

# GROWING COMPLEX GAMES

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## ABSTRACT

Do computer simulation games display emergent behavior? Are they models of complex systems or 'life' systems? This paper aims to explore and investigate how games studies can use complexity models and emergent behavior to critical analyzes the computer simulation game. (God Games, Real-Time Strategy Games, and City Building Genre) The developments in and from the natural sciences (Complexity, Emergence, Self-Organization, Non-Linear Dynamic Systems) are important intellectual tools that can aid in the development of this discipline. Computer simulation games have a similar strategy to games like Go or Chess; even though they may have fixed rules they can display unpredictable patterns of play (emergent behavior). This approach is in contrast to current models that are being deployed within the field of games studies. The introduction of complexity and emergence into game studies can allow for computer simulation games not to be dismissed but to be explored and explained, as complex games, rather than just simply simulations.

## Keywords

Play, Complex Games, Emergence, Simulation, Computer simulation, Deterministic, Agent, Behavior, Pattern

Games Studies is a discipline that takes seriously the theoretical analysis of the computer simulation game/video game. At the moment it has not developed a grand unifying theory that speaks about all aspects of games exhaustively. Rather it is a collection of newly forming theoretical and critical paradigms. The current state of games studies is bound almost exclusively within the humanities and particularly with literary and cultural theory. I am suggesting that the present model for games studies is far too narrow and limiting and it does not allow for the development of the discipline. My theoretical perspective sees the need for games studies to become much more multidisciplinary and interdisciplinary in its approach towards games. I believe that many computer simulation games particularly the games that are popularly called 'Strategy games' and 'God games' are more complex in nature than they are normally given credit for. They are complex because their designs try to mimic models that imitate aspects of the 'real world.' These 'Life-Sims' allow us to interact with physical working simulations of selected human political, social and cultural phenomena. Through the interaction of playing these

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games I believe we are given insight into the workings of our own complex society. I am not proposing that they are accurate models of ‘real world’ phenomena but they do have the behavioral characteristics of them. These computer simulation games produce complex problems, which leads me to think that they are complex within themselves. Many of the games have a similarity to strategic games like Go or Chess, in that they have simple fixed rules which generate an inexhaustible amount of possibilities of game play. The study of complexity, emergence, and self-organization and their adaptation and application of their principles to computer simulation games, can aid in a fuller explanation and understanding of these games. Games studies can use complexity and emergent models of behavior to critical analyze the computer simulation game. Seeing games as complex emergent models will change our perception of seeing commercial computer simulation game software not just simply as entertainment or toys.

### **MENTAL MODELS, SIMULATIONS AND COMPUTER SIMULATION GAMES**

Humans understand the world by constructing working mental models in their minds. Mental models are representations in the mind of real or imaginary situations. [1] They are dynamic cognitive constructs that are ever-changing and evolving. These models allow us to harness the knowledge of past events in order to better understanding the present and the future. These models are incomplete, because they are simpler than the entities they represent. As a consequence of this the models contain elements that are merely representations of reality. They are imitations because the models have no idea about how their counterparts operate in the world. [2] Therefore they can only mimic their behavior. Mental models are little more than high-grade simulations in the mind. [3] These mental models or simulations can be designed and produced as working physical models that mimic the ‘phenomena ’ that we wish to understand or explain. A mental model or simulation may resemble an object from the outside but not from the inside, as we cannot know accurately the workings inside the ‘phenomena’ we wish to understand. Simulation is a technique for achieving understanding and predicting the behavior of systems. They can imitate real systems but this imitation is possible only because distinct physical systems can be organized to exhibit nearly identical behavior. [4]The computer has now given us the opportunity to develop simulations that can attempt to mimic real or imaginary environments or systems. Computers can compute and simulate phenomena that are really difficult to understand, all we need to know are the rules.

Computer simulation games can also mimic and model ‘real-world’ phenomena as diverse as ant colonies, to managing a football club. The games are imaginary worlds in which players experience blips of graphical representations of simulated ‘real life’ situations. [5] Computer simulation games are procedural representations of aspects of reality. [6] They operate metaphorically and do not literally recreate the representation of their subject matter. A simulation is a dynamic system: a set of parts that interrelate to form a whole. [7] They can be real-time or turn based war strategy games, city building games, or any other management resource game. (Example, God games, Real-Time or Turn based strategy games) The majority of these games is not about individuals but is about groups and societies. Some game critics oppose this and see the simulation games as an exceptionally tedious genre. [8] That emphasizes the

development and nurturing of a created virtual city, or tribe as a pet. The player they suggest doesn't count as an individual. The games seem to offer the position of infinite power in order to whisper that, the individual has none. [9] However, this is a misconception, as it suggests that the importance of the player is unequal to the importance of the design of the game. Critics who support this position are looking for predictable and exhaustible game play patterns that are easily recognizable within the game. Simulation games or what I am calling complex games are unpredictable patterns within the game play, patterns that describe the potential for evolutionary growth. These types of games have been described as emergent software. [10] Software that demonstrates basic principles that are now found in all sciences that searches for simple explanations for complicated patterns.

## **COMPLEX GAMES**

Complex games are computer simulated strategy games that model and mimic selected elements of complex systems. (Complex systems are self-organizing, adaptive systems) Complex games can be from any computer simulation genre. They allow the player to play with complicated and often complex social phenomena. Many of the complex games mimic aspects of enactments of 'real-life', present or historical. Games like Sims 2, Sim City, Civilization, and Rome: Total War, Children of the Nile are prime examples of what I am calling complex games. Complex games mimic the cultural evolution of complex human societies and in so doing provides an opportunity for us to gain some insight into complex problem solving. The artificial societies grown in the computer demonstrate that certain sets of micro-rules are sufficient to generate a macro-outcome of interest. The evolution of artificial societies within complex games allows the player to "grow" social structures. It mimics a dynamic system but yet it is a reality that does not have 'real world' consequences for the players. By interacting with the games the player will need to play with them in order to learn from them. The games provide a socially acceptable means of rehearsing non-threatening ways to deal with conflict typical of the culture. [11] The more complex a society tends to be the stronger the tendency toward games of strategy. [12] Over the last 12,000 years human societies have grown more complex. Human history as a whole has been characterized by a seemingly inevitable trend toward higher levels of complexity. A complex society is generally understood to refer to such things as the size of a society, the number and indistinctiveness of its parts, the variety of specialized social roles that it incorporates. [13]

### **What are Complex Games?**

The games model a slice of the 'real world'; they are designed to function by operating a partial set of formal rules. The rules do not attempt to replicate all of the rules that exist in the real world. Instead, they operate on a chosen subset of rules that will govern cause and effect or action and reaction within their complex worlds. The complex game resembles a complex system from the outside but not from the inside. They can also imitate real physical working systems but this is only an imitation as the game does not simulate the underlying principles of the models. Complex games are constituted by a large number of simple units forming nodes in a network with a high level of interconnection. The behavior of a system is not determined primarily by the

properties of individual components of the system, but is the result of complex patterns of interaction. [14] The simple nonlinear interactions between large numbers of individual units can lead to surprisingly complex patterns at the group level, patterns that often are unexpected even if detailed knowledge exists of the group's members and their interactions. [15] Complex games have the capacity for self-organization which enables them to develop or change internal structures spontaneously and adaptively in order to cope with, or manipulate, their environment. [16] They are dynamic non-linear models that allow the player to interact with the environment and use components that have separate elements with different properties (this might be workers and soldiers in the game context) individual behaviors. The behaviors and the patterns that result from all of their interactions can be observed. Complex games are normally designed using both a bottom-up modeling techniques, (which are also known as agent-based modeling and artificial social systems) and a top-down approach. (Pre-specifying some of the parameters) The purpose of these modeling techniques is to understand properties of complex social systems through the analysis of simulations. [17] A top-down, approach requires each of the behaviors to be explicitly specified by the programmer, whereas the bottom-up approach depends on low-level mechanisms to cause high-level behaviors to emerge. [18] The argument for the bottom-up approach is that as the complexity of the game play patterns grow, it will become impossible to create all the necessary behaviors by hand. The top-down approach to creating agents will eventually become too unwieldy to use, whereas the bottom-up approach is much more scaleable. [19] This has been one of the reasons leading to a recent proliferation of the bottom-up, models being used in games like Children of the Nile.

### **Complex Games and their Deterministic Universe**

Complex games are determined, but to declare that the complex game is therefore fixed is to state something false. Is the game world, really a world without prevention, without lost opportunities, without genuine possibilities? In many complex games there is prescription, that the conditions for victory have already been determined. Yet many of these games, because of the various strategies that can be followed, produce unpredictable results. In a complex games like Sims 2, Rome: Total War and Children of the Nile, the games very rarely return to the same playing situation/state twice, a player will not be able to play the same way twice. The play will be different nearly every time due to slight variations that take place during the game. This variation is often enough to produce a new collective pattern of game play which in turn creates novelty. The novelty produces the new unpredictable behavior. However, it should be made clear that the novelty or the new patterns of game play happen over a period of time within the game play.

The rules and conditions for victory in these games whether the rules are simple or complicated; fix the complex game as a deterministic universe of play. However, because a world is deterministic this does not mean that it is without possibility. The determinism of the complex game world does not rob the player of their abilities to avail themselves to the opportunities presented. To believe that true possibilities disappear under determinism is a mistake. [20] The distinction between being a game with an open pattern of play and being a game with a closed pattern of play is strictly independent of determinism. In general there is no paradox in the

observation that certain phenomena are determined to be changeable, chaotic, and unpredictable. [21] What about improvement? Can an agent in the deterministic world of Sims 2 realistically hope to improve its life? The answer to this question has nothing to do with determinism and everything to do with the game design. Computer programmers have already proved how deterministic computer algorithms can adapt themselves to changes in the environment and learn from their mistakes. [22] If we consider a simple deterministic ALife world: An artificial Life world of programmed ants, turtles of single cell animals that exist only inside a computer. At one level nothing ever changes; pixels do the same thing over and over forever, following the simple rule of physics. At another level, we see different kinds or worlds, things may become varied. [23] In some deterministic worlds, there are things whose state changes over time, so determinism does not imply a fixed nature. [24]

## **PLAYING AND GROWING COMPLEX GAMES**

The complex games below simulate the experience of playing ‘real’ historical events and historical periods within history. The games play with the fantasy that we are part of a past civilization or interacting with historical moments. The design of the games represents a collection of counterfactual scenarios that work on the ‘what if’ principle. What if I was emperor of Rome or Pharaoh of Egypt? It seems as humans we cannot resist imagining alternative scenarios: what might have happened, if only we had or had not done something. An important problem when discussing complex games is to understand that not all games are accurate representations of dynamic systems. The data simulated from a complex game comes from a specified set of game rules rather than a direct measurement of a ‘real world’ phenomenon. [25] One of the key issues for any model is how valid a representation it is of the behavior and characteristic of the system being simulated. [26] In order for the model to give an adequate prediction the dynamics have to be similar to those of the real system it is modeling. [27] Complex games; primary concern is entertainment and therefore is not a model that can produce accurate ‘real world’ prediction. However, they do represent behavior and characteristics of the systems they simulate like the traffic flow in Sim City 4.

Complex games can be said to act as ‘transitional objects,’ objects that allow the player to move from one state of understanding to another through the play experience. The player can experiment with various techniques and decisions with the knowledge that there are no consequences for them within the real world. The player is simply experimenting with an object

that for them in some way represents reality. This allows for the experimentation and the acting out of these representations of reality and experience. [28] This makes the game a representation of the ‘real world’ with which the player can play and grow objects without having to fear the consequences. Playing with reality allows a player to better understand more of the world in which they live. In playing with these transitional objects the player is so engaged and absorbed by certain activities that they seem to flow along with it in a spontaneous and almost automatic manner, being carried away by the activity. [29] The experience of playing with this object seems so enjoyable that player will continue regardless of other duties and often great cost, for the sheer sake of doing it. Play for adults invokes too many misconceptions, for example, play is traditionally viewed as applying only to young children. [30] Play is something to be given up when you grow up. In our modern complex societies it is very risky to suggest to an adult that they are playing. The connotations of the suggestion do not have very positive meanings beyond childhood.

### **Playing with Complex Societies: Immortal Cities: Children of the Nile**

Children of the Nile: Immortal Cities is a game produced by Tilted Mill Entertainment and published by Sega. It is a computer simulation strategy game from a fast growing genre called City Building Games. The leader designer Chris Beatrice made the one of the early popular city games Pharaoh and a lot of the team also worked on other city building games like Emperor: Rise of the Middle Kingdom and the legendary Zeus. Children of the Nile qualify as a prime example of what I am calling complex games. I believe that the producers of this game also want the player to be aware that they are playing with a complex model. Part of the game advertising highlights this, for example on the box cover the publicity suggests to prospective buyers that they can “Create Living Cities”. “Everyone in your city is alive- they work, they play, they have children, they grow old. The happiness of your people dictates your success, after all, only a prosperous people can rule the world.” Even the reviews enforce the same point “....Stunning 3D environments acting almost like a living city.....” PC FORMAT. All these comments are implying that the game has the complexity of an actual city.

#### ***Game Scenario***

In children of the Nile you are the Pharaoh of Egypt the Old Kingdom. You have to build a glorious capital city and evolve from it a nation to rule. You must build a large and efficient government to realize their goals, and a prosperous private sector to support their government. It takes several generations to build a single capital city, and at the end you have to build a suitable tomb to ensure stability as power passes from one ruler to the next.

#### ***Complex Society and Evolving Play***

There are two important concepts to be understood about the nature of a complex society firstly that it is unequal and secondly that it is heterogeneous. (Something that is composed of unrelated parts).The inequality may be thought of as unequal access to material and social resources. Heterogeneity is a much more subtle concept. It refers to the number of distinctive parts or components to a society, but at the same time to the ways in which a population is distributed among these parts. In Children of the Nile it’s your responsibility as leader to encourage the

growth of farmers, nobles and peasants within your society. In other words you start with stupid undifferentiated units, who then 'self organize into more complex higher order units. At the beginning of the game your population of agents is divided equally among the occupations and roles within your society. The agents graphically represent the Egyptian people of the Old Kingdom. The game consists of a number of local interacting agents. Each agent's behavior is governed by a small set of simple rules, though it is typically assumed that the agents do not know or cannot calculate the collective patterns resulting from all agents' actions. The various states of each agent's life are fixed, unless it changes through interaction with other agents or with their external environment. [31] The large-scale effect of local interacting agents produces a novelty within the system. The produced novelty is often surprising, because it can be hard to anticipate the full consequences of even simple forms of interaction. Although the assumption may be simple, the consequences may not be at all obvious. Distinct group behaviors often emerge from interactions of individual agents operating in these artificial environments. The central focus of the game is on the Egyptian people, the graphical agents who inhabit your growing society. Instead of concentrating on the buildings the game concentrates on the needs of the agents (the people). In the game the player has to aid the agents in their aim for a better life, by moving them up in the society from simple villagers to peasants to shopkeepers and beyond, into the elite professions. At the start of the game the agents are homogenously distributed across the available professions. However, as your society grows so do the wants and needs of the agents. The increase in the life aims of the agents increases the heterogeneity of the society. Although the needs of each agent are determined by the games design and programming, the expectations vary by social class, and their needs for various services are dynamic and somewhat unpredictable. The needs and satisfaction of the agents are not within the control of the player. Agent families can become dissatisfied if their needs are not met, particularly if bread, household wares and services are not available. The loss of control within the game causes a chaotic moment as the game slips between order and disorder between equilibrium and non-equilibrium. At these moments of instability and disorder a bifurcation point appears in the game. This is the point where a new solution or a new path of choices appears for the player to engage with during the game play. These new paths will produce new behavior from the player. The emergence of order at these critical points of instability within the game is an important concept in understanding how complex games can be said to display emergent behavior. So despite the simplicity of the individual agents' cognitive and behavioral capabilities, their interaction with other agents and in their environments can produce complex emergent structures and dynamical behaviors of individuals and groups. [32] During the playing of the game the decisions made by the player are both reversible and irreversible. Reversible in the sense that the player can stop and restart the game at the same point they last saved at. Irreversible, because there is no guarantee that the exact situation will appear in exactly the same way as previously experienced. A player will never play the same way twice they will also play differently every time due to slight variations that will take place during the game it is this variation that helps to create the emergence and its novelty. The nature of complex games is such that an outcome can't be predicted beforehand; it can vary greatly depending on what the player brings to the game (e.g., luck, skill and creativity).

In *Children of the Nile: Immortal Cities* the player does not really ‘play’ the game as grow and nurture it. The player ‘grows’ their society but both the society and the people grow in unpredictable ways and there is an apparent loss of control over them. Although there are prescriptions in the game through the various scenarios and campaigns, to the observer of the game there is no way of knowing the outcome. The successful completion of each level of a scenario or campaign creates a newly emergent society. The potential of these games is not as a conveyor of values, but as a way to explore the mechanics of dynamic systems. Complex games are designed with clear and simple goals but with uncertain outcomes. The challenge in the games can be increased or decreased by the learner to keep the challenge of the task optimal. Fantasy is used to encourage players to imagine that they are completing the activity in a context in which they are really not present. Even the simplest strategy games contain a complex set of properties. Complex games can inform us that complex situations can have simple causes. A society with a great deal of heterogeneity, then, is one that is complex.

### **Playing with States: Rome Total War**

Rome Total War is the third installment in the Total War Series. It is designed by Creative Assembly and published by Activision. The game presents spectacle real-time 3D battles and a rich stimulating world of political intrigue. Again in this computer simulation game the player is expected to play and grow an artificial society. Rome Total War is a computer simulation turn based strategy war game. Turn based strategy war games in particular are very deterministic by nature, as there is a waiting period after each move. There are lots of similarities between board games and turn based games. These games like Risk, Chess, Go reside in a determined universe where the conditions of victory are known well in advance before play. What then becomes important is not the result but the strategies used by the player to obtain the result. Even if the strategies are made clear as the game progresses the strategies will twist and change forcing a player to create new patterns of play. These new patterns of collective complex play are both unpredictable and novel, as they generate new dynamic behavior from both players. In other words the behavior adapts. This produced novelty is recognized as emergent behavior. Emergence is a result of self-organizing process in which pattern at the global level of a system emerges solely from numerous interactions among the lower level components of the system. In other words the interactions of agents and decisions made by the player in different parts of the game can have a global effect on the overall playing of the game. The chaotic behavior is similar to the well known ‘butterfly effect’. If a player makes a decision to attack a city in Europe, there are unforeseen and unpredictable problems in Africa.

### ***Game Scenario***

Rome: Total war is a game of epic real-time warfare and grand scale empire building, including politics and treachery that spans more than 100 years. The game is set in 270 BC until around 14AD. In this time the Roman Empire controlled the Mediterranean world and much of Europe. The game is split into historical battles and a turn based Campaign Map. In the battlefield the player will command troops in real-time engagements. The campaign map allows the player to manage resources and to slowly grow and evolve their own empire. This is the world of

Hannibal, Julius Caesar, Cleopatra and a world of soldiers, gladiators, tyrants.

### *Playing Dynamic Historical Models*

In Rome Total War the player is a leader of a Roman faction, a noble family tied to the state of Rome. The game is a race to see who can conquer the most territory and use their influence with the senate to become the new Roman Emperor. However, you are not the only family; you will be challenged by two other family factions who will also want to rule the entire Empire. The game design of Rome Total War seems to borrow quite heavily from the state model. In the game you rule with authority and monopolize sovereignty and delegate power like the state model. You can draft people for war or work and levy and collect taxes and enforce laws. As a state, of course you are in general larger and more populous than tribal societies, so that social categorization, stratification and specialization are both possible and necessary. However, throughout the game there is a need to establish and constantly reinforce legitimacy of your rule. Hierarchy and complexity are rare in the development of human history, and wherever present there is a constant need to reinforce it. [33] No societal leader is ever far from the need to validate their position or policy, and no hierarchical society can be organized without explicit provision for this need. [34] In the game all your leadership activities and societal resources are continuously devoted to this purpose. In fact it is the reliance to these challenges to your authority that drive the game. The challenges give the player the opportunity to use the excellent 3D game engine to fight battles.

The player normally fixes on a strategy before playing the game therefore setting the conditions for victory, thus the game is deterministic. In RTS and turn based strategy games the conditions set could be to gain greater territory or to destroy all your opponents. Once the player has chosen a particular strategy at the outset, it would seem that all the interest and surprises have been removed from the game. [35] All that apparently remains is a kind of automatic playing out to reach a determined end. If a player knows exactly how the game is designed then they ought to be able to predict the computer's designed response to any of their moves. The predictions should come true provided the computer performs as designed. However, a player has no prior knowledge of the computer opponents' strategies. The player's best hope of winning the game is to predict the responses of their computer opponent. This can be attempted by trying to figure out what the best or most rational move would be given the rules and goals of the game. [36] The player can try to predict the computer's responses to their moves, by simultaneously trying to build a mental model of their computer opponent's actions. Assessment of the computer's; most rational move may depend, not only on the player's assumption that the computer has information about the present nature of the game, but also on whether the player believes the computer has information about their own ability to see several moves ahead. [37] The individual player will not be able to predict the final outcome. They would not be able to calculate the outcome of the first played moves, even though the conditions for victory have been determined. The player needs to decide what to do in each unforeseen event. But will quite often have no idea what particular possibility will arise because of the computer players' actions. In the game even though the strategies of the opponents are known an observer who has an omniscient overview of game will encounter surprises similar to those encountered by the non-

computer player. [38] Even if the observer knows the initial strategies and the details of both the player and the computer's procedures and strategies, it is almost impossible for them to predict the course of the game. [39] It is this unexpected twist and turn for the player in Rome: Total War that creates observable, unpredictable patterns of play. The produced novelty and emergent patterns which can be observed in the game.

### **Not all Strategy Games are Complex Games and not all Complex Games are Strategy Games**

Complex games are games that challenge the current state of many computer simulation strategy games. Not all computer simulation strategy games would qualify as complex in nature. Some computer simulation strategy games do most of the work behind the scenes, in order to produce a result that appears complicated. But which in actual fact is an illusion of complexity, - this doesn't mean that novelty isn't observed but its patterns of possibilities are exhaustible. In many "traditional" strategy games the game world or the setting is transformed into a very clear set of rules with clear feedback. The results of the player's actions and decisions are clear and predictable. The games perform uniformly, regardless of the scale. So when a player understands how to build something small that works, they just keep doing this over and over, replicating the same approach, getting bigger and bigger. They encourage the player to want much more direct instructional process. Many players become experts after assimilating artificial game rules very quickly. They learn quickly how to exploit the game rules. As many games use the same rules, players become expert players as soon as they install the game. In other words the expert player will want to transfer their learning across game scenarios (e.g., "[Chris Beatrice, Lead Designer of Tilted mill, personal communication]"). However, in a complex game the players with knowledge of other previous 'traditional' computer simulations strategy games may feel initially disempowered. A player will find it very difficult to "figure out" "the game enough to be able to exploit its rules. The games encourage the players to rid themselves of old preconceptions or experiences in order to successfully complete the game. They will have to play the game not by exploiting the weaknesses in the rules, but by finding creative solutions to "real world" problems encountered in the game (e.g., "[Beatrice personal communication]").

In fact, the whole point of a complex game is the fun of tracking down information to figure out what the root problem is or problems are within the game. They are about achieving goals by various means, not by exploiting arcane rules. You make decisions based on what is best for your agents rather than what is best for you the player. Players tend to assume that their agents should be doing what's best for THE PLAYER, or what would make sense in a more mechanical system. (e.g., "[Beatrice Personal Communication]"). The agents are given rules of behavior and then the game is spun forward in time and the player sees what macroscopic social structures emerge. Complex games are unique in their very nature and their capacity for self-organization rather than the actions of a grand designer (player). As the civilization grows, the nature of the challenges you face changes qualitatively, but this is almost entirely the result of the organic (complex) system.

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