

SFI Bulletin

2013, vol. 27

States of
Complexity



About the Santa Fe Institute Bulletin

Founded in 1984, the Santa Fe Institute is an independent, nonprofit research and education center that has pioneered the science of complex systems. Its missions are supported by philanthropic individuals and foundations, forward-thinking partner companies, and government science agencies.

The *SFI Bulletin* is published three times a year to keep SFI's community informed of its work. The *Bulletin* is available online, either as a web-based (html5) tablet publication or as an interactive pdf, at www.santafe.edu/bulletin.

To receive email notifications of future issues, please visit www.santafe.edu and see the **Follow Us** menu.

Editorial Staff

SFI Chair of the Faculty: **Jennifer Dunne**
SFI Director of Communications: **John German**
Art Director: **Paula Eastwood, Eastwood Design**
Design & Function: **8 Arms Creative**
Site Photography: **InSightFoto**
Printing: **Starline Printing**

Published by the Santa Fe Institute

1399 Hyde Park Road
Santa Fe, New Mexico 87501, USA
Phone 505.984.8800

Printed On:

100% Recycled Fiber
60% Post-Consumer Waste
Processed Chlorine Free

www.santafe.edu

COVER IMAGE: WWW.123RF.COM (ASSYRIAN WARRIORS),
FÉLIX PHARAND-DESCHÈNES/GLOBAIA.ORG (AIR TRAFFIC
NETWORK), PAULA EASTWOOD (COMPOSITE)

Perspectives

Improbable Institutions

BY **SAMUEL BOWLES**,
PROFESSOR, SANTA FE INSTITUTE

SPANISH CONQUISTADOR Hernán Cortés's letters to King Charles of Castile describe the exotic customs his armed band encountered as they advanced toward Tenochtitlan in 1519. But what really is striking is how familiar it all was to Cortés.

Upon reaching what is now Mexico City, he wrote: "There is one square twice as big as that of Salamanca, where more than sixty thousand people come each day to buy and sell. [There is] a courthouse where 10 or 12 persons sit as judges." He is struck that "the orderly manner which, until now, these people have been governed is almost like that of the states of Venice or Genoa or Pisa."

The Aztec class structure held no surprises: "There are many chiefs...and the country towns contain peasants who are vassals of these lords and each of whom holds his land independently; some have more than others....And there are many poor people who beg from the rich in the streets as the poor do in Spain and in other civilized places."

Cortés, of course, shared a common ancestor with the Aztec people who now so amazed him. But their particular cultural branches of humanity had parted in the distant reaches of prehistory, and their common ancestor had lived at least 13 millennia earlier in a small community of hunters and gatherers without chiefs, judges, or paupers. Somewhere along the line both branches had come up with cities, states, private property, markets, and social classes.

But why should Cortés, or anyone else, marvel at that? Are not these institutions such a superior way of coordinating human activity that they were bound to be adopted as soon as our language facility allowed communication on a grand scale? No. Had Cortés taken a wrong turn and ended up in Australia, or Southern Africa, or California (as Scott Ortman points out in this issue), King Charles would not have read of urban judges and lords and paupers, but about the government of small groups by consensus and an economy based on sharing hunted and gathered goods as they are acquired. (By institutions, here, I mean the formal laws, informal norms, and mutual expectations that regulate social interactions among members of a community.)

The emergence of the institutions common to the 16th century Aztecs and Mediterranean Europe was far from inevitable. Once evolved, their military superiority, political reach, and demographic advantages would propel them even to California, Table Bay of Southern Africa, and the Outback. But the evolutionary trajectory that initiated this process was highly improbable, consistent with there being just a handful of cases in which states emerged independently in prehistory. The SFI project on the emergence of early states has set out to understand this unlikely process.

Institutional innovation is improbable for the same reason that biological speciation is unlikely: In order for the novel entity to get off the ground, a large number of independent events must jointly occur. In the case of human social institutions, among the “mutations” that need to line up for novelty to be viable are novel beliefs and social norms.

Social institutions, like languages, are conventions; they work well if almost everyone is on board. Driving on the right is an institution in this sense, and those who try the alternative institution on their own generally don’t get very far. The same can be said of respect for the possessions of others as private property, as opposed to sharing goods as they are acquired. How both the Aztecs and Europeans came to adopt private property rather than the communal sharing practiced by their common ancestors, or how the acceptance of subjection to a state elite came to be adopted, confronts the critical mass problem that is inherent in shifting from one convention to another.

The same cannot be said about many new technologies. If I find a better way to make a digging stick or a pot, there is little stopping me from just doing it. As a result, technology is said to be dynamic, and institutions inertial, giving us the “better mousetrap” theory

“Social institutions, like languages, are conventions; they work well if almost everyone is on board.”

of history that enthrones technological progress as the reigning driver of human social dynamics. But, as the SFI project insists, this is a mistake. Of course the better mousetrap theory has its poster children: The steam engine transformed the conditions of work and life in 18th and 19th century Europe, as had the introduction of the horse to the American Plains two centuries earlier.

But novel institutions are sometimes required before a new technology can be adopted. There’s no point in cultivating a crop



Sam Bowles

or raising livestock if one cannot expect to reap the returns from these long-term investments. Irrigated farming requires a political system to define and enforce water rights. And unlike better mousetraps, states, private property, and other novel institutions cannot be adopted piecemeal. When they do emerge, their fate is determined, as Jerry Sabloff says in his video interview, by their ability to best other groups in warfare and other forms of competition. There is nothing in either process – emergence or proliferation – that guarantees that people will benefit as a result. So reassuring shortcuts like the “efficient design” hypothesis are as poor a guide to research in the historical and social sciences as they are in biology.

This is why the questions posed by the SFI project are so challenging: Institutions are characteristic of groups, not of individuals, and the evolutionary processes governing them are often marked by long periods of stasis punctuated by brief – in archaeological time – periods of innovation. Many new technologies leave behind a stampede of footprints for the archaeologist; new institutions and cultures are stingier. The result is that even in today’s datasets encompassing millions of traces of how people lived, the *n* that counts – the number of documented cases of the process by which states emerged – can be counted on one’s fingers.



Mexico, Mural

Diego Rivera's depiction of the Tlatelolco market, with the great city of Tenochtitlan beyond it, around the time of the arrival of Hernán Cortés in 1519. Cortés's men were said to be in awe of the splendid city, at the time one of the largest cities in the world, and many wrote that they wondered if they were in a dream.

The magnitude of the challenge is more than matched by the urgency of better understanding these processes. One can hope, with Sander van der Leeuw, that the project will help us grasp how our institutions today are changing – for change they must if we are to address environmental degradation, epidemic spread, the production and use of knowledge itself, and the other challenges and opportunities of our ever more connected world. ■



SFI Professor Samuel Bowles directs the Institute's Behavioral Sciences program and, with SFI External Professor Herbert Gintis, wrote *A Cooperative Species: Human Reciprocity and Its Evolution* (Princeton, 2011).



Bronze Spear Point

Military success was both an enabler and an outcome of the increasing political and bureaucratic organization of early states.



Welcome *to the* New SFI Bulletin

THE *SFI BULLETIN* BEGAN 27 YEARS AGO as a mimeographed review of people and events contributing to SFI science. Since then it has transformed several times, ranging from a quasi journal containing scholarly review articles to an accessible magazine for SFI's diverse audience.

Today, with this issue, the *SFI Bulletin* is changing again. We now present the publication in three ways: as a tablet magazine and as an online publication, with a few printed copies found primarily at the Institute. We will publish three issues a year rather than one. Instead of surveying a half dozen research themes, each issue now covers a single scientific theme. And, to offer the greatest possible relevance to our audience of scientists and nonscientists, we offer several perspectives, asking our scholars to present their work in their own words.

You might ask why we are making these changes. Our audience has always been an international one, and with the ever-expanding reach of the Internet we are striving to make the Institute's research available even more broadly. We're also taking advantage of the capabilities of digital media, including videos and interactive illustrations, for richer insights. In keeping with SFI's green initiative, we are taking a big step toward a paperless publication.

In this first issue of the new *SFI Bulletin*, Institute scientists involved in the "Emergence of Complex Societies" project, sponsored by the John Templeton Foundation, ask why states formed in six regions of the world independently. SFI Omidyar Fellow Scott Ortman proffers his thoughts on how metaphors, and the human capacity for conceptualization, help us imagine new, more complex societal structures. And SFI Professor Sam Bowles outlines why it is so improbable for *Homo sapiens* to have become the "global villagers" we are today. In whatever form you are experiencing this issue, I hope you find these questions as fascinating as I do.

Regards,

Jerry Sabloff, President, Santa Fe Institute



13 Monte Alban, Oaxaca, Mexico
Overview of ruins

Contents

SFI BULLETIN
VOL. 27 APRIL 2013

“The Destiny of Man is to unite, not to divide. If you keep on dividing you end up as a collection of monkeys throwing nuts at each other out of separate trees.”

– T. H. WHITE, *The Once and Future King*



0. Perspectives: Improbable Institutions

By **SAMUEL BOWLES**

4. Welcome to the New SFI Bulletin

By **JERRY SABLOFF**

6. States of Complexity: Why and how the state emerged in human society

By **LARRY O'HANLON**

13. Imagining Complex Societies: How conceptualization shapes social structures

By **SCOTT ORTMAN**

PHOTO CREDITS, CLOCKWISE-TOP: OAXACA, MEXICO, WWW.DREAMSTIME.COM; FAR RIGHT: GRAIN BOWL, INSIGHTFOTO. BOTTOM: ASSYRIAN SOLDIERS IN BATTLE, WWW.ISTOCKPHOTO.COM.



States *of* Complexity

BY LARRY O'HANLON

BETWEEN TWO AND SIX THOUSAND YEARS AGO something unprecedented began happening in about six separate places around the world: The people of small chiefdoms in places like the Nile Valley, Mesopotamia, the Peruvian Andes, Mexico, China, and the Indus Valley began uniting to form the first large centralized states. It's not known what triggered these transformations. There were no scribes yet to record the transition from villages to states and, until very recently, there wasn't enough information about these first complex civilizations to make detailed comparisons.

Archaeologists do know these transformations occurred in fits and starts, with some changes taking place incrementally, others shifting suddenly and dramatically. Villages grew larger. One chief in a region began to amass the accoutrements of his elevated stature, living in larger huts and, later, elaborate palaces tended by servants. He or his successors appointed bureaucrats to manage his affairs – a tax man to collect tariffs, a bookkeeper to record transactions, or a security guard to protect accumulated wealth, perhaps. People from neighboring villages began traveling to the palace to conduct business. A market located near the palace was sanctioned as the primary locus for the

region's trade. A religious structure of some size was built nearby. Families and villages began to specialize in the provision of certain goods and, in turn, were increasingly reliant on the specialties of others.

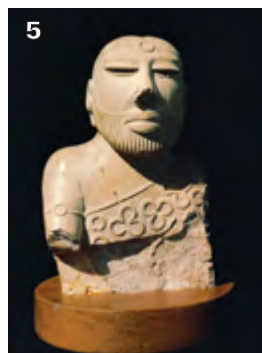
In some cases, there were phases of disintegration and collapse followed by the rapid emergence of new structures. The typically brutal exercise of military power and the resulting dominance over neighboring chiefs led to larger territories falling under one chief's jurisdiction, with military outposts and garrisons established to maintain control of the region, its labor, and its resources. New construction projects brought hundreds or thousands of people into forced toil. Droughts, disease, or food scarcity caused people to die or move in large numbers.

In these ways, a new political, economic, and social order emerged. The before-and-after contrast was striking. "The rise of the state is a key point in the evolution of human society, perhaps the most important shift for *Homo sapiens* since the advent of language in the Paleolithic until the present day," said Santa Fe Institute President Jerry Sabloff. "We want to see if there is an underlying explanation for the rise of the state through time and space. We also want to see why states did not arise."



Society Simulator

Sabloff is leading SFI's "Emergence of Complex Societies" project, supported by the John Templeton Foundation. He and a team of SFI researchers are working on the richest in-depth side-by-side analyses of the organization of archaic states to date. Drawing from many fields and a new wealth of archaeological data, the SFI team is collecting in a single database all the information they can find relating to the economics, trade, agriculture, climate, demographics, environment, disease, and other factors that make, or fail to make, a state. They will plug this data into mathematical models they are developing, then pose questions of their simulations to help them understand the critical, common themes that led to the emergence of the first states.



1. Mexico, Maya Relief

Stone relief depicting a Maya ruler-deity, 9th Century CE (IMAGE: JERRY SABLOFF)

2. Andes, Face Spout Vessel

Ceramic stirrup spout vessel (100-900 CE) from the Pre-Columbian Moche, a stratified agrarian and fishing society in coastal regions of northern Peru. This vessel depicts a Moche ruler in a turban-like headdress and earrings. (IMAGE: ALBUM/ART RESOURCE, NY)

3. Egypt, Wall Painting

Replica of a fresco from the tomb of sculptors Nebamun and Ipuky (Thebes, 1411-1375 BCE) depicting goldsmiths at work. Egyptian tomb scenes often show craft specialization and typically depict trades supervised in life by the tomb's owners. (IMAGE: ART ARCHIVE/ GIANNI DAGLI ORTI/ART RESOURCE, NY)

4. Mesopotamia, Uruk Ruins

Ruins at Warka, Iraq, site of Uruk, one of the first large cities. By 2800 BCE at least 40,000 people lived inside Uruk's walls. Newly emerging socio-political factors and the intensification of pre-existing systems of economic production might have contributed to its rapid growth. (IMAGE: NIK WHEELER/CORBIS)

5. Indus Valley, Figure

Seated soapstone figure dubbed by archeologists as the "priest-king," discovered in the ruins of Mohenjo-daro (2600-1900 BCE), one of the world's earliest major urban settlements. Indus Valley settlements exhibit evidence for a high degree of urban planning, including the first-known city sanitation systems. (IMAGE: ROBERT HARDING IMAGES/MASTERFILE)

6. China, Bronze Ding

Bronze, four-legged food vessel, called a ding, from the late Shang dynasty (1100-300 BCE). Dings were used for preparation and storage of ritual food offerings for ancestors of elites and were associated with dominion over the land, implicitly symbolizing a ding owner's power. (IMAGE: ART ARCHIVE/ART RESOURCE, NY)



Artist's depiction, central Maya village at Dos Pilas, Guatemala, showing increasing complexity.

1. Rulers' palaces were often used to conduct the administrative business of the state.

2. A central temple served as a focal point and gathering place for religious and political activities associated with the growing state.

3. The state's central plaza hosted large ceremonial gatherings for people of the region.

4. Residences of elites indicate a stratified class structure.

5. Large urban centers are likely to have been the first to install elaborate ball courts.

6. Commoners specializing in skills needed to maintain the lifestyle of the elite often took up residence in the urban center.

Human societies, of course, have evolved and have become more complex throughout prehistory and history, aided by innovations that have opened doors to later steps – from the first tools and spoken languages of small family groups; to the agriculture and animal husbandry of villages and chiefdoms; to written languages, specialized trades, markets, and militaries of cities and states; and finally to today's nations, global financial markets, international corporations, and transgovernmental organizations such as the World Bank and the United Nations. All are significant milestones in the complexity of human society, but few are as great a leap as the emergence of the state.

"As cultures evolve they not only change things, but change the way they change things," said Sander van der Leeuw, an SFI External Professor and director of the School of Human Evolution and Social Change at Arizona State University. "There are so many actors and variables involved that you can't solve, from a linear perspective, how societies organize themselves."

The only way to approach something that complex and changing is through the simplifying language of mathematics, van der Leeuw said.

The Impetus of Competition

The current general understanding of the rise of early states is that they emerge from competing chiefdoms. That is, they arise from smaller groups that are competing for resources, labor, and other essentials in a given landscape. It's in such competitive environments that the next step happens, and one of these groups becomes central to the others.

"There's a lot of discussion among scholars about the importance of conflict in such situations," said Sabloff. "But it is, in effect, the increasing organization of one of the competing groups that gives it the ability to out-compete, if you will, the other chiefdoms." The winning edge is most likely a mixture of military skill, and the ability to mobilize significant wealth and get different groups to cooperate, he said. There is a lot of debate in archaeology about the details, of course.

“Current archaeological research points to an interplay of factors, such as ability in warfare, control of trade and tribute, and then the buildup of administration to effectively control areas that might have been taken over by military conquest,” Sabloff explained. “So it’s the competition that gives rise to the state administration that allows it not only to be successful in taking over areas and other people, but then securing them and efficiently getting tribute in the form of material goods, raw materials, and labor.”

Eventually there develops something that meets the modern definition of a state: A large population with a strong centralized government, a range of socioeconomic classes, a diverse economy, and, as the earliest states develop, substantial cities.

“The complex adaptive systems we are studying are the political, economic, and social systems and their interaction with both the physical environment and the cultural environment surrounding them,” said Sabloff.

Archaeologist Henry Wright of the University of Michigan, an SFI Science Board member and External Professor and a member of the project team, has written that states tend to exhibit the delegation of administrative authority along with a degree of interdependency, and they both are necessary for managing multiple urban centers.

“What distinguishes states from pre-state polities is the specialization of administrative tasks within the central control apparatus, such that the performance of one is dependant on others,” said Wright. “The idea of indivisible chiefly authority grounded in concepts of sacred status is replaced by ideas about the delegation of authority based on competence.”

What prevents the successful state from fissioning, then, as its administrative span of control grows and as layers of hierarchy are added, is the interdependence that arises among individuals performing specialized roles – along with a willingness to promote individuals as a reward or to remove them when needed to prevent rebellions. “Any polity with three or more stable levels of control hierarchy must have developed such a strategy,” he said, “or it would have broken apart into warring factions.”

Deluge of Data

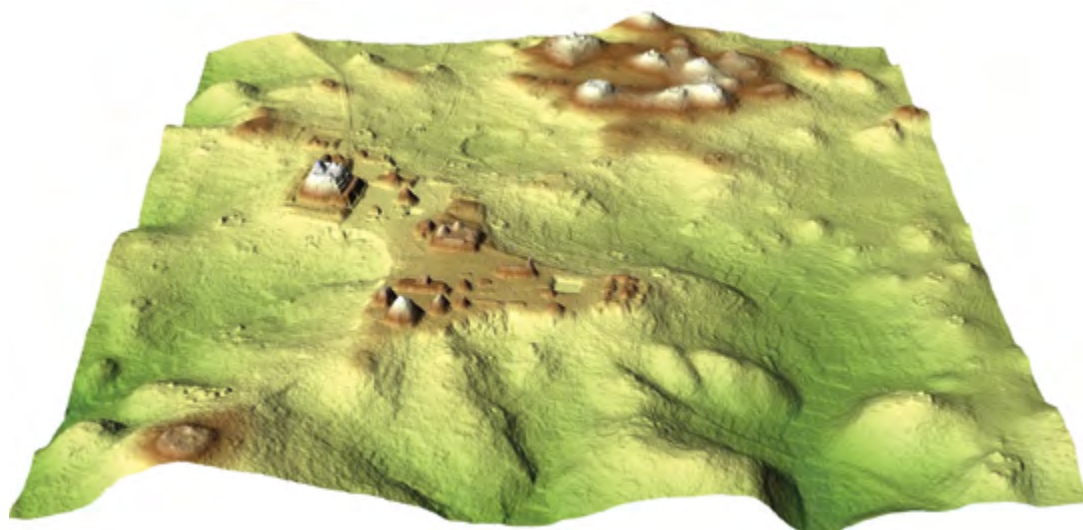
To uncover the underlying patterns of the earliest states, researchers can’t work in a vacuum. They need data. and it just so happens that this is the golden age of archaeological data.

“The reasons we’re in a much better position today than we might have been even five or ten years ago is that there are many more archaeologists, lots more field research and analyses, and a number of new efficient techniques, particularly in the realm of remote sensing – satellite imagery, aerial photography, and the like,”

said Sabloff. “We also have more sophisticated analytic techniques and more sophisticated complex adaptive modeling methods to tackle this problem in better ways than have been done before.”

Combined with more than a century of traditional on-the-ground archaeological surveys and more recent ground-breaking work to assemble this information in modern geographical information systems, the data available today allow for unprecedented advances in theory building and theory testing, said Wright.

The next step is translating that data about individual digs into something that can be compared between ancient states around the globe. But just how do you, for instance, turn satellite photos, pot sherds, and burial sites of diverse cultures into comparable data?



3-D image of the site of Caracol (1200 BCE-950 CE) in Belize, one of the great cities of the ancient Maya. The image is generated using LIDAR, for light detection and ranging, an airborne remote-sensing technology that can penetrate jungle cover, yielding 3-D images of the ground below.

“It’s hard,” said anthropologist and SFI Omidyar Fellow Laura Fortunato, the associate project lead. “You can’t directly compare some cultural practices. All you have is what’s left in the ground.” For that reason, the team will start with available indicators such as estimated population sizes, nutrition and disease information from bones, and estimates on the levels of inequality in societies based on what people are buried with after they die, she said.

After the mathematical models are up and running, the simulation itself becomes a laboratory for experiments in which the researchers can, in effect, “play God” by running histories of artificial societies. By adjusting variables such as population size and available labor, agricultural capacity, environmental stability, the number and directions of trade routes, and types and amounts of resources flowing into the system, for example, researchers can run simulations to see which of the system’s features impact other features, and under which conditions



World's first paycheck? Clay bowl found in Farrukhabad (Middle Uruk period, 4000-3200 BCE). After a period of labor, workers may have received rationed amounts of grain or other compensation, measured in standard-sized vessels.

states emerge. They can even run parallel simulations, isolating variables to try to find the subtle differences that matter most.

"We are in a very fortunate position to explore a whole range of evolutionary hypotheses, so we can play around with, let's say, varying strengths of different evolutionary processes," said Anne Kandler, an assistant professor in the School of Mathematical Sciences at City University London and an SFI Omidyar Fellow alum. "We can bundle them together. We can look at them separately, and that gives us some information about what each process does individually, as well as what we need to do in order to get complex systems going, to achieve the rise of complex societies."

The outputs from the model will be mathematical statements, of course, but they can be interpreted in terms that give insights into societies. One such output drawing on network theory, for example, could be which persistent social network structures could lead to long-term stability and which to relatively fast-changing structural features of the society, said Kandler.

Just as critical will be examining places in the world that seemed to possess all the necessary attributes for state formation but mysteriously did not incubate states.

"All the reasons for ancient states were present in California, but we didn't see a state emerge," said modeler and SFI Postdoctoral Fellow Eric Rupley. "Why not in Hungary? Why not

in the American Southwest? This needs to be looked at from the reverse. It will give us unique insights."

It's also expected that models dealing with different variables – like population or wealth – might distill results that seem contradictory. But anomalous results are a good thing, said Rupley, because they can be used to improve the models or focus future research.

Global Villagers

"It's cool because we'll be working with such big datasets," said Rupley, "and we have the ability to integrate such different expertise."

"We have a unique team here of both faculty and postdocs, interns and external faculty, to contribute to the project," said Sabloff. SFI is suited to assemble such a team, he said. "At SFI we model everything from metabolic networks to cities. Human societies are at the most complex end of the scale."

Scholars on the transdisciplinary project include anthropologists Laura Fortunato, Paula Sabloff, Charles Perreault, and Paul Hooper; archaeologists Jerry Sabloff, Eric Rupley, and

Scott Ortman; mathematician and modeler Anne Kandler; and physicist Murray Gell-Mann. External Professors on the team include archaeologists Henry Wright, Sander van der Leeuw, Tim Kohler of Washington State University, and Peter Peregrine of Lawrence University, whose *Outline of Archaeological Traditions* database and *Encyclopedia of Prehistory* are among the most cited cross-cultural, cross-history comparisons of emerging societies to date.

Ultimately, studying the emergence of states should have practical benefits, including insights into our modern society. "It took humans well near two million years to master matter," said van der Leeuw, regarding humanity's tool-making prowess. Then it wasn't until the late 18th century that fossil fuels freed us of energy constraints and led to an explosion of invention over the last 200 years, he said.

Now, with critical societal and environmental challenges, and with the Internet and modern transportation and trade essentially immersing us all in one massive, hyper-connected worldwide society, we might be able to pose new questions. What does this unprecedented level of connectedness imply for human social complexity, and what possibly might be the next steps?

How to even pose that question properly could be learned from looking at societies of the past, van der Leeuw said. "What I expect we will learn is not a recipe for the past that we can apply to the present, but a way of thinking that will change our way of thinking about our society." ■

Larry O'Hanlon is a science journalist, carpenter, tool collector, and geologist based in Placitas, New Mexico.



Watch Jerry Sabloff's interview at
www.santafe.edu/states

SANTA FE INSTITUTE



HELP US ASK Big Questions SUPPORT SFI SCIENCE NOW

SFI's Supporters Are:

Individuals who appreciate fresh scientific approaches to understanding society's most complex issues.

Companies whose collaborations with SFI through the Business Network bring transdisciplinary insights to significant business questions.

Philanthropic Foundations that seek solutions to humanity's biggest problems.

Ways to Contribute:


Funding from private sources provides the majority of SFI's operating budget. Donors receive our bimonthly newsletter, the *Update*; our science magazine, the *SFI Bulletin*; invitations to special events; and announcements about other ways to become active members of SFI's community.

To contribute directly to SFI's mission, visit www.santafe.edu and look for the blue "Support SFI" button. Your tax-deductible gift in support of our annual operating campaign will make an important difference in the magnitude and impact of scientific collaboration at SFI.

You can also support a specific program, such as the SFI Omidyar Fellowship, the Institute's complexity education programs, or individual research projects.

For details and ideas about how to make the most of your philanthropic giving, call our Development Office at 505.946.3678.

Why do SFI's donors support the Institute?
Read their stories at
www.santafe.edu/givers



This petroglyph presents a Tewa Pueblo Indian male leader as a cloud being who fertilizes the world with a drop of his semen.

IMAGINING COMPLEX SOCIETIES

BY **SCOTT ORTMAN**, SANTA FE INSTITUTE OMIDYAR FELLOW



Scott Ortmann

The societies in which most humans live have changed dramatically over the past 10,000 years. At the end of the last ice age, all humans lived in hunting and gathering bands where nearly everyone was related, generalized reciprocity was the norm, families produced almost everything they needed, and group decision-making was consensual. In contrast, today most of us live in industrial nation-states where we will never meet most of our compatriots, economic exchange is the norm, families produce only the tiniest fraction of the goods and services they need, and political decisions are made through bureaucratic governments.

THESE CHANGES make clear that the complexity of many human societies – as defined by their scale, functional differentiation, and control structures – has increased dramatically in recent millennia. How and why this occurred is one of the central questions of anthropology, but despite sustained attention we are still a long way from a truly scientific understanding. In this essay I'll offer my own view of the problem and what I think is needed to move research in this area forward.

My point of departure is Bruce Trigger's *Understanding Early Civilizations* (2003), the most detailed comparative analysis of early state societies yet produced. Trigger chose to work with a sample of early civilizations that developed independently, had never been subservient to other societies, and for which both archaeological and written sources are available. As a result, he did not compare the earliest state societies in various world regions, but the earliest ones for which a well-rounded picture is possible. Thus, he examined the Aztec (1100 – 1519 CE) as opposed to the Teotihuacan

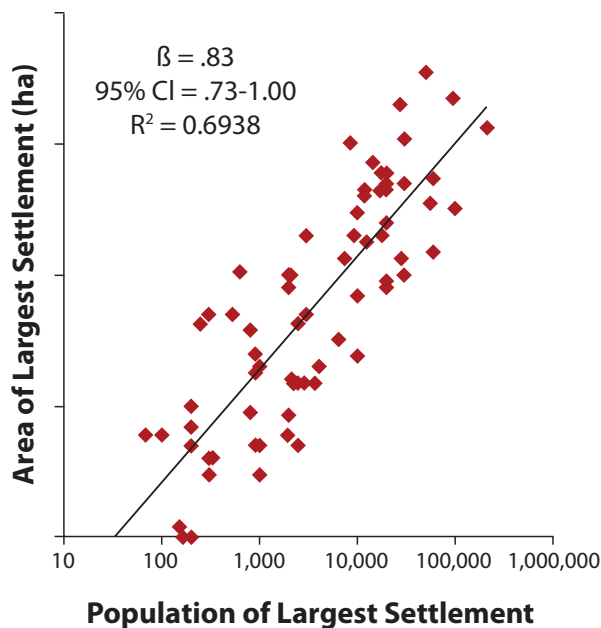


Figure 1 Population vs. settled area of the largest settlements in archaeological traditions from around the world. The fit line is a power law with exponent β . (Data from Ortman and Blair 2012)

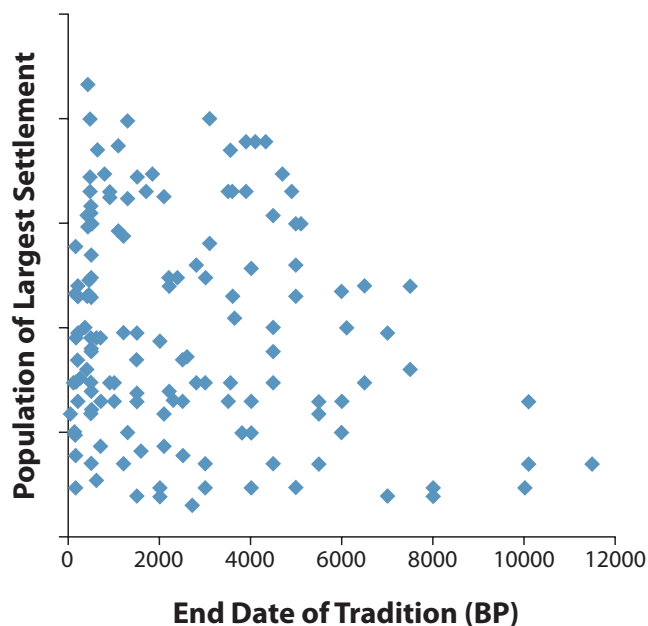


Figure 2 End dates and largest settlement populations of archaeological traditions from around the world. (Data from Ortman and Blair 2012)

(100 BCE – 750 CE) period in Central Mexico, the Early Dynastic III (2500 – 2350 BCE) as opposed to the Uruk (3400 – 3100 BCE) period in Mesopotamia, and so forth. In his view, the disadvantages of working with civilizations from more recent periods were outweighed by the advantages of examining the richer available evidence for the symbolic and cognitive aspects of each society, in addition to their economic and sociopolitical structures.

His basic findings are striking. First, the economies of early civilizations were highly variable and reflected the process of local

commoners and rulers. Anthropomorphized forces of nature required material sacrifices in order to persist and fulfill their roles in maintaining the *natural* order; and in the same way, elites required surpluses and labor from commoners in order to fulfill their roles in maintaining the *social* order.

To the extent that variation across independent cases implies latitude in adaptive possibilities, and uniformity implies constraints, these findings imply that the strongest constraint in the emergence of early civilizations was beliefs that supported

new scales of social coordination. This is in strong contrast to the view, enshrined in many approaches to human behavior, that the primary constraints were material or technological. Trigger's results suggest instead that the way forward in our efforts to understand social complexity is to focus on the process by which beliefs that support complexity were invented and

“In all these societies, relations between humans and the forces of nature were imagined as parallel to relations between commoners and rulers.”

adaptation to the specific environments in which each emerged. Second, the political organizations of early civilizations also varied, falling into one of two basic types: *city-states*, where a large number of farmers lived with elites in urban centers and full-time craft specialists produced goods that were distributed to all through markets; and *territorial states*, where most farmers lived outside of urban centers, and craft specialists produced goods primarily for the elite. Third, the religious beliefs of early civilizations did NOT vary. In all these societies, relations between humans and the forces of nature were imagined as parallel to relations between

adopted within societies. In other words, we need a better understanding of how human society itself emerges from shared abstract ideas, or what I would call *cultural models*. When viewed from this perspective, many traditional explanations for the emergence of complex societies turn out to depend on and presuppose this more fundamental process. It is clear that agricultural intensification, economic and bureaucratic specialization, technological advances, and warfare were all involved; but what is it that makes people feel it is safe to invest in farmland or to depend on others for the goods and services they need; that it is natural to hand

over surpluses to rulers; or that it is appropriate to kill people who have never harmed them directly? Trigger's results suggest human imagination was much more central to this process than we have previously considered.

Articulating how abstract ideas that promote social coordination are invented and spread through society is a challenging task, but due to progress in several fields it is becoming possible to sketch an outline of how it might occur. The first point to recognize is that economies of scale are intrinsic properties of human social networks. This has been amply demonstrated for contemporary urban systems (Bettencourt, et al. 2007; Bettencourt, et al. 2010), and it is also apparent in the archaeological record. For example, Figure 1 plots the population vs. the settled area of the largest site in archaeological traditions from around the globe. The power law fit to these data, which span five orders of magnitude, exhibits the precise economy of scale, in the form of area per person, predicted by urban scaling theory (see Bettencourt 2012); but in this case, each point represents a settlement that developed in a different cultural tradition, with a different technological and economic base, and in a different part of the world. These data make a strong case that as human social networks grow, they necessarily lead to systems that require fewer resources per person, and produce more per person. In other words, the benefits of scale for human groups have always been there.

If this was all there is to the problem of social complexity, one might expect all human societies to have grown consistently in scale and complexity over time, but this is not what has happened. Figure 2, for example, plots the age of various archaeological traditions against the population of the largest settlement in each tradition (a reasonable proxy for overall complexity, see Chick 1997; Naroll 1956). The chart shows that the range of complexity in human societies has grown exponentially since the end of the last ice age, but many societies have remained simple over this period. It's also important to emphasize that societies where complexity accumulated were not always located in more productive areas, or in areas where agriculture had been practiced the longest (Ortman and Blair 2012). So why has complexity accumulated only in certain societies, despite the intrinsic benefits of scale?

The answer derives from the fact that what is good for groups is not always good for the individuals comprising them. For example, both multi-cellular organisms and social insect colonies are functionally-specialized and hierarchically-organized collectives that are highly successful in maintaining and transmitting accumulated knowledge, in the form of genetic instructions, to the next generation; but they also have little regard for the fates of most cells or insects (Maynard Smith and Szathmari 1999). This same pattern is apparent, in an attenuated way, in human societies. For example, economist George Steckel and anthropologist Jerome Rose (2002) examined health indicators for Prehispanic New World societies and found that the median health of individuals declined as societies grew more complex. This suggests social complexity emerges from mechanisms that promote coordinated behavior even if it is not in the best interest of each individual. In



Figure 3 This image from the Codex Borgia (Postclassic Central Mexico) shows maize growing from the body of a sacrificed spirit being.

the case of multi-celled organisms and insect colonies, the solution was to make the coordinating individuals (cells, insects) genetic clones or siblings. That way, genes that promote cooperation could spread even if the most cooperative individuals left no offspring. What was the solution for humans?

I think the solution has a two-part answer. First, humans do possess some groupish predispositions that have evolved since the genus *Homo* became distinct from our living ape relatives. Psychologist Jonathan Haidt (2012) argues that these *moral instincts* – especially concerns over care, fairness, loyalty, authority, and sanctity – co-evolved with the human capacity for language and culture. Economists Sam Bowles and Herb Gintis (2011) have also shown that the conditions faced by early humans were appropriate for the evolution of these predispositions. As a result, it appears reasonable to conclude that the characteristics of early, small-scale human societies reflect the mix of selfish and groupish instincts characteristic of human nature. If so, the subsequent accumulation of social complexity in some societies would seem to derive from the ways particular cultural models, invented by particular humans in specific contexts, interfaced with human moral and emotional instincts.

Given this first part of the answer, the second part derives from neuroscientist Antonio Damasio's (1994) model of human decision-making. His model has the following elements. First, humans possess evolved hormonal and neural circuits that



Figure 4 Marble cylinder seal from Uruk-Warka, depicting the king as the good shepherd, feeding flowers to domestic animals

induce responses to various stimuli automatically. Think of what happens when you touch a hot stove, get thirsty or hungry, or are startled by a sudden movement or sound. The cascades of responses, including those related to our moral instincts, are known as *primary emotions*. Second, our nervous system continuously monitors our body state and stores “images” of the body states associated with our experiences. If you’ve ever gone for a hike without water, “images” of the resultant thirst and anxiety become part of your memory of the experience. These images of body-state responses are known as *secondary emotions*. Third, humans form intuitions regarding potential courses of action through “gut feelings,” which is to say, by associating specific instances with models of our previous experience, including their associated secondary emotions. As a result, human preferences typically derive from the implied emotional outcomes of alternative courses of action.

Damasio’s model gets us part of the way to an explanation for coordinated behavior, but there is one final, crucial step where human imagination takes center stage, recruiting human nature in the service of social goals. The key insight comes from the linguist George Lakoff and philosopher Mark Johnson (1980), who demonstrated that abstract human thought is fundamentally metaphorical: We typically use the imagery of relatively

concrete domains of experience to form intuitions about more abstract domains, especially in the social, political, and ecological realms. Most important, the source domains of these conceptual metaphors ultimately derive from our basic bodily experience, including associated secondary emotions. For example, contemporary Americans often imagine a nation as a body in forming opinions about social policies, and psychological experiments show that body-state imagery influences this process (Landau, et al. 2009). Also, in my own research on Tewa Pueblo origins, I’ve found that imagining the community as a garden, with women as corn plants and men as clouds, was central to the emergence of an inter-community ceremonial system that supported permanent villages and community-level specialization (Ortman 2012) (also see my video presentation at www.santafe.edu/imagine). These observations suggest that social complexity ultimately emerges from people behaving in terms of the body-state imagery of their shared social metaphors. (If you habitually imagine your community as a family, and you have experienced loving parents, then surely your leaders have your best interests at heart.) In social insects, chemical circuits encoded by genes induce coordinated behavior automatically; in humans, culture achieves similar results by linking models of the social, political, economic, and ecological worlds to our automatic and evolutionarily-ancient emotional response systems, including moral instincts. And the more deeply-ingrained these metaphors are, the more effectively they channel human behavior.

This is not to deny that human societies maintain competing models of the social world, that some individuals behave



Watch Scott Ortman’s presentation at
www.santafe.edu/imagine

in accordance with dominant models simply because it is the path of least resistance, or that others actively resist these norms. There is also still a lot to learn about why specific metaphors are persuasive in certain contexts and not in others. Humans are not ants. Nevertheless, deeper reflection on the role of human imagination reveals its fundamental role. Put simply, the earth could not support as many people as it does today if humans had not invented the concept of government from our basic experiences of family life, or the concept of money from our experiences trading small and precious objects. All good ideas seem obvious once someone has them, but the cultural models that subsidized the accumulation of social complexity, and which seem natural to us today, were not self-evident to our distant ancestors. Instead, these models had to be invented and promoted. Once invented, they could spread for a variety of reasons, but they didn't have to. As in biology, I suspect that both material and cultural (aka political) constraints – cultural genotypes, if you will – influenced the process of invention and adoption, and there was significant path dependence (Wagner 2011).

These details aside, the research reviewed here suggests that a fundamental factor in the emergence of complex societies was new cultural models that recruited the emotional concerns and moral instincts of farmers and herders in support of hierarchical and functionally-specialized organization. For example, in Uruk, Mesopotamia, the world's first city-states were founded on the idea of the king as the good shepherd: The king protected and provided for his human flock, and it was thus right and natural for his subjects to obey him (Algaze 2008:128-129) (Figure 4). Many readers will recognize that this imagery continues to play a role in all three of the world's major monotheistic religions. In other parts of the world, the specific imagery was different (among ancient Maya people, for example, the king was maize), but in all cases these cultural models emphasized the benefits of hierarchical and functionally-specialized organization while hiding its disadvantages, thus tipping the scales of moral intuitions and public sentiment in favor of larger-scale social coordination. And there is little doubt that these societies have been spreading ever since, for better and for worse.

At this point, the outline sketched here is little more than a qualitative framework. Much work remains to be done to translate this framework into a quantitative and testable model and to assess the influence of cultural models in comparison with other factors that clearly were involved in the emergence of complex human societies. This will take time, hard work, and good collaborators. But if we are ever to understand the fundamental nature of human societies and why they seem to be becoming more complex all the time, I believe this is the direction in which we should be working. ■

SFI Omidyar Fellow Scott Ortman is author of Winds from the North: Tewa Origins and Historical Anthropology (University of Utah Press, 2012) and is also the Lightfoot Fellow at the Crow Canyon Archaeological Center.

References

- Algaze, G., 2008, *Ancient Mesopotamia at the Dawn of Civilization*. University of Chicago Press, Chicago.
- Bettencourt, L. M. A., 2012, The origins of scaling in cities. *Santa Fe Institute Working Papers* 12-09-014.
- Bettencourt, L. M. A., J. Lobo, D. Helbing, C. Kühnert, and G. B. West, 2007, Growth, Innovation, Scaling, and the Pace of Life of Cities. *Proceedings of the National Academy of Sciences of the U.S.A.* 104:7301-7306.
- Bettencourt, L. M. A., J. Lobo, D. Strumsky, and G. B. West, 2010, Urban Scaling and Its Deviations: Revealing the Structure of Wealth, Innovation and Crime across Cities. *PLoS ONE* 5(11):e13541.
- Bowles, S. and H. Gintis, 2011, *A Cooperative Species: Human Reciprocity and Its Evolution*. Princeton University Press, Princeton.
- Chick, G., 1997, Cultural Complexity: The Concept and Its Measurement. *Cross-Cultural Research* 31(4):275-307.
- Damasio, A., 1994, *Descartes' Error: Emotion, Reason, and the Human Brain*. G. P. Putnam, New York.
- Haidt, J., 2012, *The Righteous Mind: Why Good People are Divided by Politics and Religion*. Pantheon Books, New York.
- Lakoff, G. and M. Johnson, 1980, *Metaphors We Live By*. University of Chicago Press, Chicago.
- Landau, M. J., D. Sullivan, and J. Greenberg, 2009, Evidence That Self-Relevant Motives and Metaphoric Framing Interact to Influence Political and Social Attitudes. *Psychological Science* 20(11):1421-1427.
- Maynard Smith, J. and E. Szathmari, 1999, *The Origins of Life: From the Birth of Life to the Origins of Language*. Oxford University Press, Oxford.
- Naroll, R., 1956, A Preliminary Index of Social Development. *American Anthropologist* 56:687-715.
- Ortman, S. G., 2012, *Winds from the North: Tewa Origins and Historical Anthropology*. University of Utah Press, Salt Lake City.
- Ortman, S. G. and L. Blair, 2012, *Expanding the Atlas of Cultural Evolution*. In *The Principles of Complexity: Life, Scale, and Civilization*, Santa Fe Institute, Santa Fe, New Mexico. August 6-8, 2012.
- Steckel, R. H. and J. C. Rose (editors), 2002, *The Backbone of History: Health and Nutrition in the Western Hemisphere*. Cambridge University Press, Cambridge.
- Trigger, B. G., 2003, *Understanding Early Civilizations*. Cambridge University Press, Cambridge.
- Wagner, A., 2011, *The Origins of Evolutionary Innovations*. Oxford University Press, Oxford.

