'll find you're too old to do so.

SCIENCE & TECHNOLOGY

## The Math Beneath

**THE SOURCE:** "On Early Warning Signs" by George Sugihara, in *Seed Magazine*, Dec. 20, 2010.

ON THE SURFACE, IT DOESN'T seem that financial modeling has much in common with climate science, ecology, or neuroscience. But in fact these fields are grappling with similar mathematical problems: how to map nonlinear, deeply interconnected systems and anticipate systemwide collapse, notes George Sugihara, a theoretical biologist at the Scripps Institution of Oceanography in San Diego.

For financial modelers, the challenge is to predict crashes. An investment banker looking at one portfolio will not be able to see the systemic factors that could lead to a meltdown. Likewise, a marine scientist trying to protect a species of fish will not be able to account for all of the variables in the system that affect the survival of that particular fish without looking beyond that one species. In the field of climate science, linear models cannot predict what we know historically to be true: that climate change can be rapid and extreme. The existing models are all very good for painting a picture of a complex system at a specific point in time, but they do not have the ability to explain "jumps in variability," or

what mathematicians call heteroscedasticity.

Complexity theorists—the mathematicians who explore these sorts of systems—are beginning to pinpoint some early warning signs of systemic collapse. One is that as systems get closer to meltdown, they become slower to respond to external stimuli. Another is that pulses occurring in neighboring parts of the web become synchronized. For example, nearby brain cells fire in unison in the lead-up to an epileptic seizure.

A similar pattern emerged before the recent financial crash. Over time, financial institutions' investment holdings became more alike (the perverse result of each institution independently pursuing extreme diversification) and began to respond to changes in the market nearly simultaneously. When large financial institutions such as Lehman Brothers fell apart, the fallout was not unlike what happens in an ecosystem in which many animals rely for sustenance on one large animal species that suddenly dies out.

Heed Einstein, Sugihara advises: "Everything should be made as simple as possible, but not simpler."

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## The Revolution That Wasn't

**THE SOURCE:** "Refuting a Myth About Human Origins" by John J. Shea, in *American Scientist*, March–April 2011.

JOHN J. SHEA IS AN ARCHAEOLOGIST. He is also a flintknapper, or someone who makes stone tools. While on a dig at a 195,000-year-old

site in the Lower Omo River Valley Kibish Formation in Ethiopia, he was given pause by the stone tools our supposedly "primitive" human ancestors had left behind. Nothing about the tools seemed archaic or primitive in the least; they were made by hands that skillfully manipulated a range of rock types, and were not all that different from what a flintknapper could make today. What separates these "primitive" flintknappers from "modern" humans?

Maybe not much, says Shea, a professor at Stony Brook University. Archaeologists have for too long per-

An archaeologist says it is time to discard the notion of distinct primitive and modern periods.

petuated the idea that there are distinct primitive and modern periods, with a revolution occurring between the Middle and Upper Paleolithic periods (roughly 40,000 years ago). In fact, fossil evidence challenging that view has been around for decades.

From the 1970s onward, archaeologists based their idea of the Paleolithic revolution on artifacts from Europe, where they had found fossils of *Homo sapiens* with Upper Paleolithic tools dating back 35,000 years, and *Homo neanderthalensis* and other protohumans with earlier tools. But later, when they began to look outside Europe, in Asia and Africa, they found much older *Homo sapiens*—some dating as far back as 200,000 years—with the same primitive tools once associated with Nean-

derthals. To accommodate this evidence, archaeologists theorized that modern behaviors emerged tens of thousands of years after the earliest Homo sapiens.

The tendered explanation is a nice way of fitting the evidence to a long-cherished narrative, but it is not really scientific, Shea says. The archaeological record shows that “modern” behaviors have cropped up in different regions for long periods of time but then vanished. (Archaeologists label sites yielding this kind of evidence “precocious,” which,

according to Shea, merely reflects these scientists’ bias.) If modernity were a revolutionary shift, why would it disappear for prolonged periods?

Shea believes that things such as sophisticated stone tools don’t appear because of sudden shifts in human abilities. Humans create them because their particular environment demands them, and because they can build on the technological advances of their forebears. Rather than focus on the illusory progress of Homo sapiens, Shea argues, archaeologists

should study variations of human behavior from place to place.

If you look at stone tools produced in eastern Africa from 284,000 to 6,000 years ago, you don’t find a steady accumulation of different technologies, but constant and wide variation depending on the needs Homo sapiens faced given the environmental conditions of the time. In recent centuries humans have exhibited great variation in stone tool technology, but “no anthropologists in their right minds would attribute this variability to evolutionary differences,” Shea says.

## OTHER NATIONS

# India’s Vanishing Officers

**THE SOURCE:** “The Officer Crisis in the Indian Military” by Dinesh Kumar, in *South Asia: Journal of South Asian Studies*, Dec. 2010.

INDIA’S ARMED FORCES ARE among the largest in the world, with more than 1.3 million troops on active duty. But they are facing a crisis: They can’t find enough qualified and willing candidates to fill their junior officer ranks, reports doctoral candidate Dinesh Kumar of Monash University in Melbourne.

The shortage is not entirely new, but today it is worse than ever, in part because the opening of India’s economy has created new avenues for upward mobility. In addition, new officers face the unappealing prospect of being shipped off to the country’s counterinsurgency missions against separatists in the province of Jammu and Kashmir.

In 1997, when the Ministry of Defense first hired an advertising agency to burnish the military’s image, the army faced an officer shortfall of nearly 13,000, more than 25 percent of the slots it was seeking to fill. Three years later, the shortfall reached 31 percent. The navy and air force have smaller but growing shortages.

In addition to recruitment, India’s military faces problems with retention. Between 1995 and 2007, requests from officers for early release surged by nearly 200 percent, suggesting “a very high level of internal dissatisfaction.”

The armed forces’ woes could abet regional instability. India’s military must be prepared to fight nuclear and conventional wars against China and Pakistan (six of the army’s 13 corps are located along the disputed borders with those two

nuclear powers), and the officer crisis undermines its capabilities. One retired officer Kumar interviewed said, “In a future war, we will suffer. When today’s leadership grows 30 years hence, it will be mediocre at very best.” He predicted that India could lose the next war with either China or Pakistan.

## OTHER NATIONS

# Who’s Dying in Canada

**THE SOURCE:** “Lesson From Canada’s Universal Care: Socially Disadvantaged Patients Use More Health Services, Still Have Poorer Health” by David A. Alter, Therese Stukel, Alice Chong, and David Henry, in *Health Affairs*, Feb. 2011.

CANADA’S UNIVERSAL HEALTH care system is often cited as an example for the United States, but it is not without its limits. A new study finds that although ready access to health care in Canada helps to narrow the gap between haves and have-nots, Canada’s poor continue