[WORLDS HIDDEN IN PLAIN SIGHT]

The Evolving Idea of Complexity at the Santa Fe Institute

1984–2019

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editor

TIMELINE
The Santa Fe Institute Across the Decades

1984–1999: Mavericks

2000–2014: Unifiers

C	**Computation**
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HOW TO READ THIS VOLUME

The interconnected nature of complexity science enables you, the reader, to choose your own adventure, as it were. At left are the broad themes tying together the eclectic essays in this book. Follow the shaded tabs on the right edge of the page to pursue a topic.

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ENGINEERED SOCIETIES

Jessica C. Flack, SFI, and
Manfred D. Laubichler, Arizona State University
Christian Science Monitor, January 7, 2016

In the American Southwest, in a remote canyon between Albuquerque and Farmington, New Mexico, lie the ruins of the cultural hub of the ancient pueblo peoples who populated the region roughly between AD 900 and 1150.

Chaco Canyon was the architectural and social masterpiece of its time, the region's center of trade, religion, and social organization. Its buildings were the largest in North America until the nineteenth century. Some appear to have been constructed so as to be aligned with solar and lunar cycles. A system of symmetrically radiating roads connected Chaco with the rest of the region.

Chaco was the result of decades or centuries of planning and building, and many of Chaco's features go well beyond those functionally related to survival. What purpose do these features serve, if not simply to provide shelter and security for Chaco's inhabitants?

To scholars, it's clear Chaco's design played a central role in setting up, maintaining, and reinforcing the complex social organization of the peoples who constructed it.

Human history is full of similar examples. The Balinese water temple system that emerged in the ninth century features iconic, stylized monuments and evolved rituals that optimize planting cycles and water distribution. The opaque voting protocol invented by Venetian families in the 1500s helped ensure tamper-free elections of their doge.

Humans have been attempting to engineer social outcomes presumably since language evolved and made feasible the coordination of many individuals. It began when groups of hunter-gatherers decreed the first rules of social interaction, was advanced when the first agricultural societies set down regulations for water use and distribution, and has now expanded in contemporary society to our online behavior.

Reactive Social Engineering

A trained mechanical or electrical engineer might balk at using the term *engineering* to describe attempts to orchestrate social outcomes. Social engineering has never been a precise endeavor—nothing like designing a cell phone tower or constructing a water wheel for milling grain.

There are no meticulously drawn blueprints for social systems, and no objective tests that would allow us to predict the success of interventions. In fact, the history of human social engineering, right up until the present, is based largely on human intuition about the few directly attributable causes of a problem and how to adjust them.

> Scientific models that seek to predict the consequences of human actions with some reasonable accuracy—such as game theoretical models of economic behavior—for the most part ignore human individuality in favor of aggregated outcomes.

As a result, attempts at social control have been mostly reactive responses to the consequences of previous actions and decisions. If we think crime rates are too high, we invest in police and prisons.

Unfortunately, as the US incarceration rate attests, such ham-handed social solutions often backfire.

Is proactive social engineering desirable? Is it even possible to effect the outcomes we want in a medium as complex and uncertain as human social behavior?

The Cusp of Understanding

One reason for this lack of precision—assuming for the moment that social engineering could be deployed to advance the common good—has been a lack of detailed data about individual human behavior. Scientific models that seek to predict the consequences of human actions with some reasonable accuracy—such as game theoretical models of economic behavior—for the most part ignore human individuality in favor of aggregated outcomes.

But this is changing. With digital technology it is now possible, for the first time in human history, to track individual behavior and interactions, empirically study the behavior of humans in groups, and quantify the process of collective decision-making using such advances as geotagging, eye-movement tracking, and data mining of social media activities.

Currently, much of human social data collection is occurring online and is controlled by private companies. According to social media marketing strategist Jeff Bullas, as of 2014, 72 percent of internet users in the US and 64 percent of users worldwide use social media. Facebook has 1.55 billion monthly users, up from one million only ten years ago. The average American user spends more than one quarter of every online hour on social media, and almost 50 percent of Americans say Facebook is the number-one influencer of their purchases. Google+ has been around for only four years and already there are one billion Google+ enabled accounts.

Consequently, Google and Facebook are storehouses of detailed data on the minutia of human behavior, and they certainly are experimenting with new kinds of social engineering, for better or for worse. In a controversial 2014 study published in the *Proceedings of the National Academy of Sciences*, scientists, in collaboration with Facebook, manipulated user feeds to study how negative and positive emotion spreads over social networks. In 2012, in a study published in the journal *Nature*, Facebook studied the effect of its political mobilization messages on real-world voting.

Without a doubt, corporate or government control of these data is a major privacy concern. But within the data (if appropriately anonymized) is immense potential for gaining fine-grained insights into social patterns and designs as, increasingly, people from all walks of life are living online lives.

Synced Multidata

Syncing time, location, and other data collected in this digiverse with all that goes on in the material world is not far off, and such "time series" data come with even greater potential. It is already possible, for example, to track an individual's movements via cell phone and, increasingly, through image capture coupled to image tagging.

One estimate of the number of video cameras used for surveillance worldwide is on the order of 100 million. By 2008, London—supposedly the most monitored city in the world—was estimated to have one camera for every fourteen people.

All your online activities synced with the world of bus schedules, stock markets, and weather . . . what's next? The data sets of the near future will contain systematically sampled data on a much wider range of behaviors at many complementary levels of analysis.

Proactive Social Engineering

What will we do with all this information? Is it indeed possible to deploy all of it for useful good?

Machine-learning approaches that can find patterns and correlations in vast data sets already make decent predictions about your movie preferences, the style of clothes you are likely to purchase, whether you will comply with a doctor's orders, and the like.

But this is not yet *understanding*. Skeptics argue that these correlations will not help with designing social outcomes—that we will be no closer to engineering utopia, assuming we could agree on what might constitute utopia, than we were before.

Jorge Luis Borges captured this view in his famous short story, "On Exactitude in Science":

> In that Empire, the Art of Cartography attained such Perfection that the map of a single Province occupied the entirety of a City, and the map of the Empire, the entirety of a Province. In time, those Unconscionable Maps no longer satisfied, and the Cartographers Guilds struck a Map of the Empire whose size was that of the Empire, and which coincided point for point with it. The following Generations, who were not so fond of the Study of Cartography as their Forebears had been, saw that that vast map was Useless . . .

But Borges in some ways got it wrong. He is correct that detailed maps cannot be the goal—but they can serve as rigorous starting points. The behavioral maps we build with the vast data that are now being collected will allow us to find and quantify the hidden regularities in our social interactions—regularities we may think we understand but have never measured. Why is religious fundamentalism on the rise across the globe? How is it connected to income inequality, educational achievements, disease patterns, environmental degradation, and climate change? Why do we fear some people (xenophobia) and embrace others (xenophilia)? What factors, for individuals and groups, determine whether we perceive a foreigner as a threat or an opportunity?

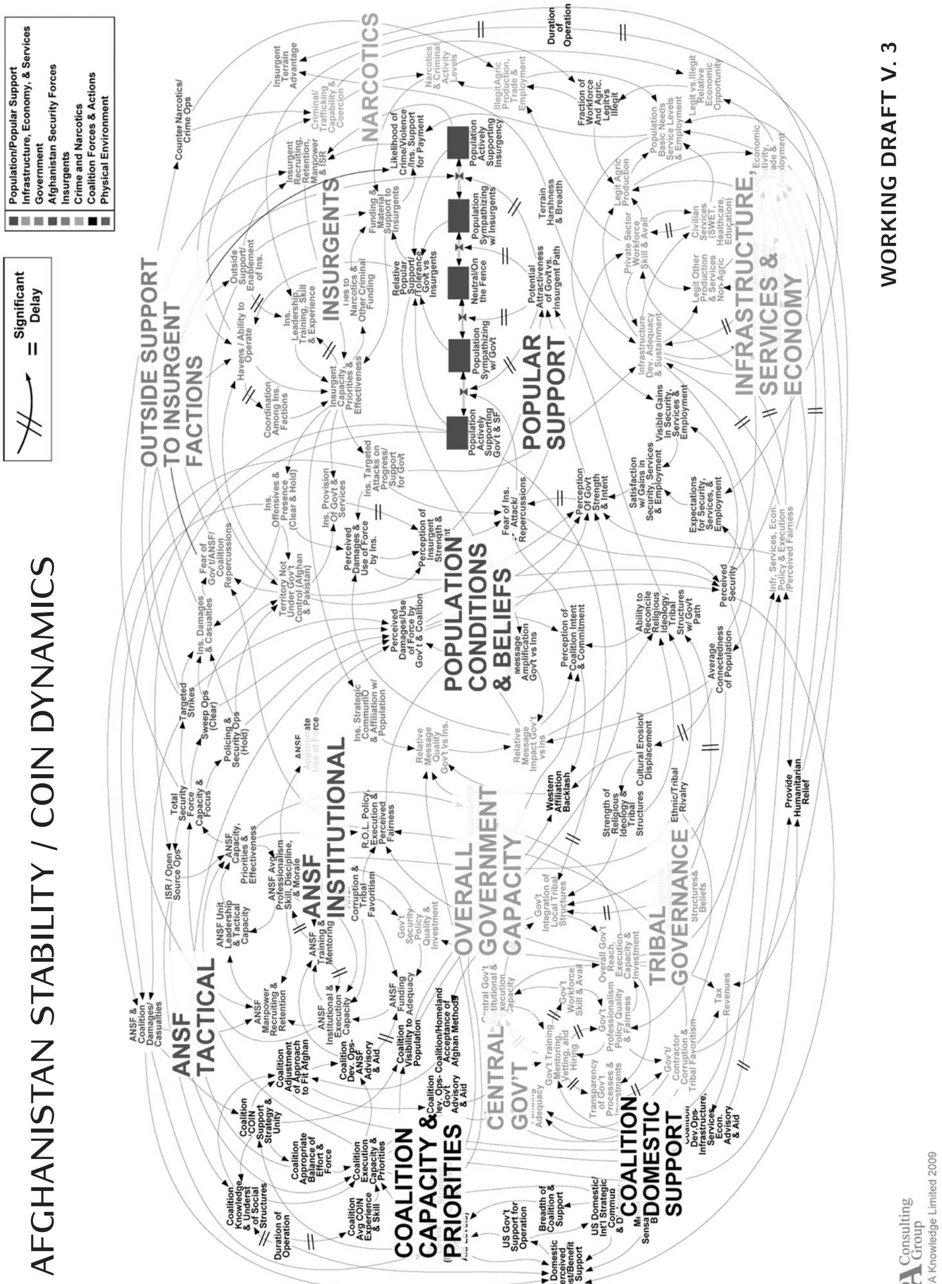

FIGURE 1. The “famous” causal-loop diagram shown to General Stanley McChrystal in 2009. PA Consulting Group

With an understanding of these regularities in hand, we will be in a position to infer the rules and strategies that humans use to guide their decision-making, and with this information build testable, predictive simulations of social outcomes at the societal level.

Such simulations would also allow us to test alternative futures—futures with both desirable and undesirable outcomes. These in turn would inform policy making (a.k.a. social engineering) that would be, for the first time in human history, empirically based.

This is complex systems science at its finest—reducing seemingly irreducible social complexity, through careful consideration of the data, to an elegant, compressed, predictive, and biologically and socially realistic theory of society.

As we develop this theory we will come to understand what factors matter. Which data can be ignored? How much of a role is there for chance and randomness? And, hence, what we can change to large and small effect at the individual and collective levels?

We may one day even be able to produce a rigorous, quantitative version of the now-infamous "causal loop diagram" (a.k.a. "spaghetti diagram") produced in 2009 by a consulting group for the US Army to explain counterinsurgency dynamics in Afghanistan (fig. 1).

Famously, when shown that one ponderous slide during a briefing in Kabul, the man in charge of the military operation at the time, General Stanley McChrystal, remarked: "When we understand that slide, we will have won the war!"

General McChrystal saw the futility in seeking understanding through wanton oversimplification of human social dynamics. Perhaps, though, by studying these dynamics empirically and in detail, we'll understand them well enough to not simply win wars but to avoid some of them altogether.