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 perpetuated 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.

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

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-