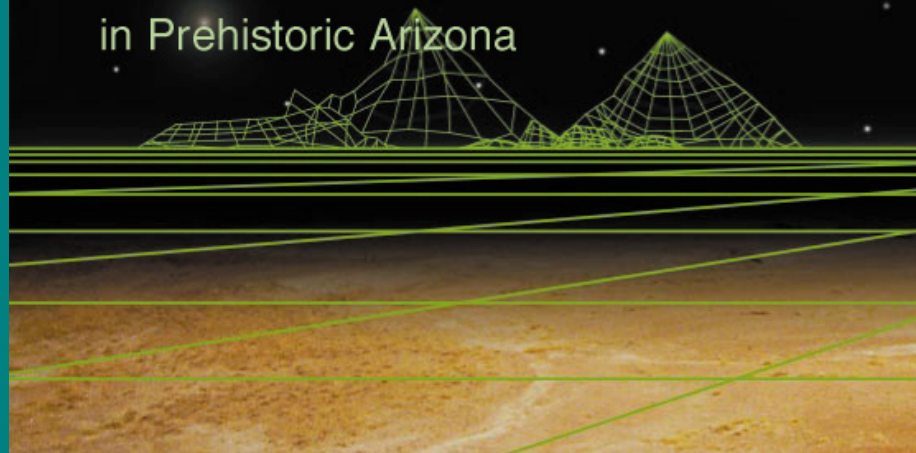


Artificial Anasazi

Digital People Farm
a Computerized Landscape
in Prehistoric Arizona



Artificial and Real Prehistoric
Worlds:
Agent Based Modeling in the
Prehistoric American Southwest

Archaeology:

The only discipline with the time range to study long-term culture change.

- Impossible to experiment making verification difficult
- Agent based modeling allows us to “rewind the tape” of cultural evolution.

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Jeffrey S. Dean ³,
Joshua M. Epstein ⁴

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[\[2\]](#) University of Massachusetts

[\[3\]](#) University of Arizona

[\[4\]](#) Brookings Institution and the Santa Fe Institute

Anthropological Complexity

- Simple Societies - Hunters and gatherers, non-intensive agriculturalists, egalitarian, achieved status, few specialized roles
- Complex Societies - Chiefdoms, state level societies, intensive agriculturalists, hierarchical, ascribed status, specialists

Sciences of Complexity


- All human societies are complex
- Relative complexity
- Need to use agent based modeling to study a society that transitions from one level (simple agriculturist to chiefdoms)
- Anasazi simple agriculturalists - no transition

Anasazi

- Prehistoric Pueblo peoples (Hopi, Zuni, etc)
- Simple technology (corn, squash, & bean agriculture)
- Complex religious, social, & political organization







A topographical map of Arizona with a brown, textured background. The state's outline is shown in white. Two red dots mark specific locations: one in the north-eastern part of the state and another in the south-western part. A white silhouette of the United States is positioned in the lower right, with a small grey rectangle highlighting the location of Arizona. The text 'Long House Valley' is placed near the northern dot, 'Phoenix' is near the southern dot, and 'ARIZONA' is centered in the state. The words 'United States' are written inside the white silhouette.

**Long House
Valley**

ARIZONA

Phoenix

*United
States*



QuickTime™ and a
decompressor
are needed to see this picture.



A.D. 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000

A. AGGRADATION - DEGRADATION AND ALLUVIAL GROUNDWATER VARIABILITY

AGGRADATION
↓
DEGRADATION

HIGH WATER TABLES

LOW WATER TABLES

B. POLLEN

HIGH EFFECTIVE
MOISTURE
↑
LOW EFFECTIVE
MOISTURE

C. DENDROCLIMATE: TEMPORAL VARIABILITY

TREE GROWTH
DEPARTURES

**C. DENDROCLIMATE:
SPATIAL VARIABILITY**

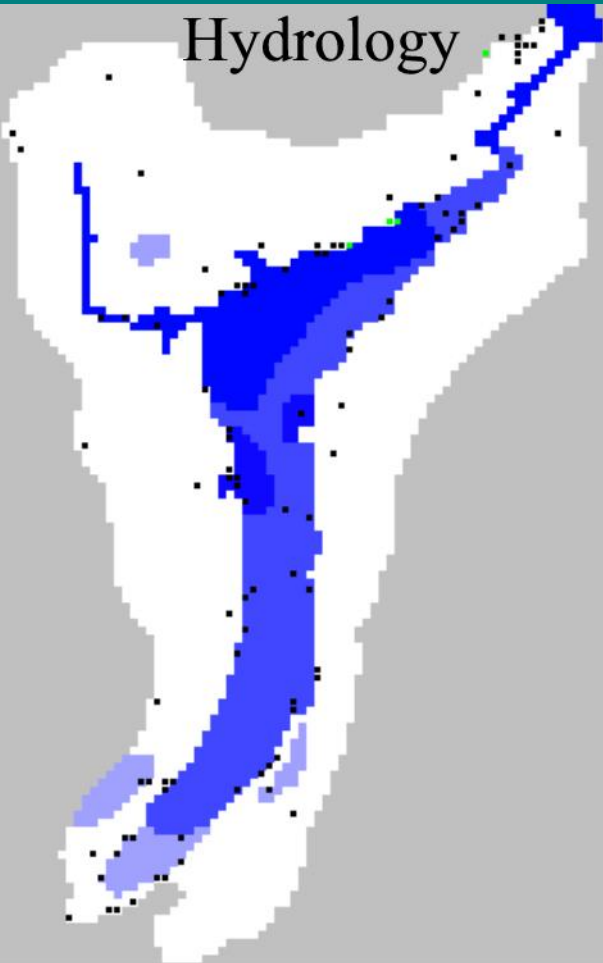
STANDARD DEVIATION

D. GENERALIZED COLORADO PLATEAUS POPULATION

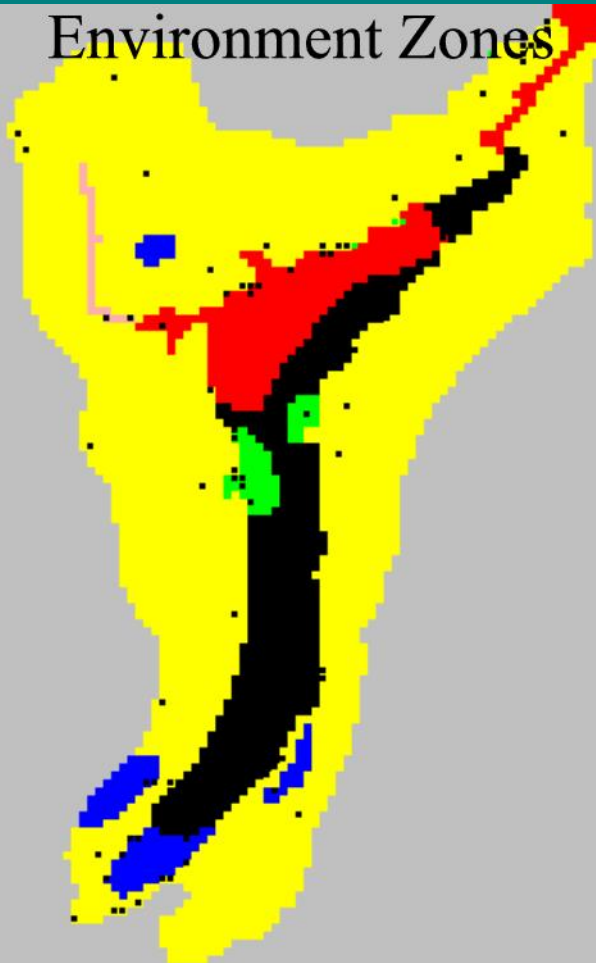
A.D. 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000

Sample of Environmental Model Data

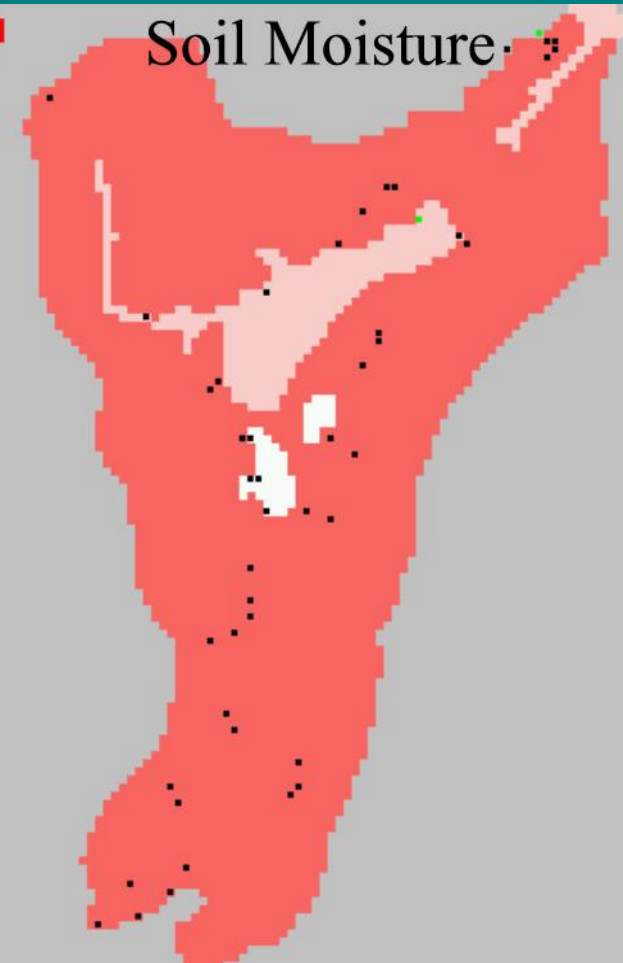
Hydrology



Environment Zones



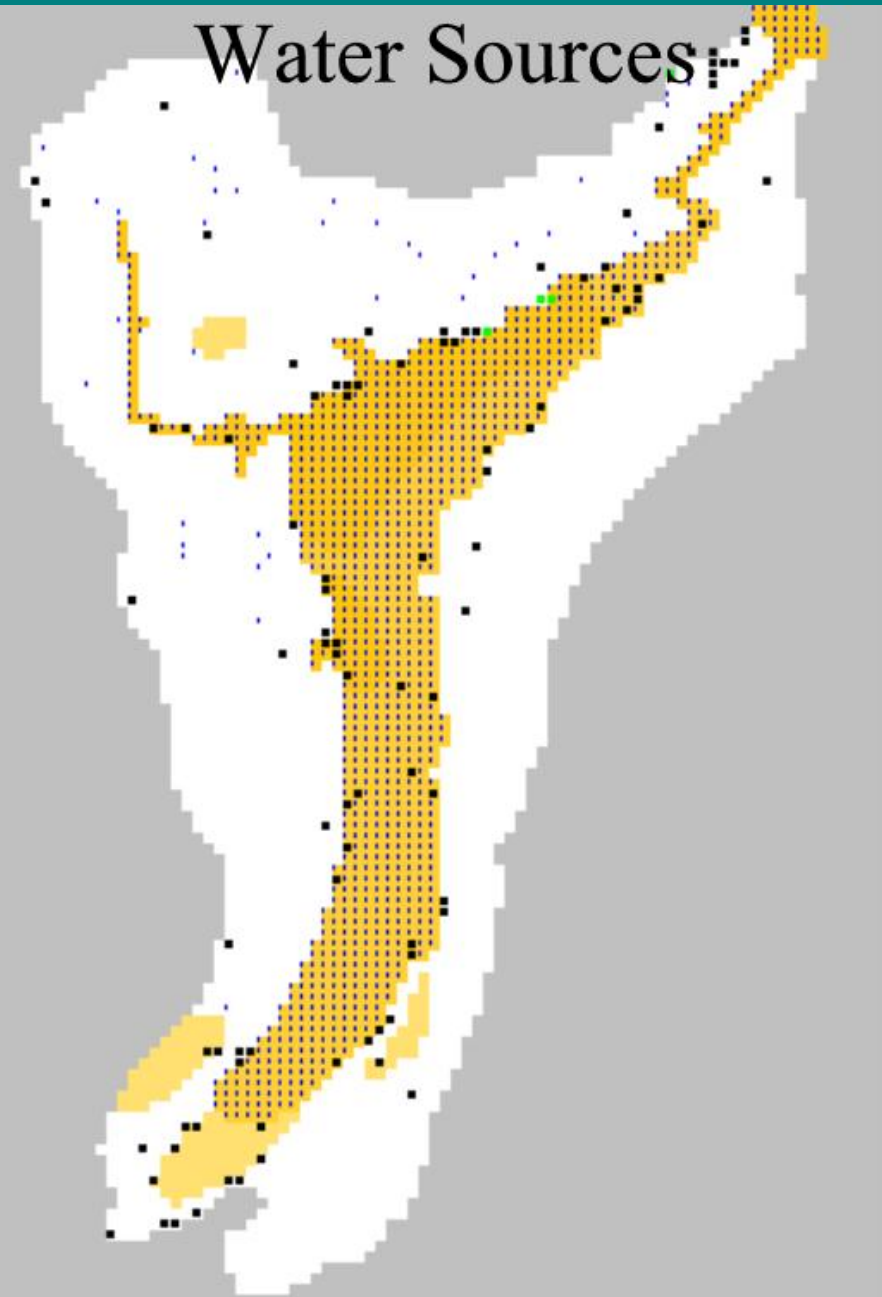
Soil Moisture



Sand Dunes



Water Sources





Excellent Test Case for Understanding the Past

- Ethnographic and historical data
- Most detailed environmental record in the prehistoric world
- Aridity provides excellent preservation
- The test area is geographically bounded
- The area has been 100% surveyed and limited excavations
- Marginal environment makes cultural responses necessary

Culture History

- Corn agriculture became important about 500 B.C.
- Excellent agricultural conditions begin about A.D.1000
- Dramatic population increases begin about A.D. 1000
- Environmental degradation in the the mid A.D. 1100s
- Late A.D. 1200's major environmental degradation
- Region abandoned about A.D. 1300

Maize Potential

Movie of maize potential

QuickTime™ and a Video decompressor are needed to see this picture.

Real and artificial population play out their lives on the reconstructed landscape

Households (agent) Attributes:

- Demographic, marriage, and nutritional requirements derived from Pueblo ethnography & world wide agricultural groups
- Maize is a proxy for all food resources.
 - Households consume 160 kg maize per person per year
- Households can store 2 years supply of maize

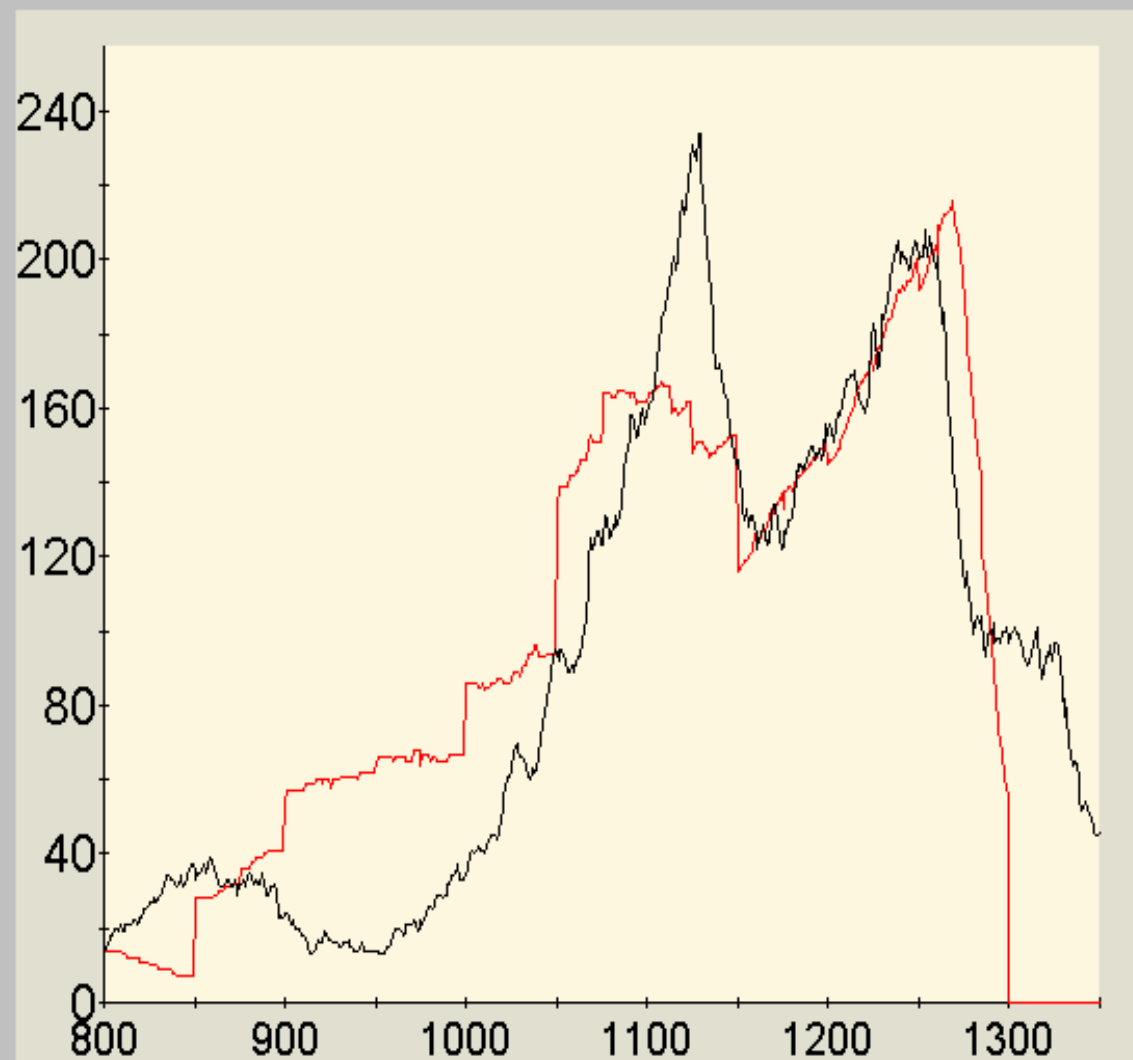
Household (Agent) Movement Rules

When household reaches a certain size:

- Selects farm land able to produce 160 kg. per person per year (corn production estimate of previous years production plus amount in storage)
 - If not sufficient household moves to better location or leaves the valley.
- Next household selects residence location
 - Must be within one km of farm land
 - May already be occupied

QuickTime™ and a
Microsoft Video 1 decompressor
are needed to see this picture.

Households vs Year AD

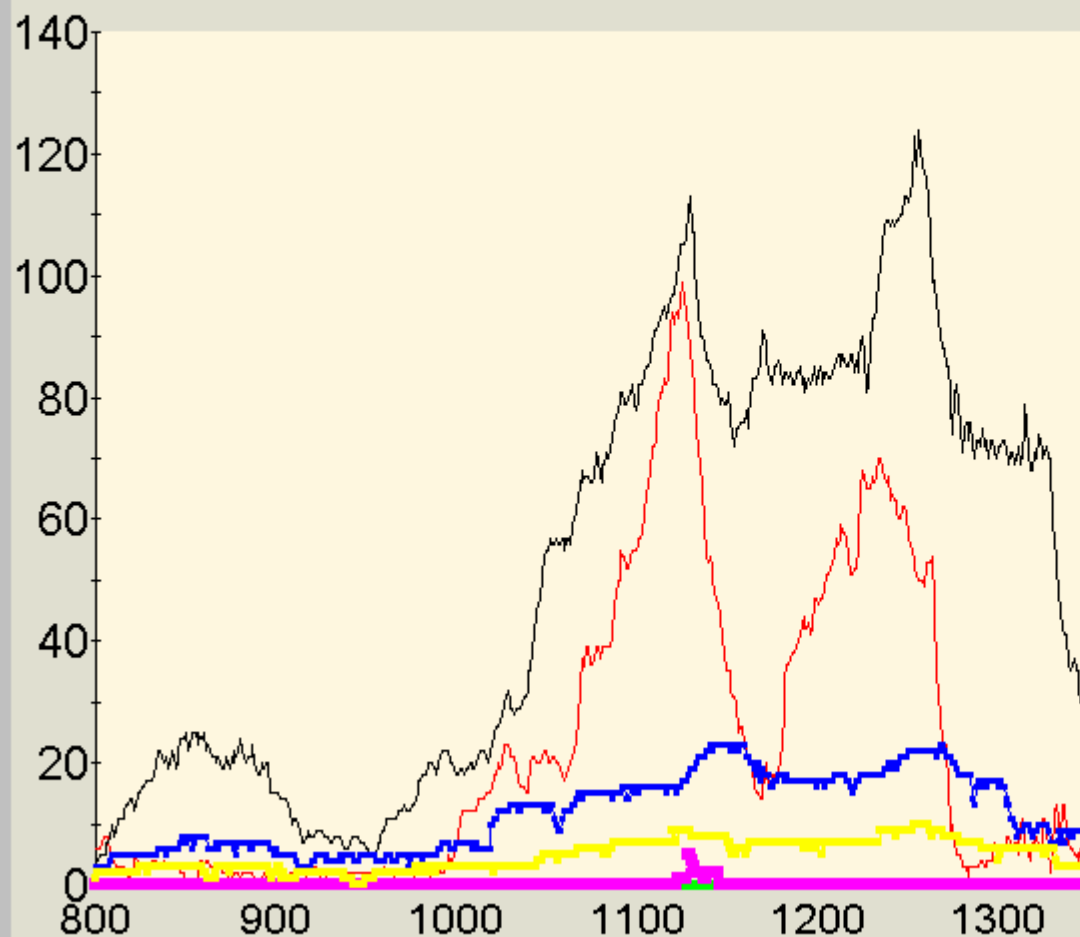


DataView #1

— Historic Households

— Simulated Households

Farms vs Year AD



Farms in:

- General Valley Floor
- North Valley Floor
- Mid-Valley Floor
- Uplands Natural
- Uplands Arable
- Kinbiko Canyon

One third to one fourth of the population could have stayed in the area after A.D. 1300 if:

- Lived and farmed in the north part of the valley
- Lived in medium sized dispersed settlements

Environmentally improving conditions permitted:

- Increased population
- Experimentation in various social forms
- Increased social complexity
- Use of more sub-environments for settlement and farming

Environmentally deteriorating conditions encouraged:

- Increasing concentration of population
- Abandonment of some sub-environments for settlement and farming
- Abandonment of entire region eventually
- Acceptance of new ideological cults (?)
- Violence and warfare (?)

External Causation = $2/3$ to $3/4$ change

Internal Causation = $1/3$ to $1/4$ change

Technological / Economic factors

Ideological factors

Socio-political factors

What has agent based modeling done to help understand behavioral change?

Test suppositions for which there was only indirect evidence

Understand the relative importance of environmental and cultural factors (external vs internal).

Agent based modeling as a tool for discovery

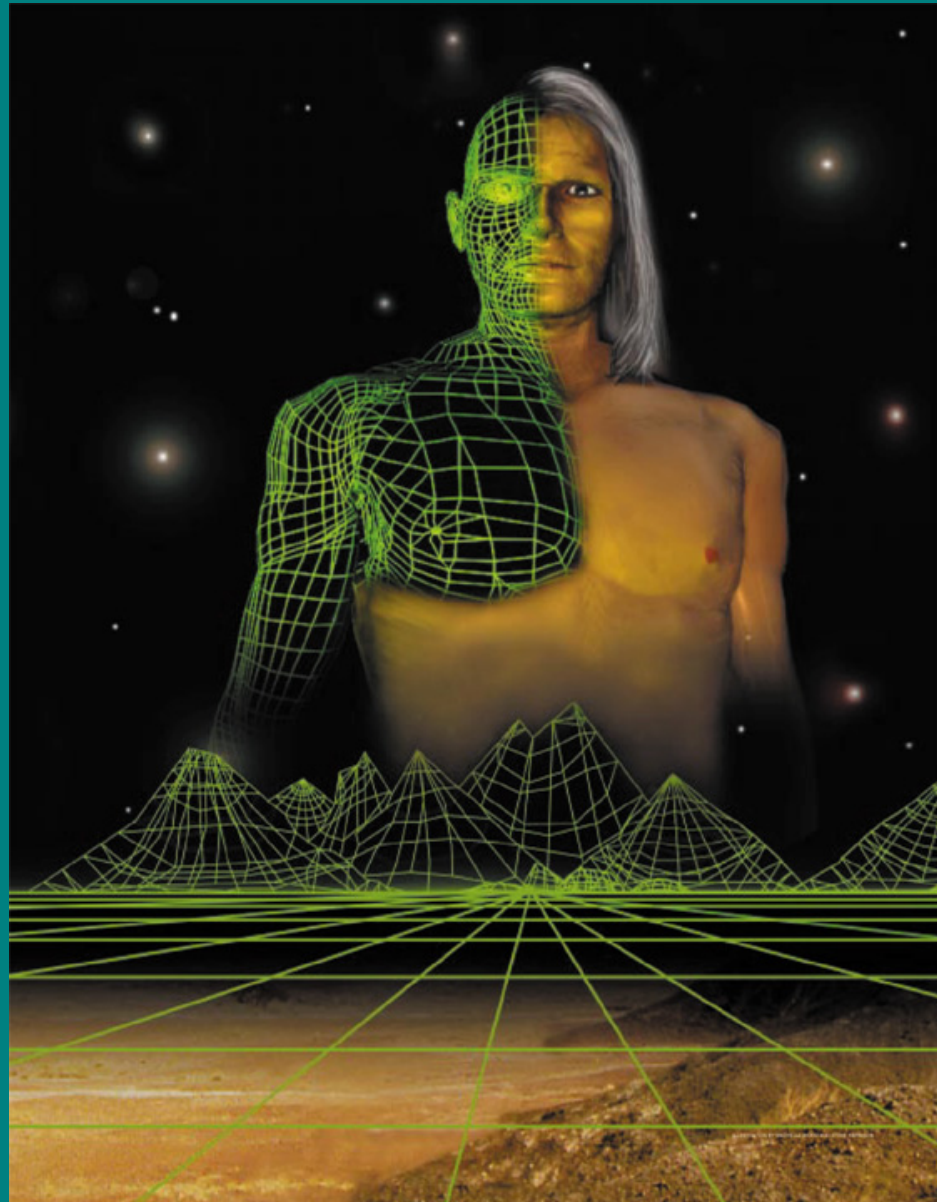
Humanizing prehistoric populations

What can agent based modeling not do to help understand behavioral change?

- Present a well rounded view of a prehistoric culture

Possible to “rewind the tape” for
a clearer understanding of aspects
of the past

- Environmental, demographic, nutritional factors can explain two thirds to three quarters of the population distribution
- Social, political, and ideological factors may explain the remainder



External versus Internal Causation of Culture Change

“Art is a lie that helps us see reality” - Pablo Picasso

Agent based modeling is also a lie that helps us see reality

The end of the presentation, but
not of the Anasazi which remains
a vibrant and vigorous culture
today

