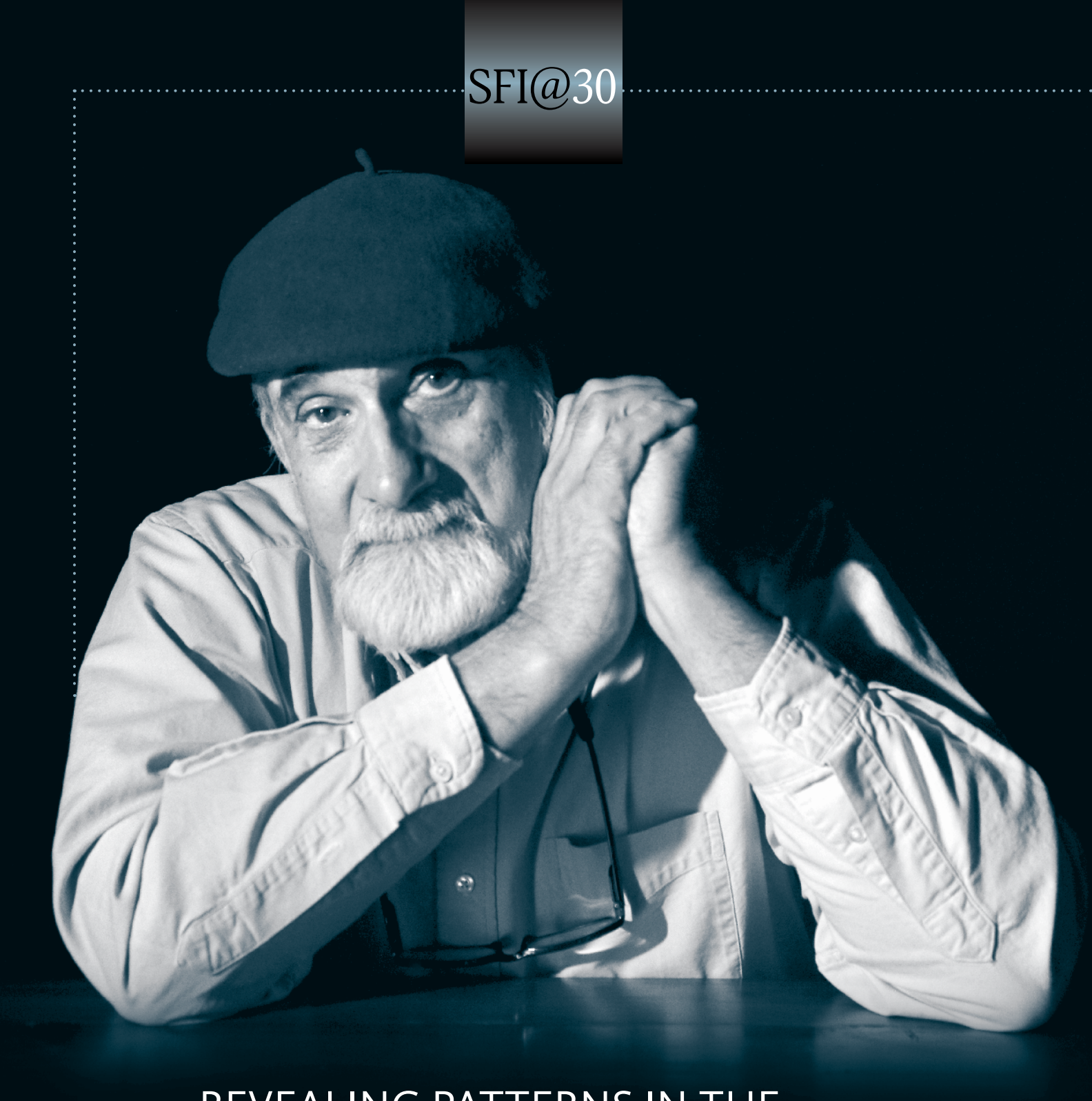

REVEALING PATTERNS IN THE ARC OF **HUMAN HISTORY**

BY HENRY WRIGHT
Albert C. Spaulding Distinguished University Professor of Anthropology, University of Michigan; External Professor and member of the Science Board and Science Steering Committee, Santa Fe Institute

When SFI's founders took up the challenge of developing a predictive science of complex systems in 1984, some of them already had in mind the utility of such an approach to solutions for long-term human problems. Murray Gell-Mann had a lifelong interest in archaeology and matters of deep history. Robert McCormick Adams was a key contributor to the study of the evolution of civilizations in both Mesopotamia and Mesoamerica. Could not the deep-time perspective and the solidly material record afforded by archaeology provide the data to test the implications of complexity theory for understanding the emergence of new forms of human organization?

Surprisingly, the first major SFI initiatives did not involve the study of the first states and empires, what anthropologists, archaeologists, and historians have termed "complex societies." Instead, perhaps because of the chronological precision and the year-to-year record of rainfall (crucial for village farmers in a semi-arid environment) provided by tree-ring studies, or perhaps because of the insight provided by the living descendants of the earlier Pueblo peoples, or perhaps because SFI is located in the North American Southwest, our first major archaeological study was of emerging forms of organization in our own backyard.

Early simulations of societal change

As has so often been the case with SFI research, Institute scholars tried several different initial approaches, not in competition but in a mutually informed exploration of different assumptions, different scales of analysis, and different computer platforms for expressing social emergence in the Southwest. Here are some examples.

George Gumerman was head of SARG – the Southwestern Archaeological Research Group. SARG was concerned with building a comprehensive database of environmental, demographic, and social information for the entire region's prehistory. As this work proceeded, the group's members saw a need for some way to integrate the many different interacting variables thought to be important in the cultural ecology of the prehistoric agriculturalists of the Southwest.

Gumerman and his team of human biologists, hydrologists, paleo-climatologists, and others joined with Joshua Epstein and colleagues from the Brookings Institution (around 1993) to create an agent-based model using a modeling platform called "Sugarscape." In this model, called "Ancient Anasazi," electronic people were born, grew up, married, raised children, migrated, and died on a landscape mimicking the resources of an actual valley in northeastern Arizona called Longhouse Valley. This valley was represented as 100-meter squares, each with soil features and centuries of year-by-year rainfall change inferred from the ancient tree-ring record.

On another front, Tim Kohler – a veteran of research on the ecology and social organization of both woodland societies in the North American Southeast and ancestral Pueblo communities in southwest Colorado – had taken a post at Washington State University and attended an SFI workshop in 1992. There he met SFI's Chris Langton, who was in the process of developing "Swarm," a

Left: Henry Wright. **Above:** Some of SFI's earliest archaeological projects sought to build databases incorporating environmental, demographic, resource, and social information. Between AD 900 and 1150, Chaco Canyon in today's northwestern New Mexico was a major center of Pueblo culture.

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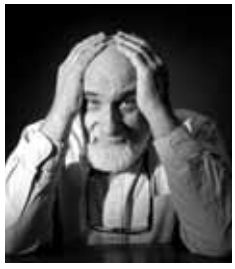
Year-to-year records of rainfall provided by tree-ring studies informed some of the Institute's early archeological studies of ancient societies in the present-day Southwestern United States.

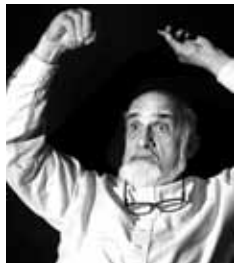
prototype agent-based modeling platform.

One of Kohler's Ph.D. students, archaeologist Carla Van West, had recently completed a reconstruction of maize productivity for southwest Colorado with a spatial resolution of 200 meters and a temporal resolution of one year. This team of three modeled household location and community development through an application built on Swarm, which they called "Village." In this model, virtual households contained people who were born, grew up, married, raised children, migrated, and died on a landscape representing the resources including water, game, fuels, and maize – all changing from year to year.

Interestingly, the two independent simulation projects – although they used different platforms and models, spatial configurations, and production assessments – produced regional population rises and falls that tracked well with the archaeological record established through archaeological surveys in the two areas. The details of which settlements grew to be important centers and how and when population declined, however, were not elucidated by the first simulations.

Both teams have since added additional kinds of interactions. These include forms of economic production other than agriculture, exchange, mechanisms for the development of social alliances, leadership, and conflict – all of which help to generate simulations more useful in both understanding specific trajectories of human systems and in testing hypotheses about human systems in general.





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Patterns in deep human history

In recent years at SFI, the special contribution of archaeologists and historians has been the study of the trajectories of human organization over long periods of time.

New methods for precisely dating cultural phenomena, for example, emphasize the often-rapid pace of organizational transformations and the primacy of some variables over others. My own work on 18th century state formation in central Madagascar shows that the region was transformed from small, warring polities to a consolidated regional state in less than 15 years. Precise estimates of the population using a model developed by the late anthropologist Robert Dewar show that the population increase was too fast to have been a result of local reproduction as some scholars have argued. It is more likely that families, and perhaps whole communities, moved in to join the new and increasingly successful form of hierarchical polity. Thus, in this case (and no doubt in others), population growth is not an external driver of political change, but a variable within the socio-political system.

The comparison of different cases of societal transformation reveals often-unexpected regularities. A number of recent initiatives supported by the John Templeton Foundation seek to approach the coding of comparable cases. In particular, a research project led by SFI President Jerry Sabloff is undertaking a comparative study of the rise of the first archaic states across the globe.

Within this overall project, one study, headed by SFI Professor Paula Sabloff, is coding a range of state and nonstate societies known from the archaeological and documentary records.

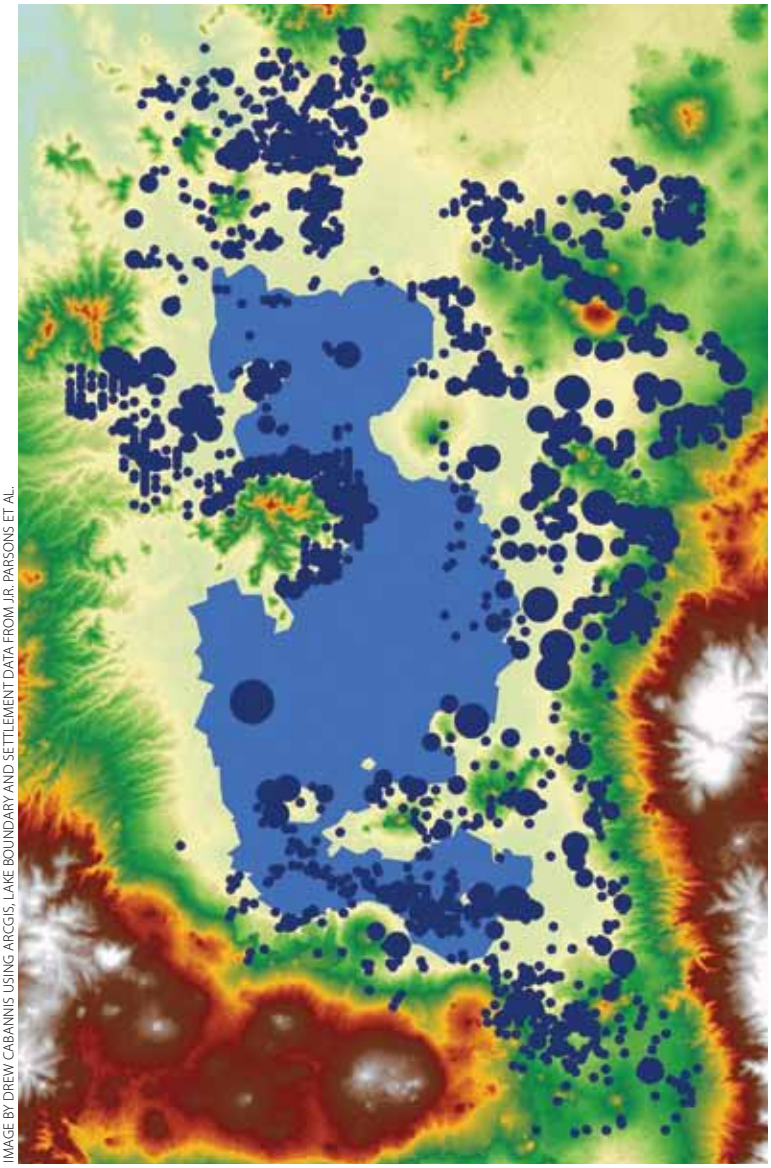

IMAGE BY DREW CABANNIS USING ARCGIS, LAKE BOUNDARY AND SETTLEMENT DATA FROM J.R. PARSONS ET AL.

Map of the pre-Hispanic Basin of Mexico, site of modern-day Mexico City, showing various sizes of human settlements (blue dots) and early lake boundary (light blue area).

Coding has revealed data mismatches due to the varying archaeological and historical traditions in various parts of the world. But these are being overcome, and the SFI research is revealing interesting patterns in the slow pace of village development after the shift to agriculture, versus the rapid pace of the emergence of state polities and urban economies.

In another perspective, a team led by Scott Ortman and Luis Bettencourt has started to apply theory introduced by Bettencourt in a 2013 article in *Science* – one viewing modern cities as social and spatial networks – to ancient settlements, specifically the pre-Hispanic Basin of Mexico. In a recent article in *PLOS ONE*, Ortman and Bettencourt found that these settlements exhibit scaling properties consistent with modern cities, but with different baseline parameters reflecting simpler transportation technology and agricultural productivity.

Together with Arizona State University faculty members Jose Lobo and Michael Smith, they also are beginning to code data to characterize the most ancient cities in places such as Mesopotamia, China, Mesoamerica, and the central Andes to see if the scalar relations observed in modern urban centers by SFI's cities and urbanization research team, led by Bettencourt and Geoffrey West, also apply throughout human history – and how they might need modification or reconceptualization.

These latest projects underscore an acceleration of research at SFI on long-term regularities and on the unexpected emergence of similar organizational phenomena in unrelated parts of the world. In my view, the future holds great promise, not only for theory building, but also for the creation of genuinely practical strategies for dealing with communication crises, political instability, and urban inequality in our world today. ◀

Henry T. Wright is the Albert C. Spaulding Distinguished University Professor of Anthropology, University of Michigan, Department of Anthropology and Museum of Anthropology. Early in his career he became fascinated with competing explanations of the evolution of complex human social formations. His subsequent research took him to Iraq, Iran, Turkey, Egypt, Madagascar, Syria, and China, where he focused on the development of models for understanding societal and ecological change, including state formation. He is a MacArthur Fellow and a fellow of the National Academy of Sciences and is an External Professor and member of the Science Board and Science Steering Committee of the Santa Fe Institute.