Chapter 11
How Did Sugarscape Become a Whole Society Model?

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11.1 Introduction

The goal of archaeological simulation is to help us understand how we became us. It helps us understand past social systems and their dynamics of change so that we can better understand who we are and where we came from. The initial strategy for doing this, as proposed by Doran (1970), involved simulating realistically complex societies in realistically complex environments. In keeping with the generalizing aims of the processual archaeology of the time, the hope was that accurate models of social systems could help us understand social dynamics in general.

This effort ran counter to a deeply rooted tradition of human exceptionalism that is closely tied to historical particularism and that characterizes anthropology and western approaches in general. It casts humans as fundamentally different from the rest of nature. Its inevitable conclusion is that the tools used to study the rest of nature, including all natural systems, are unsuitable for the study of humans. The erosion of this divide, most recently by the social statistics movement of the early nineteenth century and by Darwin's (1872) contention that natural selection can explain the origin of the human moral capacity, has not been digested to any significant extent, especially in social science (Taylor 2013). Human exceptionalism continues to underlie critiques of systemic approaches to human culture and society, although there is an emerging movement in cultural anthropology, sometimes called multispecies ethnography (Kirksey and Helmreich 2010) to situate humans in their broader natural context as social beings among others (see for example Tsing 2013; Kohn 2013).

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This widespread assumption that methods used for the study of the rest of nature could not be used to study humans made it necessary for early practitioners of simulation in archaeology to convince their colleagues that simulation of systems could in fact help us study human societies. They had to convince them that simulation could be used to study something as complex as culture. In early applications, the scope of modeling was broad, as was the scope of implications. Entire cultures, as defined and imagined by anthropologists of the day, were modeled to learn about and explain all cultures. To increase the level of believability and strengthen the argument that simulation could be used to study real societies past and present, these were usually ethnographically or archaeologically known societies. This ancestral form of archaeological simulation can be called realist-generalist. It strove for a concrete form of realism in which elements of the simulation correspond to elements of the real historical world, as opposed to a fuzzier kind of verisimilitude in which the simulation creates a believable but hypothetical world. It led to the emergence of so-called whole society models (Aldenderfer 1998; Lake 2004).

Very quickly and quite naturally, the whole society approach gave rise to a more particularist school of simulation that sought to understand specific societies in specific historical and environmental contexts. This form of simulation is ultimately concerned with general explanation, but focuses very tightly on a well-defined archaeological case to generate its general understanding. There is emphasis on the immediate goal of understanding a context in its own terms, and usually a discussion of broader applicability or at least the potential for such. The scope of modeling is broad, as entire social systems are modeled and specified as closely as possible and in as much detail as possible, but the scope of implications tends to be narrower because the immediate concern is with understanding a particular context, as a way of eventually building greater general understanding. This is a realist-particularist form of archaeological simulation, in that it puts the particular case front and center.

A third stream of archaeological simulation retains the concern for general explanation of the ancestral form, in that it seeks generally applicable explanations of archaeological phenomena, but adopts an abstract, rather than realistic portrayal of reality. Here the emphasis is on the modeling of general processes, sometimes in no particular context at all. The particular case either becomes one of many instances of the general phenomenon, or sometimes disappears completely. Following applications in the biological and material sciences, this approach seeks to model very specific and simple processes in the pursuit of general explanation. In this form, the scope of modeling is narrow, because few processes and kinds of objects are modeled, but the scope of implications is very broad. This is an abstract-generalist form of archaeological simulation.

To at least some of its practitioners, however, this high level abstract-generalist approach has become no less a form of whole society modeling than its realist cousins. In some regions of the discipline this form has effectively become a whole society modeling of a new kind that replaces the use of context specific realism to produce historically realistic output, with process specific realism that produces verisimilitude in an attempt to increase general understanding. In this paper, I will briefly outline what I see as the main threads of the emergence of abstract-generalist

simulation and its rise to the status of whole society modeling. I will try to tell in broad outlines the story of how some strands of archaeological simulation moved beyond early concerns for demonstrating that the method is useful for studying the human past. In some areas of the discipline, we see a near reversal of situation, from early days when people wondered whether computer simulations could ever be complex enough to be informative about human society, to a situation where people are wondering whether understanding human society requires anything else than very general, abstract natural-like models.

11.2 The Realist-Generalist Ancestral Form

Early simulators initially struggled against skepticism that societies are system-like. Systems are sets of elements that interact according to given rules. Computer simulations portray the operation of systems. The question of whether human societies are systems, or at least have system-like properties, has therefore been of great importance to archaeological simulation from the start. Applied to archaeology, the question acquires a chronological dimension: Is social change system-like?

The question was not new, and its modern formulations can be traced back at least to Quételet's (1835) Essaie de Physique Sociale (see also Quételet 1848). Despite some optimistic post-war statements outside the field (Stewart 1947, for example), opinion within anthropology and archaeology, especially in North America, was generally skeptical of overarching explanations of a systemic nature, as exemplified in Boas (1920). Even in the 1970s, anthropology and archaeology on both sides of the Atlantic were still reeling from the perceived excesses of classical unilinear evolutionism that had become ideologically tainted by the mid-century struggle against the extreme classical evolutionary theories of Aryan racial superiority. In that context, systems were suspect. On the other hand, institutional pressures created by expanding academic departments and the need to secure external funding were encouraging social scientists to search for general explanatory frameworks like those available to their natural science colleagues.

In keeping with Doran's (1970) manifesto for archaeological simulation, and given the debates about whether society is a system and whether computer simulation can usefully approximate it, most early simulators adopted a realistic approach and had generalist goals. They attempted to portray credibly human-like societies that were usually closely inspired from archaeologically known instances (Thomas 1973; Wobst 1974 are the classic examples). As processualists, they sought to provide insights about the mechanisms of human social organization and social change in general. There was also a marked concern for understanding how the archaeological record itself relates to our reconstructions of the past.

For the pioneers of archaeological simulation, society was unambiguously a system. The archaeological record was both the material signal of the operation of that system, as well as a system in itself, the operation of which held its own lessons for understanding the past. In his simulation of Steward's Great Basin

settlement patterns, Thomas (1973, p. 174) defines a settlement-subsistence pattern as "a *system* of interrelations between loci of human occupation (sites)" (emphasis original). Wobst's (1974, p. 147) classic early effort is stimulated by the need to "integrate the particular result into a systemic whole", and to "proceed to the systemic level" of explanation of the archaeological record.

While many of their non-simulating colleagues in the heyday of processualism were receptive to the idea of society as system, they weren't always convinced that computer simulations, however elaborate and complicated they could be made with contemporary tools, could approximate the level of complexity needed to really learn about human social systems, or even that humans were capable of formulating the required hypotheses and experiments.

Even fairly friendly critics like Donn T. Bayard (1973, p. 377), who granted the basic premise that societies are systems, points out in discussing William Longacre's (1966, p. 95) suggestion that archaeologists are in the privileged position of having access to a wealth of cultural systems from the past, that "the archaeologist's 'laboratory' does not consist of cultural systems; it consists of a severely limited sample of the remains of the material manifestations of cultural systems". But Bayard goes on to suggest that even if archaeologists did have access to the entirety of the human record, it's limited size in terms of data, as opposed to even small physical systems, would be inadequate to make it amenable to study by physical science-like approaches. In other words, even granting that society is a system, and that social change is systemic, we could never prove it, much less understand it's dynamics. The amount of data available, or even potentially available, is so small that it would be impossible to derive systemic rules from the observations. Archaeology, according to this critique, was in no position to replicate the explanatory successes of the physical sciences.

Merilee Salmon (1978), an even friendlier critic, argued early on that even if human societies are systems, neither General Systems Theory nor Mathematical Systems Theory can be much use to the archaeologist, the first because it is not real theory, the second because it does not usually identify causal factors of phenomena. Interestingly, Salmon (1978, pp. 181–182) gives as an example the case of a sociology dissertation (unidentified in the text) that "explains" recent (at the time) US demographic trends by fitting the population growth curve to a model developed for fruit fly populations, pointing out that the explanation doesn't take into account factors such as "the availability of various contraceptives, the widespread publicity about the dangers of over-population, or the existence of family planning agencies". A very different reading of the same example might emphasize that it raises serious questions about whether any of those factors are relevant to the evolution of human social systems. This question is essentially the one asked my modern practitioners of the abstract-generalist approach, as I will explain below.

Hodder (1985) went farther in challenging the very idea that society is a system or even system-like. He was an especially observant and credible critic, having himself been one of the early practitioners of archaeological simulation (see Hodder 1978). His work features some of the best examples of realist-generalist simulation, including his work with Elliott and Ellman (1978) on Neolithic axe dispersal in

Britain. His main criticism of the systemic view of society is that it doesn't see humans as active participants in the construction of their society, whose goals and preferences are formed in a unique historical context. This results, in his view, in an overly deterministic model of society that ignores both culture and agency.

Certainly, Hodder accurately describes some of the processual work of the 1970s. But processual work in general, and archaeological simulation in particular, don't have to ignore the actor or the context. Taking them into account does take a different approach to modeling, one that was emerging by the mid-1980s. Full-fledged agent-based approaches, foreshadowed by cellular automata in other fields (see Gardner 1971 for a useful review of early efforts), promised to allow the archaeologist to address the main critiques raised by Hodder and others, by introducing individual choice, perspective, agency, and historical contingency to artificial societies that could help explain the human past and by implication, the human present.

The two main criticism that were levelled at the realist-generalist form of archaeological simulation were that (1) it wasn't particularly realistic and (2) that it couldn't aspire to general explanation. It was thought that the artificial social systems modeled were hopelessly inadequate to portray human societies because they lacked complexity, and especially because they lacked human-like agents. They couldn't aspire to general explanation because the social systems they sought to explain were unique and irreproducible, or at the very least, not subject to the kind of repeatable experimentation that could allow us to find out whether they were system-like.

11.3 The Realist-Particularist Approach

The increasing complexity and realism of archaeological simulation through the 1970s and 1980s, as well as the promise for more of the same, led to an approach that increased the realism of some archaeological simulations. These usually focused on very specific archaeological contexts, well bounded in time and space. The main defining characteristic of this type of simulation is its realism. It seeks to portray actual archaeologically observed systems. However, it is distributed over a wide spectrum of particularism from very weak to very strong. The strongly particularist efforts seek to understand a particular archaeological context for its own sake, with little concern for general explanation. In such strongly particularist work, there is often a sense that while two particular contexts can be interesting in their own right, one cannot help us understand another. For example, the Maya collapse is interesting and should be studied, and the Easter Island collapse is interesting and should be studied, but comparing them is not actually very informative. The weakly particularist (or more generalist) efforts tend to prioritize the study of the particular context, but their ultimate aim is to provide material for comparison, because comparison is seen as informative.

While this realist-particularist approach in archaeological simulation usually has overall generalist aims, it sometimes de-emphasizes the general implications of

simulation results in favour of local understanding of a time and place. The strategy proposed is to get at the general understanding through the detailed study of a particular case, rather than using general process to explain cases. The scope of modeling here is broad, and the scope of implications is narrow.

Some early simulation efforts in anthropology pushed the realist-particularist approach to the extreme. MacLuer et al. (1971) built a microdemographic simulation of the population of four Yanomamo villages in which the simulated individuals in the starting population corresponded to actually living members of the ethnographic population. They sought "(1) to check field data for consistency and indicate areas in which more data are needed, and (2) to study demographic structure" (MacLuer et al. 1971, p. 194).

Highly realist and very particularist simulation is inevitably a large undertaking and some of the true 'mega-projects' of archaeological simulation belong to this category. They are so large in scope of modeling that they require large teams, and in some cases are well over a decade in the making. Tim Kohler's team (see Kohler and Varien 2012 for a recent statement), for example, have worked on increasingly elaborate and realistic models of social and environmental change in the American southwest. While their motivation is clearly expressed in terms of the potential for general explanation of human adaptation to environmental change, the immediate fruit of their labour is a deeper understanding of the Pueblo collapse. More significantly, they seek general explanation through detailed investigation of a particular case.

The ENKIMDU engine (Wilkinson et al. 2007) is only one aspect of a similar project has been dealing with social and environmental change in ancient Mesopotamia (Altaweel 2008; Wilkinson et al. 2007), with an emphasis on agriculture. Here again, the overall aims are generalizing, but the method is to focus on a particular case in great detail in order to get at larger questions.

11.4 The Realist-Abstract Border

A great many archaeological simulations fall within the region of realist-particularism as defined here, although it is admittedly a large region with fuzzy edges. Some of this work, while it features a particular case, doesn't push the realism quite as far the Kohler's Village project or ENKIMDU and it emphasizes general applicability to a greater degree. Lake's (2000) MAGICAL work on information sharing among early Hebridean foragers explores a particular case to learn about the social dynamics of new environment occupation and the formation of the archaeological record. MAGICAL abstracts the environment and the subsistence base of the modeled population to high degree while keeping them in a well defined archaeological context and while comparing its output to observed data. Conolly and colleagues adopt a similar strategy for their work on the spread of early agriculture in Europe (Conolly et al. 2008) and bronze age settlement patterns in the Agean (Bevan and Conolly 2011). These are just a few examples in a crowded field.

The application of computer simulation to early human evolution (at least until the Upper Paleolithic) perhaps marks the point at which the realist and the abstract regions meet. One can't be faulted for wondering whether most ABM studies that deal with pre-modern humans are about any specific case at all. The Paleolithic tends to be treated as a single, all encompassing case for which there is no comparative basis. The farther back the period with which one deals, the truer this seems to be. For example, because of the time scales involved and because of the conceptual remoteness of our ancestors, one generally models hominin dispersal (e.g. Mithen and Reed 2002; Nikitas and Nikita 2005), not the particular features of *a* dispersal for its own sake. The "case" here is a species at the global scale, not a particular population in a particular environment at a particular time. The concern, by default, is for general explanation, although it can be seen as quite particularistic if the target for explanation is the single human line of descent, and especially if hominin phenomena are treated in isolation from, or somehow differently from those related to other species.

Wobst's (1974) simulation of paleolithic populations fits into this border area. It is realistic in terms of population processes, but largely abstracts subsistence strategy, a typical target of realist simulation. It is ambiguously case-specific because it deals with human ancestors rather than *some* human ancestors. It puts general applicability front and center and treats the case in some ways as a necessary evil.

If we can agree to call Wobst's work proto-agent-based, there is another example of early simulation in archaeology that while not agent-based, brings us right to the edge of the abstract generalist approach and probably is an important precursor. Wobst used general demographic principles to model Paleolithic population, but he still intended some level of realism. Ammerman and Cavalli-Sforza (1971, 1973) were simply searching for a mathematical model that was known to be consistent with a natural process and that could be used to describe an archaeological phenomenon. They found it in Fisher's wave of advance and applied it to the spread of farming in Europe. This was part of an approach championed by Renfrew (1977) in the 1970s for the identification of families of mathematical models that could be used to describe archaeological phenomena.

Over time, simulators operating at the edges of this realist-abstract border created a firmly abstract-generalist approach. They were gradually freed from traditional archaeology's concern for the context for its own sake, and they found a like-minded audience for whom they could confidently treat society as system.

11.5 The Abstract-Generalist Approach

The abstract-generalist approach focuses on modeling high-level processes and is concerned with the specific case as an instance that illustrates the operation of the process. Whereas the realist approaches try to portray a context in some detail by modeling many processes and features, the abstract approach models few processes,

sometimes a single one, and does not even necessarily tie it to a real particular case. Frederik Barth (1966) had already emphasized the central importance of generative models in the explanation of social phenomena. Generative models are those that use a set of elements and rules for interaction between them to produce a pattern or an outcome. They can be opposed to descriptive models which impose conditions. Effectively even the most generative model has descriptive elements. For example, while a model of foraging may let a settlement pattern emerge from the interaction between agents and patches, it might describe a sequence of environmental change over time by imposing a climate change curve. It would not necessarily let the climate change emerge from the interaction of climatological variables. Ultimately, no model can be completely generative.

The abstract generalist approach using generative models really started coming into its own when Epstein and Axtell (1996) provided researchers with possibly the first useable agent-based sandbox. Devoid of particular cultural, geographical, or temporal context, it allows the student of a social phenomenon to ask "how could the decentralized local interactions of heterogeneous autonomous agents generate the given regularity?" (Epstein 1999, p. 41), which Epstein calls "the generativist's question".

Since the 1970s the increasing availability of computational tools has allowed archaeologists working in that generative tradition that emphasizes process over case and general explanation over contextual understanding, to turn their models into simulations, for example in Optimal Foraging (Winterhalder 1986) or Dual Inheritance Theory (Shennan 2009), among others.

Mesoudi and Lycett (2009) is typical of this school. It features an abstract model of culture change, not tied to time and place, and explores the operation of random and frequency dependent copying in order to produce general insights that can be applied to a variety of cases. More significantly, it explicitly makes the link between human evolution and other natural processes by highlighting potential implications of their conclusions for "non-human cultural datasets" (Mesoudi and Lycett 2009, p. 47).

Hahn and Bentley (2003, p. S120) go further in arguing that society is a natural construct, although they do it through the study of a particular case. They show that changes in baby name frequency in the US are "satisfactorily explained by a simple process in which individuals randomly copy names from each other, a process that is analogous to the infinite-allele model of population genetics with random genetic drift. By its simplicity, this model provides a powerful null hypothesis for cultural change".

Most of the ABM work at the abstract end of the abstract-generalist region uses available theory to investigate the degree to which it can account for either observed or intuited social phenomena. Neo-Darwinian Theory and Economic Game Theory from of the bulk of this work. All of it assumes that society is a natural construct not that different from any other natural phenomenon. The use of theory and method derived from natural sciences, however, is not inherent to abstract-generalist approaches. There is no reason why someone might not use social theory, for example, as a framework for an abstract-generalist investigation. But such work

seems to be nearly absent from the landscape, perhaps because of the interests and propensities typical of abstract-generalist workers. Vaneeckhout (2010), for example, begins a modeling effort which could easily lead to generalist-abstract simulation and which is based on Levi-Strauss' (1979) theory of house society. Whitehouse et al. (2012) build a simulation around the theory of divergent modes of religiosity to understand transmission of religious beliefs. While both efforts deal with particular case studies, their aims are clearly generalizing, and the modeling approach is abstract rather than realist.

11.6 Conclusion

In some senses, the realist position in archaeological simulation is grounded in a worry that there is something unique and difficult to account for in human social organization. In its extreme formulations, this human exceptionalist position argues that nature itself is socially constructed by humans (see Holtorff 2000–2008 for an archaeological discussion). It reflects early and ongoing concerns that computer simulation cannot adequately capture a human element necessary to the social object. It is partly a reaction to the human exceptionalist critique of the use of natural science-like method and theory for the study of humans.

The abstract position, on the other hand, expresses a conviction, at least until it can be rejected, that society is a natural construct. From that point of view, the demonstration is far from conclusive that human society is not the outcome of the natural processes that we observe at work in the evolution or the behaviour of other related species, or even of abiotic phenomena.

This is not a new debate. It was reflected in the mid-nineteenth century in the split between the Anthropological and Ethnological Societies in London. For Dunn (1861, p. 189) of the Ethnological Society, "The barrier is indeed impassable which separates man from the Chimpanzee". For Wake (1872, p. 83), the Australian Aborigines can teach us about a time when, quoting Darwin, he thinks that our ancestors had "only doubtfully attained the rank of manhood".

It is also reflected in the great controversies of the mid-twentieth century between, for example, Leslie White and the Boasians. For one side, cultural evolution could be described, if not quite explained, by energy equations. For the Boasians, humans required a more subtle treatment. It exists today in archaeological simulation in the form of the bifurcation between a realist school that continues to engage dirt-based archaeologists, and an abstract school that is increasingly speaking to more receptive audiences outside traditional archaeology, including physics, economics, evolutionary biology, and evolutionary psychology.

If the abstract position in archaeological simulation argues that human societies can be studied using the tools we have reserved for the study of the natural world, the emerging multispecies ethnography work discussed in the introduction seems to make the diametrically opposite claim that the natural world can profitably be studied using the tools we have so far reserved for documenting

and understanding human societies. Does this herald a convergence of views between hard-nosed, simulation wielding evolutionary archaeologists and their free-spirited deep ethnography conducting anthropological cousins? This is an interesting question. It certainly opens up a new avenue for dialogue where such avenues have had a habit of closing over time.

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