Archaeological Dialogues (2025), 1–17
doi:10.1017/S1380203825000017

CAMBRIDGE UNIVERSITY PRESS

ARTICLE

Games and gamification in archaeology: Developing analogue modelling as a research tool into cultural evolutionary processes

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Abstract
This article reports from an interdisciplinary, archaeological and philosophical research project developing and using an *analogue model* in archaeological research. With prominent uses outside of archaeology, analogue models can offer a unique *participatory* perspective to prehistoric processes. As such the paper contributes to recent discussions in this journal and elsewhere on the role of games, play and gamification in archaeological research, teaching and cultural heritage. Our analogue model critically discusses cultural-evolution-based models of selected European Neolithic and Bronze Age models and develops a perspective based on the life history and the Capability Approaches. In times of climate and war stress, our model can offer a hopeful perspective of the human past, present and future without compromising on scientific insights.

Keywords: Games; evolution; philosophy; archaeological theory; modeling; heritage; Life History Approach; Capability Approach

Introduction

This article reports on an interdisciplinary, archaeological and philosophical research project developing and using an *analogue model* in archaeological research. In our pilot project, a playable analogue tabletop model of selected Neolithic and early-bronze-age human-environment and socio-cultural interactions was constructed. This article discusses various aspects of the model.

The use of playable models or games in archaeological *research* is, to our knowledge, currently virtually non-existent (Politopoulos et al. 2023). Some *teaching* and *cultural heritage* uses of archaeologically themed games can be found (Reinhard 2018; Boom et al. 2020), but games as a tool of *research* seem to remain unexploited in archaeology. The use of analogue games in the teaching of history generally in schools and academia is spreading, at this stage seemingly driven by individual enthusiasts (see e.g. Fielder 2019; McCall 2020 & 2022; Rael 2021; O'Donnell 2024), but largely awaiting its institutionalization.

At the same time, analogue models have widespread and long-established research and knowledge acquisition uses outside of archaeology. In a branch known as *professional wargaming*, many of the world's largest militaries and military alliances such as the North Atlantic Treaty Organiztion (NATO) routinely use tabletop models to game out conflict scenarios, such as the Russian 2022 invasion of Ukraine (Gentile et al. 2023). There are departments and teams dedicated to designing and leading gaming-based investigations into strategic planning (Sabin 2012; MOD 2017; Wojtowicz 2020). The earliest examples of military strategic uses of analogue

models go back to the *Kriegsspiel* used to train officers of the Prussian army in the 19th century (for a comprehensive history and current uses, see Caffrey 2019).

In the commercial realm, analogue and digital games routinely dip into archaeological or other historical themes.[1] Yet, the models of the supposedly "real world" processes they convey have been criticized for implying colonialist and other presumptions and may not as such necessarily serve as good starting points for modelling for research purposes (Ford 2016; Rey Lee 2017; Borit et al. 2018; Politopoulos and Mol 2021; Arponen 2022). From the 1990s, the growing academic field and discipline of *game studies* has emerged to critically discuss both digital and analogue games as a cultural form, including representations of supposedly historical processes, race and gender imagery and more (Bogost 2007; Alonge 2019; Trammell 2023). In archaeological contexts, the immense popularity of historically themed digital games is having more and more impact on how people encounter and experience cultural heritage as it features in these games (Champion 2016).

Why use analogue models in research? A common argument made in favour of analogue models is that they are an *inexpensive and approachable way* of studying human interaction scenarios. In comparison to computer-based digital models, analogue models have the advantage of being comparatively easy and low cost to develop, as no programming skills or special equipment are required to produce and play them. Another advantage of analogue over digital models is that, where a digital model has its rules black-boxed in the code of the computerized model inaccessible to the player, in an analogue model the rules of the game are fully transparent and visible to the player, which enhances learning and reflection upon the play experience.

Another intriguing aspect of using analogue and digital models in research (as well as teaching, public outreach and cultural heritage) is that, as *playable* models, these models allow players to inject their own *agency* into the phenomenon they are studying (Suits and Hurka 2005; Nguyen 2020; Bódi 2022). Games can have powerful *narrative qualities* experienced through direct player participation in the unfolding game process (Wardrip-Fruin and Harrigan 2009; Rudy McDaniel and Fiore 2010; Arnaudo and Kapell 2018). In comparison to media such as literature and film, games are a unique medium precisely due to the ability to give the students agency to manipulate the phenomenon that they are learning about.

Related to the question of the scale and scope of analogue models, perhaps the most pressing challenge about analogue models concerns the practical accessibility, the *playability*, of the analogue model for researchers and students. While analogue tabletop gaming has for some decades now been a growing commercial industry, it remains something of a niche hobby still and, for example, pales in economic comparison with the multi-billion-dollar digital gaming industry. As such, potential users of analogue models cannot be expected to necessarily command ready abilities and heuristics to comprehend analogue game mechanics such that the actual play of and immersion in the model can proceed without some learning and getting used to the mechanics first. For this reason, the relative simplicity of the analogue model seems at this stage a prerequisite which, however, can pose limits to the detail the model can deal with. However, simplicity in a model can be a boon if it focuses on and foregrounds the essential aspects of the phenomenon being modelled.

We believe that, by offering a participatory, even if high-level, model for researchers to engage with, an analogue model can offer a unique perspective into prehistoric processes. The present article seeks to illustrate the possible insights through a reflective, critical discussion of cultural evolutionary models in archaeology.

We conceive of our effort as a part of a broader emerging interest in games in contemporary society, among others documented in a recent discussion article in this journal (Politopoulos et al. 2023). The growing interest in games is only natural given that commercially especially the digital gaming industry now literally dwarfs the film and music industries in the estimated size of the market (around 160 billion USD for games versus a good 40 and 19 billion for film and music, respectively[2]). As argued in the aforementioned discussion article (Politopoulos et al. 2023), taking games and play seriously involves overcoming the cultural perception that play and games are for

https://doi.org/10.1017/S1380203825000017 Published online by Cambridge University Press

children only. In our article we wish to show that games as analogue models can facilitate serious and reflective engagement with archaeological and anthropological thought. For archaeologists, a particularly pressing issue about the gamified representation of the past is that, for massive numbers of people historically themed games are now the primary medium of engaging with cultural heritage and with archaeological and anthropological knowledge generally (Mol et al. 2017). In the future, if not already now, an analogue model or other gamification output from archaeological research projects may be an increasingly necessary part of a solid publication strategy.

With these preliminaries in mind, let us now dive into the content of our paper.

Cultural evolution in research and games

The development of our analogue model took the shape of an engagement with existing models of cultural evolution in the literature in a critical dialogue regarding how elements of these ideas are lifted and used in commercial civilization-style games.

To begin with, in the familiar general picture arising from modern cultural evolutionary thought as described in disciplines such as anthropology, archaeology, and human behavioural ecology, humans, as any other organism is, are conveived first and foremost as tasked with generating their subsistence from their environments, a perspective we have elsewhere referred to as *biologism* (Arponen et al. 2019). Human groups are assumed to be engaging with their environments 'as efficiently as possible given a defined set of available options and constraints', argued two behavioral ecologists recently (Ready and Holton Price 2021; compare Persky 1995). Such processes of developing greater efficiency are commonly referred to as *adaptation* leading to greater *fitness*.

Early seminal works in this tradition of anthropology, following the model from Charles Darwin's *On the Origin of Species* (1859), were Lewis Morgan's (1877) and, later, Edward Tylor's (1920) influential evolutionary stage models (see also Brinkmann and Arponen 2024). Some decades later, in a classic New Archaeology approach, Leslie White put forward a view of 'cultures as thermodynamic systems whose principal function is to harness free energy and put it to use' (Service and Sahlins 1960, foreword; see also White 1959; White and Dillingham 1973). Later on in the same book, Marshall Sahlins and Elman Service defined the so-called Law of Cultural Dominance along similar lines of the total energy throughput:

> that cultural system which more effectively exploits the energy resources of a given environment will tend to spread in that environment at the expense of less effective systems. (Service and Sahlins 1960, 75)

While not necessarily articulated in terms of ever-growing *energy throughput*, the basic tenets of this growth-through-adaptation model of cultural development is in active use to this day in anthropology and archaeology (Winterhalder and Smith 2000; Creanza et al. 2017; Tylén et al. 2020; Barsbai et al. 2021).

Some decades after New Archaeology, in another classic archaeological formulation of the cultural evolutionary approach, Johnson and Earle (1987, 3) described a framework that views 'individuals as active agents' seeking to 'meet their basic biological needs and those of their families' within environments representing opportunities and limitations. Culture, in turn, was viewed as the body of technologies, political organization techniques and knowledge 'that help individuals in their quest for survival' (Johnson and Earle 1987, 4). In a more recent paper, Turchin et al. (2018) provided a large-scope quantitative analysis of human development described as the growth of human ability to manage increasing social complexity defined in terms of the number of people under hierarchical leadership. One of their suggestive conclusions is in

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line with the aforementioned dominance concept from Service and Sahlins in that 'societies in the Americas were not as complex as those from Eurasia at time of contact, which may be a contributing factor in explaining why European societies were able to invade and colonize the Americas' – even while they are careful to point out that one culture cannot be thought of as 'better than' another (Turchin et al. 2018, E147).

Central to the general cultural evolutionary perspective in anthropology are the ideas of efficiency, adaptation and fitness and these as processes of acquisition of *traits* or *packages* of traits (Prentiss et al. 2009; Shennan et al. 2015). In the classic works in this area, human culture appears as a system of 'extra-somatic means of adaptation' (White 1959), where the adaptation refers to both the development of technical *as well as* socio-cultural or political technologies of management – that is, cultural evolution is about the development of both 'tools' and 'ideas'. At least since Binford's seminal work, the cultural evolutionary approach has had no particular difficulty in accommodating the 'two cultures' (Snow 1998) of natural scientific and socio-cultural approaches in its overall account of human development. Johnson and Earle (1987, 4) saw and captured this idea with great clarity as they summarised a view in which 'culture is the technology, the organization, and the knowledge that help individuals in their quest for survival', giving rise to an interlocking dynamic of 'subsistence intensification, political integration, and social stratification'. Such a framework promised for them to 'describe and explain the evolution of human societies from earliest times to roughly the present' (Johnson and Earle 1987, 1).

Moving forward along the timeline of anthropological thought about cultural evolution, in the so-called dual inheritance theory (Richerson and Boyd 2005), a distinction is made between *evolutionary* processes of advantage and selection whose ontology resides in genetics and *cultural* processes of imitation, learning, and innovation. Their ontology is conceived to reside in individual and collective mental processes that underlie potentially culturally diverse human language use and reasoning (compare Tomasello 2009 in anthropology and Searle 1996 and 2010 in philosophy). Here, Richerson and Boyd frequently refer to individual and perhaps group cultural *psychologies* relating these to such cultural phenomena as norms and values, altruism, the concept of prestige and prestigious individuals and so on.

Overall, crucial in the theory is the idea that evolutionary and cultural processes operate at *different speeds*: Cultural processes of learning and imitation are much faster than the genetic processes of inheritance and transfer of advantages to the next generation, hence the label "dual". Richerson and Boyd nonetheless want a *causal* theory of cultural evolution in which cultural processes both receive and give inputs to and from genetic processes. Yet, as the processes happen at different speeds, the coupling is not one-to-one but rather the cultural realm especially can be conceived as having a certain independence due to its comparatively high speed of change. Figuratively speaking, the approach can perhaps be seen to have 'three balls in the air' at all times, each of which is moving and changing at different speeds: the environment; different cultural processes of learning, imitation, and innovation; and the genetic processes of (biological) evolution. In this triple juggling act, dysfunctional and maladaptive changes are conceivable deriving from the relative independence of the different balls. Cultural evolution reflects the fluctuating balance and interactions of all these processes.

More recently still, Anna Marie Prentiss has provided a theory pluralistic 'extended evolutionary synthesis' of the cultural evolutionary processes (Prentiss 2021) seeking to bring together the most recent developments in evolutionary theory that throw light on the most diverse aspects of contextual cultural and biological evolution and their different tempos. Where classical cultural evolutionary theory attracted followers with the promise of generating relatively simple interpretative heuristics, with the help of which archaeological findings can be situated in an interpretative frame, Prentiss reports a bewildering variety of factors possibly affecting evolution:

> technologies evolve via cultural transmission processes in diverse ways dependent upon the nature of the technology, learning strategies, gender relations, marriage practices, intergroup

https://doi.org/10.1017/S1380203825000017 Published online by Cambridge University Press

> interactions and ecological context. Thus, we recognize remarkably different inheritance systems within and between different social contexts. (Prentiss 2021, 3)

One might justifiably ask 'whether most archaeologists would have a reasonable ability to identify complex processes described by advanced evolutionary models', as Prentiss does in the closing section of her paper (Prentiss 2021, 5).

On the highest level of generality, the challenge or the problem, depending on how one looks at it, is that the classical concept of Darwinian evolution promised a certain *directionality* to evolution, and with that, it suggests certain *markers* of evolutionary adaptive development – at least until the 1960s, these markers included the idea of adaptation being visible in higher energy throughput, so in technological advances, growing populations and forms of political leadership capable of controlling these. In later theoretical developments the directionality has been (rightly) denied. For example, Boyd and Richerson frequently mention the possibility of cultural evolutionary *maladaptation*. Similarly, the *teleological* concept of evolution as having a progressive or other direction has been rejected (Prentiss 2021, 2; however, also see Marcus 2008 on directionality).

However, this means logically that the classical markers of evolution do not apply as indicators of adaptive evolution, because they can be markers of adaptation or maladaptation, or they can even be accidents. In other words, they are not necessarily markers of adaptation at all. The downside here is that now the concept of evolution arguably is in danger of losing its character as a 'heuristic device' (in the sense of, e.g., Zeder 2009, 197) capable of structuring archaeological interpretation by way of suggesting general markers of evolutionary adaptation to which archaeology can connect its more specific data and interpretations.

Madsen and colleagues noted that the concept of evolution acts as a heuristic device, speaking of 'comprehensive models that show how a set of invariant principles interact with variability to [evolutionarily, adaptively] shape historical phenomena in consistent ways' (Madsen et al. 1999, 252). In the article Madsen et al. draw from another American heavy-weight of cultural evolutionary analysis, Robert C. Dunnell (1989), and deal with the question: 'why would people expend such enormous amounts of energy on tasks and objects seemingly unrelated to their survival or to reproduction?' Dunnell attempted to account along cultural evolutionary lines for 'wasteful' behaviours, such as the appearance of 'elaborate' ceremonial activities in certain eastern North American case studies. Madsen et al. conclude that 'Dunnell conceptualized waste as a behavior not involved in reproduction and that can act as an energy buffer in times of environmental shortfall'.

Logically, the problem with this explanation of wasteful behavior as an instance of evolutionary adaptation is that, had there been no environmental shortfall, then the same behaviour would now appear in fact simply wasteful. That is to say, in this case it would seem to be accidents of the environment that make, or do not make, a given behaviour evolutionarily adaptive or simply a mistake. This is not welcome, because the evolutionary explanation typically wants to be a *causal* theory (Richerson and Boyd 2005, 6 and in passim) connecting adaptation, selection and the environment causally, not by accident. In other words, the actual underlying evolutionary process becomes in principle unknown to us, as we cannot plausibly deduce markers that signal successful adaptations, and so cultural evolutionary theory loses its heuristic function as evolution recognises no intention (in philosophy, Jerry Fodor and Massimo Piatelli-Palmarini 2011, have articulated the problem in terms of the 'intentional fallacy').

In such circumstances of theory pluralism and no clear (plausible) sense of how evolution might actually structure socio-cultural change, have archaeologists implicitly fallen back to the classical default markers of evolutionary processes such as demographic change and the development of socio-cultural and technological tools to control this?

In European archaeology, elements of the foregoing views can be found in some accounts of the Neolithization. In the literature overview by Schier (2022, 387) of the European Neolithic

https://doi.org/10.1017/S1380203825000017 Published online by Cambridge University Press

mentioned in the introduction above, it was argued that two broad groups of approaches can be identified:

> Reviewing the Neolithization debate of the last decades we observe a persistence of integrationist approaches on a regional scale, whereas more or less deterministic models claiming to explain the Neolithic transformation (rather than to describe its structure and process) prevail on super-regional or even global scales.

While the 'deterministic' label may be contestable, the classic cultural evolutionary explanatory scheme is visible in many accounts. In some of these views, 'institutionalized differentiation in society that creates hierarchy in decision-making and access to resources' has been argued to generate 'social inequality with the origins and spread of agriculture' in Europe (Price and Gebauer 2016, 136). Elsewhere, Shennan (2008, 86–87) has developed a view of the European Neolithic in which centralized political decision-making 'institutions … that integrated larger numbers of people into a cooperating unit could be more successful in competition than groups not integrated in this way'. In such a view, there is no visible attempt to distinguish Boyd and Richerson's cultural processes from the genetic evolutionary processes – and why do so because, in the timescales covered, the cultural and the genetic will have had sufficient time to causally interact and shape one another and become indistinguishable in the often relatively coarse archaeological record? The explanation and resulting narrative seem therefore to fall back to classic, yet in theory rejected, markers of adaptation treating cultural phenomena such as hierarchical or cooperative decision-making and agricultural innovation as markers of evolutionary advantage and thus as successes in dealing with the changing environmental and other realities.

Elsewhere, in processes triggered by changing climate and demographic pressures, an image of the so-called Yamnaya migration into Central Europe as driven by military-technological superiority of the in-coming 'warrior-like youths' has been proposed (Kristiansen et al. 2017) as well as vigorously contested by others (Brück 2021; see, e.g., Furholt 2021). Again elsewhere, a long-term development towards the European Bronze Age, weapons, weapon technologies and 'warrior aristocracies' are said to have emerged, attempting to assert control over 'globalizing' connectivities between the Northern European and Mediterranean cultures (Kristiansen and Larsson 2005). A persistent 'strong man' narrative is arguably visible in these accounts (Arponen and Ohlrau 2023) as well as a certain domination-based understanding of power (Lund et al. 2022; Forst 2015; Furholt 2025). In this sense, there may remain a 'success and prestige bias' (Henrich and McElreath 2003, 129–130) in cultural evolutionary thought that in practice continues to foreground classical markers of evolutionary success despite their rejection in theory. Interestingly, these generic cultural evolutionary perspectives have found a ready use in commercial analogue and digital gaming. The perspective is evident in titles such as the long-running digital games franchise Civilization and many analogue games (Mol et al. 2017; 2021; Arponen 2022).

A common denominator in many of these games is the foregrounding of the acquisition of technological developments and the *fitness* that these generate in the game environment. For example, in Peter Rustemyer's analogue boardgame *Paleo* – the winner of the prestigious 'expert game of the year' category of the *Spiel des Jahres* award in 2021 – players can craft various generic tools such as the 'torch' or 'stone axe'. Such acquisitions typically involve two things. There is a *transactional* opportunity cost of some kind representing a decision over a short-term versus a long-term benefit: A technological development costs resources and gives no immediate benefit *now* but will do so *later* by improving the player's action economy and efficiency in some way. As such, the cultural evolutionary mechanics in games tend to mirror archaeological ideas about the 'delayed return' nature of groups and societies as they develop towards sedentism, social differentiation and political complexity (Childe 1936; Woodburn 1982). This imagery of a long

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transition from a life on the edge of starvation in the 'stone age' towards more and more techno-cultural sophistication has periodically been challenged in anthropology (Sahlins 1972; Graeber and Wengrow 2021), but continues to animate commercial game design and, with that, the popular imagination.

Another concept from cultural evolutionary theory making rounds in commercial game design is that of the *technology tree* — or a 'tech tree' more colloquially (Ghys 2012). Analogue and digital games depicting cultural evolution or development processes often conceptualise evolution as having a tree-like structure whereby the development of a given technology 'unlocks' a further step or stage in the technology tree, enabling the development of further technologies not available to those 'civilizations' not yet that high up in the tree. The imagery of the tree appeared in Service and Sahlins (1960), where it was used to explain the concepts of specific and general evolution. The origins of the imagery presumably go back to the 'tree of life' concept in Darwin's *On the Origin of Species* (Chapter IV).

The tree-like structure of cultural evolution evokes the now-repudiated concept of evolutionary *stages* of development conceptualizable in terms of the number of branches or forks that a given 'culture' has reached within one and the same tree structure (see Brinkmann & Arponen 2024). This in turn relates to imperialism and the idea that Europe was at a different 'stage' of development as compared with the 'primitive cultures' they were encountering (as 19th and early 20th century anthropology would refer to them, e.g., Tylor 1920).

While the tree-like structure of human development evokes questionable associations today, it also seems to describe the commonly accepted idea that the possibility of the emergence of given innovations is always contextual and dependent on preconditions 'on the ground'. Such contextualism might imply some manner of a tree-like structure where the 'unlocking' of certain kinds of technologies may be necessary for the development of others. Also, it seems indubitable that, historically, for example, the European colonial powers did have a military technological advantage (Reinhard 1996). As Stephen Shennan has noted, '[T]he existence of such power differentials cannot be denied, regardless of any views people might hold about the prejudices in the construction of directional evolutionary schemes' (Shennan 2011, 205).

Be that as it may, game designers would presumably have eagerly seized upon the tree-structure for at least two reasons. As noted above (see also Arponen 2022), game designs typically leverage *transactionality* as a design technique: Building upon mechanisms of opportunity costs and means–ends relationships, games often involve incremental investment–acquisition–investment loops that gradually grow and intensify in their throughput. Second, game designs also typically like to present players with what are often referred to as *multiple pathways to victory*, which the tree-like structure again facilitates rather well in how specialization in, say, military developments, as opposed to cultural or economic pathways to victory, enable variable strategies and increase replayability.

A related aspect is the structuring of commercial games around what in the game industry is referred to as 'area control'. Typically, players score victory points for geographically spreading out into the game world, expanding their cultural borders and building 'cities' and modernizing them with production facilities of diverse kinds. These developments expand the resource and production base, evoking again the intensifying investment–acquisition–investment loop. Arguably, there are uncomfortable implicit echoes of expanding the '*Lebensraum*' and the rest of the ideologies, now rejected in archaeology, about '*Völker*' or peoples and 'archaeological cultures' (Kossinna's '*Siedlungsarchäologie*') – especially as, typically, the player factions often remain the same 'people' (the Germans, the Aztecs, etc.) and 'under the same flag' throughout the millennia as depicted in these games (Brinkmann and Arponen 2024). In the concept of 'area control', there are obvious echoes of colonial and capitalist dynamics, as pointed out in contemporary post-colonial (for an overview, see Hingley 2013) as well as in older classic de-growth (Daly 1996) and environmental feminist literature (Merchant 1980; Merchant 2017; Oksala 2018). Elsewhere, we have examined the connection of these themes to biological ideas

https://doi.org/10.1017/S1380203825000017 Published online by Cambridge University Press

about 'territories' as well as to the concept of 'spheres of influence' in political science (Arponen and Ohlrau 2023).

Developing the model's mechanics

From the start, the development process of our analogue model was conceived to have an interactive and iterative character (in game studies, compare Zimmermann 2003; Fullerton 2008). The development began with a consultation round with colleagues and archaeological literature to identify basic themes and processes. A first iteration of the model was then produced, which was subsequently played with archaeological colleagues. The feedback from this playtesting was fed into the model in iterative development cycles that still continue.

In this manner, already the development of the model was conceived to constitute a phase of *research*, as archaeologists would be interrogated about their knowledge of the period in response to questions arising from play. As one colleague remarked during the consultation phase, 'this game triggers thoughts I have never thought before'. The approach was *not* to hand the archaeologists a ready model but rather to involve them in its continual iteration and development.

At this point in the development, the realization was made that the model was going to have to take a high-level approach to its subject matter, at which point the concept of *cultural evolution* came to the fore. In this sense our model is parallel to many of the most talked about archaeological works of the recent times that also adopt a large explanatory scale (Kristiansen et al. 2017; Kohler and Smith 2018; Turchin et al. 2018). Even such 'Big Data' approaches are based ultimately on simple premises often drawn from cultural evolutionary insights. Also, as will be discussed further below, often it is the cultural evolutionary perspective that makes its way into commercial civilization-scale games.

In the practical design of the model, one of the present authors used their game design experience in commercial analogue game design.[3] The design techniques used included correlating the theme with the mechanics (Gary 2018), where the so-called worker placement mechanic was selected (Engelstein and Shalev 2022, Chapter 9). Then, the 'core loop' (a term frequently used in digital game design), that is, the 'transactional sequence' of play, was designed (Arponen 2022). This loop or sequence designates the core dynamics of the model as they are incorporated into the game's mechanics. In our case, the multi-turn sequence is that of placing workers to collect resources so as to acquire new technologies and generate new workers using those resources. In addition, the placement of settlements on the game map to increase and amplify the worker placement and resource acquisition processes is part of the sequence. To this core loop or sequence, a victory point mechanism was attached, about which more will be discussed below. In practice, the resulting game play mechanics proved to be accessible even for archaeological colleagues not necessarily versed in analogue games.

Here is a brief 'bricks and mortar' overview of the games mechanics as it exists in the current phase of its iterative development (Fig. 1). The model is played on an abstract 'point to point' map consisting of players' starting locations (round spaces) connected by lines to spaces referred to as landscapes (square spaces with round settlement slots attached). The landscape spaces accommodate 'water' and 'forest' landscape tiles, drawn and distributed at random during the setup. In a future iteration of the model, the possibility of basing the model's map on 'real world' locations can be considered.

Each landscape tile features two of the model's five resource types, distributed in a particular asymmetric pattern across the landscape tiles. In addition, a special 'prestige goods' resource type (e.g. amber) exists, with an asymmetric distribution. Each tile can be turned around revealing another two resource types and allowing the players some flexibility in their resource availability.

https://doi.org/10.1017/S1380203825000017 Published online by Cambridge University Press

Figure 1. The analogue model featuring a point-to-point map, wooden resource and 'worker' pieces and landscape and technology tiles.

Players of the model have a set of wooden 'worker' pieces that they may place on the landscape tiles according to certain rules about adjacency to their settlement discs. A worker placed on a tile automatically gathers one of the resource types afforded by that tile. The model is played in phases, starting with the worker-placement and resource-gathering phases. After these phases, players use their resources to pay to take actions as described in the paragraph about the 'core loop' above. In a final phase, the players take their placed workers back from the map and return them to their player mats (to be placed again on the next turn).

Here, we get to the catch that distinguishes this model from its more traditional cultural evolution inspired counterparts: For each worker for whom all the resources produced by said worker were *not* spent by the player (including workers the player was unable to place), the player must lose one victory point and remove the worker in a kind of 'population bust' process. The idea here is not to evoke starvation but leadership delegitimization and 'voting with feet and paddles' processes (Furholt et al. 2020, 28). Victory is adjudicated to the player with the most victory points at the end of the game. The manner in which the model couples the players' victory point gains to the number of workers employed by the players – and conversely, subtracts victory points for failing to do so – represents one of the most central aspects about the model's depictive power; more detail on this is given below.

Here, our analogue models' take on the rather popular worker-placement mechanic differs from that seen, for example, in many commercial games. Typically, the 'workers' simply represent available labour power to be deployed at will and rarely inflicting costs on the player.[4] In our model the worker delivers the resources, thereby challenging the player to enable the participation of the worker in the life of the 'tribe' by managing the use of the delivered resources. This reflects the critical engagement above with fitness, adaptation and productivity as the ultimate ends of cultural evolution, where our contention is that inclusive participation (inclusive fitness) is more properly the end goal, a view deriving from the Life History and the Capability Approaches discussed in more detail below.

As mechanical systems, games as analogue models constitute a truly unique medium characterized by the *participatory* perspective of actively *playing* through simulations of historical processes as opposed to passively watching them in film or reading about them in literature

https://doi.org/10.1017/S1380203825000017 Published online by Cambridge University Press

(Nguyen 2020). As with theories and big picture narratives, say, of the emergence of the European Bronze Age (Kristiansen and Larsson 2005) or 'neo-processual' approaches to the European Neolithic (Schier 2022), analogue models of it are also necessarily based upon implicit or explicit ideas about the nature of the key processes at play in these historical transformations. In the work of the modern classic game studies scholar Ian Bogost, the term 'procedural rhetoric' became part of the canon in the still-young discipline of game studies (Bogost 2007). 'Procedural rhetoric' designates the way in which the game or model structures and defines its own possibility space through its rules and processes and thus enables and constrains what can be represented in and through the system. The rules and system interactions have thus a way of speaking a 'rhetoric' of their own that enables and constrains representation without using words or concepts. Parallel observations have been made about computer-based modelling in archaeological contexts (Deicke 2020, 18).

Recognizing the high-level scale and scope of our approach, in this part of developing our model, our starting point was to critically probe into the concept of cultural evolution in terms of how it is conceived in anthropological, archaeological, and other related literature, on the one hand, and how it features in so-called civilizational games in the commercial realm, on the other. From this critical starting point we went on to develop our model's approach based on the *Life History Approach* to cultural evolution and combined it with our archaeological interests in the *Capability Approach*. We will describe these aspects in the following sections.

Our model of cultural evolution. The Life History Approach meets the Capability Approach

The development of our model proceeded against the background of the foregoing ideas concerning cultural evolution in anthropology and archaeology and in commercial games. Our model sought to explicitly construe a model world that was not based on a simple Darwinian model of 'fitness through trait acquisition' and the associated investment–acquisition–investment loop. Instead, our perspective draws from the so-called life history and the Capability Approaches. In this section we describe the key ideas of these approaches and how we used them to construe the basic dynamics of our model.

The so-called *Life History Approach* to (cultural) evolution often begins from the observation about the considerable length of the human adolescence in comparison to other primates and mammals. In the words of some of the pioneers of the approach, Hillard Kaplan and colleagues observed that human lives exhibit 'an extended period of juvenile dependence' and 'support of reproduction by older post-reproductive individuals'.

> [This] extended learning phase, during which productivity is low, is compensated for by higher productivity during the adult period and an intergenerational flow of food from old to young. (Kaplan et al. 2000, 156)

From these observations, the Life History Approach develops the more general point of view that humans can garner an evolutionary advantage from investing in their own communities and kin, however exactly conceived (Ensor 2011; Ensor 2021). In this sense, human communities may adopt a 'slow' and 'inward' strategy of energy allocation in reproduction and training over the long juvenile period, with 'returns to investments' made 'outwards' later when these members reach an older age (Sear 2020). By contrast, the classical concept of cultural evolution would seem to emphasize the reproductive drive and predicate a 'fast' strategy of optimization, efficiency, adaptation, trait acquisition and the search for fitness to that goal. The Life History Approach recognizes that there is temporal dimension to cultural evolution, a trade-off between current and future reproduction and fitness. In archaeology, the Life History Approach has been suggested to

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explain the fluctuation in prehistoric human demographic development relating to the 'agricultural revolution' and trade-offs this may have generated in terms of investment in reproduction and investment in health of communities (Shennan and Sear 2021). In fact, we found that, unless the players watch out, our analogue model reproduces these 'population bust' dynamics in play, which will be discussed in greater detail below.

As a second key influence behind our concept of cultural evolution as presented in our model, we have adopted the so-called *Capability Approach* as it originates from the work of the Nobel Prize-winning economist and philosopher Amartya Sen (classically in Sen 1980; for an overview, see Nussbaum and Sen 1993). In Sen's description, the Capability Approach views:

> human life as a set of 'doings and beings' – we may call them 'functionings' – and it relates the evaluation of the quality of life to the assessment of the capability to function. (Sen 2012)

Central to this view is the idea that *being able* to lead an active life, having opportunities and perspectives or having capabilities to function ('doings and beings') is the criterion of how satisfied human beings might be with their lives. Sen's ideas about capabilities constitute the groundwork for the United Nations Human Development Index (UN HDI) based on the idea, as the UN HDI website puts it, 'that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone'. As such, Sen's ideas contrast with the 'havings'-based concept of human material well-being in the long philosophical tradition going back to early utilitarianism (Cohen 2004). Recently, Sen's ideas have begun to make inroads into archaeological analysis (Arponen et al. 2016; Smith 2019; Vésteinsson et al. 2019; Munson and Scholnick 2021; Hutson 2023; Arponen et al. 2024; Ohlrau et al. 2024).

In terms of the mechanisms of our analogue model, while the model in some ways deploys a fairly classic Darwinian core loop of worker placement and increased resource collection through various pathways of amplification of these placements, our model adds a central twist relating to the 'win conditions' of the model. To mimic the Life History Approach's emphasis on 'slow' investment in community on the one hand and the Capability Approach on the centrality of 'doing and being' to human well-being on the other, in our model players score points from acquiring new members of the community (workers), and conversely, they lose points by being unable to involve them in the community activities and/or fully use the resources these members generate. For us, the mechanic couples the idea of investing in communities as involving the nurturing and inclusion of new members of the community in its activities. The idea of the player as a 'manager' of the affairs of their in-model 'chiefdom' can find support in certain 'social'-based, as opposed to 'economic entrepreneur'-based, views of prehistoric leadership (Roscoe 2012), in concepts of the *corporate-network* (Feinman 2001), and in *heterarchical* (Crumley 1995; Crumley 2005; Ray and Fernández-Götz 2019) as well as anarchist (Angelbeck and Grier 2012; Angelbeck et al. 2018) views of political organization. We also believe the concept of 'intrinsic value' in Widlok (2013; 2017) can be understood to relate to capability of social participation as an intrinsic end.

As a result of the 'win conditions' our model adopts, the role of technological development shifts in comparison to the classic cultural evolutionary model. Technologies now do two things. Some of them work in the classic 'Darwinian' manner and improve the resource acquisition engine the players develop in the model (their productivity), which in turn amplifies, among other things, the acquisition rate of more 'workers'. Yet, such an expansion can be a trap if the expansion occurs too fast, such that the new members cannot be fully included in the activities of the community, represented in our model by the player's inability to make use of all the resources generated by a given worker – this is the 'population bust' phenomenon referred to above. This contrasts with the classic cultural evolutionary model's implication that expansion of productivity represents an evolutionary advance *tout court* in absence of questions regarding whether such expansions have communally beneficial or harmful effects, or whether such expansions benefit the

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community in some larger sense. In fact, in the classic view, population growth is conceived to precede and propel innovation, as increased population pressure is thought to necessitate the development of societal solutions (more on this shortly). So, in this sense, societal solutions appear as responses to external pressures rather than as fruits of 'inward' investments into the life history and capabilities of the community.

The possibility of a 'bust' in the model mirrors Sen's classic critique of exclusively economic 'havings-based' concepts of value, as discussed above. Classic economic measures of the performance of economies in terms of total throughput (say, the gross domestic product (GDP)) not only is blind to distributional differences inside those economies but also does not typically consider the impact of those distributions upon capabilities of different subgroups to 'do and be' something in life, as the critique of the classic economic paradigm from the Capability Approach camp has had it (ul Haq 1995).

The classic models of cultural evolution occasionally raise the question about the *direction of causality* in cultural evolution. For example, in Johnson and Earle's concept of the causal direction, as they put it, 'it is fundamentally population growth (of which warfare, as in the example above, is one result) that propels the evolution of the economy' (Johnson and Earle 1987, 5). That same direction of causality is arguably present, for example, in Shennan (2008) and Kristiansen et al. (2017) (discussed above).

In our model, being something *playable* by humans, the model's dynamics are, so to speak, 'primed' by assuming a player is interested in winning the game within the 'bounded rationality' of their grasp of the game and certain aspects of randomness pertaining to the model's setup (Simon 1957; Kahneman 2011). The player will understand, or come to understand across multiple plays, how the game can be won. As explained above, our model ties the winning and losing of victory points to the players' 'reproductive success' in bringing more workers into play and, crucially, keeping those workers participating in the activities of their in-model 'chiefdom'. The direction of causality is from the concern of the player to maintain participation to the means the model offers in terms of technological and other developments and behaviours that facilitate the expansion of the capabilities of the 'workers' (implying perhaps a kind of 'kin selection' dynamic see Hamilton 1964).

The direction of causality must not necessarily be seen as an 'artificial' product of the priming of our model but rather as an effect of the underlying meta theory based on the life history and Capability Approaches. If this is so, this might show us that Johnson and Earle, too, end up with their concept of the direction of causality because of the assumption that primes their thinking, namely, the familiar evolution theoretical assumption that organisms, as humans do, always necessarily as a matter of a biological fact 'aim at' reproductive success. Our model replaces this assumption with another one, namely, with the (implicit) idea in the capability appoach that individuals 'aim at' their own and their group's capability expansion (to which reproductive success can be an important *means*). Johnson and Earle evoke the aforementioned 'kin selection' theory, using it to explain how altruistic self-sacrificing behaviour, too, can be viewed as aiming at 'reproductive success', only they conceive it broadly to help that of kin. Similarly, our model can evoke the kin selection theory to account for the altruistic concern for 'kin capability'.

The foregoing also means that both Johnson and Earle's model and our model cannot speak of having *discovered* that the direction of cultural evolutionary causality is such and such but rather that direction goes into the respective models as a *meta-theoretical presupposition*. This does not invalidate the models but does call attention to reflectivity about the fundamental assumptions underlying our models.

The discussion in previous sections (of Richerson and Boyd 2005; and Prentiss 2021) concluded that there may be an internal tension between theory pluralism about cultural evolution and the status of such theories as *causal* theories. The argument there was that whatever markers of fitness such theories might suggest, they cannot serve as *causal* markers of adaptation and fitness, since the vagaries of the differently paced cultural and evolutionary processes in a changing

https://doi.org/10.1017/S1380203825000017 Published online by Cambridge University Press

environment might by coincidence cancel out the putative advantages. Logically, this means that individuals and groups are evolutionarily best off by investing in a broad-based manner and in the long term in the capabilities of future generations, in groups rather than individuals, and thereby hoping to create the conditions for adjusting or perhaps even exploiting the vagaries of change. That is to say, the capability and the Life History Approaches might actually provide us with good heuristics, not a causal model, of adaptation and fitness in cultural evolution.

We conclude with one final point about the impact of modelling decisions on the causal processes exposed by the model. Some in archaeology have speculated about the frequence of different *personality types* in human groups – from extreme altruism to extreme egoism – and the impact thereof on human development (Hayden 2014, 15–17). Analogue models as *participatory* media allow a unique perspective to such personality dynamics as players interact with each other and the model environment. Hayden's conclusion was 'that individuals who aggressively pursue their own self-interests constitute a small but extremely powerful element in all populations' and that such:

> aggrandizers are probably responsible for many of the fundamental transformations of culture that archaeology has been able to chronicle over the past 40,000 years. (Hayden 2014, 17)

Our experience of player interactions does not obviously support such a conclusion. True, different players bring different personality types to the table – this is readily visible. However, there is no sense to saying that 'aggrandizers' necessarily on average dominate play. Rather, the impact of personalities is contingent and contextual to the type of game being played (see in particular 'bounded community' in Salen Tekinbaś and Zimmerman 2003, Chapter 28; see also Chapter 8 in Schell 2008). In some systems, semi-cooperative play is a necessity to not have the other players turn against oneself – a phenomenon known as 'ganging up' or 'bashing the leader'. It is not obvious that an 'aggrandizer' necessarily is the best dispositioned to 'play' such game systems. That is to say, again, the presuppositions going into the model design impact the kind of conclusions one can draw from it.

Conclusion

With the foregoing discussion of our analogue model, we hope to have illustrated the value of play in and for archaeological research (*pace* Politopoulos et al. 2023). Analogue models can be an inexpensive, low-skill, accessible method of examining fundamental presuppositions of archaeological models by utilizing games as a unique, *participatory* medium.

By economic measures alone, there are strong indications that games and gamification will be the 'medium of the future' that publics increasingly use, among others, to engage with representations of cultural heritage. At the same time, the representation of cultural heritage in the 'blockbuster' digital and analogue games often feed on models of *cultural evolution* whose underlying presuppositions should be made explicit. It is an imperative that archaeology changes with the times and utilizes what gamification can offer to archaeological research, teaching and public outreach.

In our model we incorporated insights from the life history and Capability Approaches to develop a playable analogue model of selected aspects of the European Neolithic and Bronze Age. The model affords a perspective to these processes, emphasizing the community participation and (kin) capability expansion aspects of human development, whereas the classical cultural evolution models have tended to emphasize demographic growth and expanding investment–acquisition–investment trajectories. We believe that, in the present times of climate and war stress, our model

https://doi.org/10.1017/S1380203825000017 Published online by Cambridge University Press

can offer a more hopeful perspective on the human past, present and future without compromising on scientific insights.

Acknowledgements. The authors would like to thank our colleagues for playtesting and commenting on different iterations of the model.

The article was written in the framework of the Excellence Cluster ROOTS – Social, Environmental, and Cultural Connectivity in Past Societies, with funding from the Deutsche Forschungsgemeinschaft (DFG; German Research Foundation) under Germany's Excellence Strategy – EXC 2150–390870439.

Notes

1 A classic digital game is the Civilization franchise, currently with *Civilization XI* in its sixth iteration (2K Games 2016), with the 7th game about to be published at the time of writing this. In the analogue game space, the German commercial archaeologist Peter Rustemeyer's *Paleo* (Hans im Glück 2020) evokes the vagaries of hunter-gatherer life and has enjoyed much recent success.

2 Figures from https://gamerhub.co.uk/gaming-industry-dominates-as-the-highest-grossing-entertainment-industry/ (last visited on 1 March 2024).

3 *All Bridges Burning: Red Revolt and White Guard in Finland, 1917–1918* (GMT Games 2020).

4 Some worker placement games do have players pay a subsistence or accommodation cost for each worker, usually exacted as a deduction of some of the resources the workers themselves have produced (see, e.g., *Agricola*, Lookout Games, Uwe Rosenberg, 2007). These discussions, however, take us too far into specifics about game design and may not interest the readers of this journal.

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Cite this article: Arponen VPJ and Brinkmann J (2025). Games and gamification in archaeology: Developing analogue modelling as a research tool into cultural evolutionary processes. *Archaeological Dialogues*. https://doi.org/10.1017/S1380203825000017