New Games of Life: Cellular Automata and Subsurface Discourses in *SimCity*

INFXXXXX: Children's Cultural Texts & Artifacts

Assignment 3: Term Paper

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When game programmer Will Wright published the first official version of *SimCity* through startup game company Maxis, he made sure that players understood that they had acquired what the company insisted was a revolutionary new product. "SimCity is the first of a new type of entertainment/educational software," the manual declared, "called SYSTEM SIMULATIONS" (Sim City – Manual, Docs, Documentation, n.d.). The company would later replace this rather pedantic epithet with the much catchier "software toy". *SimCity* and its successors - none of which had much staying power save for *The Sims* - were not mere "games" that could be won or lost, like *Donkey Kong*. Rather, they were platforms for open-ended, creative play. *SimCity* and its sequels now rank among the most well-known digital game series of all time, and new versions of have been released for the iPhone, iPad, Nintendo Wii, and Nintendo DS.[1] The Wii and DS versions, in particular, ensure that a new generation of children are playing the game, and not just those who were fans of the series from its early years.

Naturally, it did not take long for educators to take notice of *SimCity*'s popularity. Maxis had seemingly found the secret formula to teach subjects ranging from urban planning to system dynamics. *SimCity* has been used as a classroom tool in primary schools and secondary schools. In Sweden, it is used in an annual urban-planning contest for children. The game is praised both as a fun alternative to dry civics lesson and as a complex system that children can access and master, thereby improving their "higher-level" thinking.

Critics of *SimCity*, however, have attacked it on a number of fronts. The game has been accused of promoting fiscal conservatism, urban sprawl, car culture, and even an overly "American" version of urban planning, as well as an overly Californian version of municipal politics. Ignoring some of the more charged rhetoric, what concerns urban theorists and other

[1] I will use *SimCity* to refer both to the original game as well as the series in all cases where a statement applies for both variants. I will refer to one of the titles specifically in other cases.

stakeholders is that *SimCity* seems to prize the materiality of cities – the buildings, power plants, roads and highways, and everything else that can be bought with tax dollars – while ignoring social issues such as homelessness, diversity, and poverty. These are not trivial concerns. It is rather alarming that Will Wright and Maxis constructed a model of the city that privileges money and things over people. Why do *SimCity* cities have to constantly grow in order to prosper? Why are municipal politics reduced to little more than number crunching? Could Maxis not have offered a more well-rounded game that could teach children about even the most troubling aspects of city life?

In this essay I will show that many of the issues raised by the critics were not deliberately encoded into the game, but were actually a by-product of the theoretical structures that were selected to inform its design. Like all other software, the *SimCity* games were developed using high-level programming languages, languages that adhere closely to the fundamental principles of computer science. The game content that is presented to the player sits on top of a substructure of constructs that are created by code. Some of these constructs have been used since the earliest years of modern computer science, while others were developed more recently. In the case of *SimCity*, it is composed primarily of a series of *cellular automata,* two-dimensional arrays of "cells" that multiply and die according to fixed sets of rules. The cellular automaton has been around for more than forty years, and contains key discourses that reflect both its structure and its history. It is these discourses, expressed at the content level by *SimCity* that are the source of many of the characteristics of the game that concern critics.

This essay contains four main sections. In the first, I examine the issue of *SimCity* as an educational tool in more detail, drawing on statements made by both supporters and critics. In the following section I describe cellular automata in more details, and explain how they operate

in *SimCity*. I will then explain how cellular automata function as agents of discourse in digital games, and, finally, I will examine *SimCity* from a critical discourse analysis (CDA) perspective, drawing out the major themes expressed by its cellular automata and describing how they influence the game's content as presented to the player. I will then end with a short discussion on the wider issue of digital discourses.

SimCity as Teaching Tool: Arguments For and Against

Digital games in general, and *SimCity*-type games in particular, have always enjoyed abundant, sometimes breathless, praise as supposedly invaluable new teaching tools (for early examples, see Pahl, 1991; Frye & Fager, 1996). MIT's Klopfer, who focuses his research on the "development and use of computer games and simulations for building understanding of science and complex systems" (Eric Klopfer, n.d.), declared that "video-game development has advanced greatly in recent years, creating powerful learning opportunities through rich virtual spaces," and specifically mentioned titles in the *SimCity*, *Civilization*, and *Railroad Tycoon* series as examples (Klopfer, 2005, p. 10). In 2008, at Future City, a Swedish urban planning competition for children, the use of *SimCity 4* was studied by researchers from the University of Malmö. It was concluded that the game "effectively provides a fictitious urban environment where the students could experiment and make use of their scientific knowledge" (Nilsson, 2008, p. 7). In an article on "gaming literacy", Hsu and Wang state the following about the virtues of *SimCity*:

> Players can connect their gaming experience to elements and challenges involved in governing a real city, such as budget management, expansion of city population, and satisfying the residents' different needs. The attainment of the gaming literacy in the SIMCITY simulation game familiarizes learners with the learning content and promotes their higher order thinking skills (e.g., problem solving) in different subject areas (e.g., social studies or math) (2010, p. 405).

The educational virtues of *SimCity* and related titles, as touted by these authors and others, fall into two categories. Firstly, it is claimed that these games educate players on urban planning, municipal politics, and similar matters. From this perspective, it is the content of *SimCity* that provides the educational material. Secondly, *SimCity* and games like it, according to their supporters, teach more abstract skills such as problem solving, mathematics, and system dynamics. In this respect, it is the gameplay that teaches, as players learn to master a game and its rules.

Running parallel to this commentary is criticism of *SimCity*, both as an educational tool and as an accurate simulation of a real-world city (which further detracts from its educational value). Kolson, an early critic, identified three main problems with the game: its privileging of the role of the urban planner in city building, its disregard for the politics of race and ethnicity, and its emphasis on the material aspects of cities as opposed to the social (1996). I believe that the first two points can be grouped together into a larger critique of *SimCity*'s disregard for the more troubling political, social, and cultural issues that complicate urban life. The third point reaffirms the game's reluctance to engage with the experiences of real people. Recent versions of the game have opened up on this front – the player occasionally has to deal with the NIMBY problem – but only to a very limited degree. *SimCity* is still largely a game about people in the abstract.[2]

Lauwaert, writing more recently, reviews several years' worth of academic criticism of the *SimCity* series, and claims that most of this earlier work centres on three main points. The first issue is that the game "only offers zoned and thus sprawling urban development options to

[2] Another of Will Wright's successful game series, *The Sims*, does focus in on individual people and their lives. I would argue, however, that the series' deterministic gameplay offers only a very limited depiction of reality. This is beyond the scope of this essay, however.

the player" (Lauwaert, 2007, p. 197). Lauwaert's point here is that the game offers a quintessentially American, colonial perspective on the city: roads are laid out in a grid, capitalist elements of city life are prized, and sprawl and expansion are privileged and rewarded. She contrasts this with a more "organic" conception of the city in which balance and harmony are emphasized over constant growth. Her second point relates back to the first, in that *SimCity* "exclud[es] other visions on urban development (most notably those of New Urbanism)" (Lauwaert, 2007, p. 197). Explaining her point further, Lauwaert claims that "contrary to…New Urbanist beliefs, the cities you construct in SIMCITY are zoned, sprawled, and necessitate driving" (Lauwaert, 2007, p. 198). Her third point, finally, is that the game is heavily influenced by "the principles of California's realpolitik as practiced during the 1980s" (Lauwaert, 2007, p. 197). What Lauwaert means here is that *SimCity* privileges suburban middle-class concerns: property value, crime, and taxes, among others. Moreover, the solutions to these problems supposedly reflect the values of 1980s Los Angeles: expansion, low taxes, and as many police stations as possible. At the same time, other issues such as social policy and the care of at-risk populations are ignored. Wardrip-Fruin (2009) echoes many of these same concerns.

I believe that these are all valid concerns, to varying degrees. But the ways in which these issues are considered and discussed are somewhat problematic. Consider the complaint about California-style politics. Did Will Wright intentionally design *SimCity* so that it would emphasize the social and political issues – as well as the solutions – that reflect the values of middle-class Southern California? He has never given any indication that this is the case. So why does the game appear to emphasize such values? Lauwaert, moreover, notes the Wright claims inspiration from the New Urbanist movement (Lauwaert, 2007). Why, then, does his

game seem to disregard fundamentals New Urbanist values? Was this simply carelessness on the part of Wright? Or is there something else going on here?

These and other issues may be understood more clearly if we consider *SimCity* from a perspective that goes beyond content and gameplay to consider the game's internal structure from a computer science perspective. As I show in the next section, *SimCity*, from an abstract, theoretical perspective, is little more than a series of *cellular automata*. A better understanding of this construct will allow for a more nuanced comprehension of the game itself.

Software Toys as Cellular Automota

Scholars and educators, then, tend to focus on the content of these games, and the experiences of players as they manipulate this content. Their work is valuable, since this content makes up the manifest experiences of gameplay. But digital games are not simply containers for content. This content – primary the graphics, but also the sounds produced by computer and console hardware – is actually an audiovisual representation of just a portion of the data that is processed by the source code that operates a game. Code, among other duties, sets the rules of a game, defines and manipulates the data that shapes content, and determines what data to show onscreen. It does this largely by creating constructs that adhere to fundamental principles of computer science, the most important being *data structures* and *algorithms*. These constructs play an important role in shaping the discursive themes and structures communicated to the player. To explain the science behind *SimCity*, I will draw on statements that Wright himself has made concerning the game's underlying structure. I will then expand on this information by consulting relevant sources on theory, and, finally, I will explore *SimCity*'s gameplay to better understand the details of its mechanics.

SimCity's actual source code is largely inaccessible[3], but I do not consider it necessary to get to that level of detail. Instead, I will focus on the constructs expressed by the code: data structures, which organize information according to agreed sets of principles, and algorithms, which manipulate data structures in order to accomplish specific goals. A simple example of a data structure is an *array*, a collection of data elements arranged across one or more dimensions. A simple example of an algorithm is *quicksort*, which efficiently sorts a set of data elements, such as those stored in an array. Developers typically design their products around these theoretical structures, and then turn to programming code to recreate them digitally.

With respect to *SimCity*, Wright has spoken often about how the game is organized around a central paradigm known as the *cellular automaton*. In their well-known article about this construct, Packard and Wolfram define cellular automata as "mathematical models for systems in which many simple components act together to produce complicated patterns of behaviour" (1984, p. 901). This is a topic that Wright talked about in detail in a public seminar he held with Brian Eno for the *Long Now Foundation* in 2006. While discussing a number of issues related to the topic of "generative systems", Wright had this to say about SimCity and cellular automata:

> A lot of our games are built upon cellular automata at a very simple level to simulate what seem to be very complex things. SimCity...in fact is underlain by a set of very simple cellular automata...They have very simple rules for things like crime, and traffic, and pollution. And on top of that we lay all these nice graphics of cars and factories and all that. But really underneath it's a simple grid-based system (Long Now Foundation, 2006).

Wright spent several minutes demonstrating a classic cellular automaton program known as the *Game of Life*, which will also serve here as an straightforward introduction to these models.

[3] *Micropolis*, an open-source version of the original *SimCity*, was released by *Electronic Arts* in 2008 as a donation to the *One Laptop Per Child* Program. The name was changed for copyright purposes.

Game of Life, designed by British mathematician John Conway in 1970, was the first true cellular automaton paradigm. It is composed of two elements. The first element, a data structure, is a grid of squares, or "cells", that can either be empty or filled in, like pixels on a screen. Cells that are filled in are deemed "alive", while empty cells are "dead". The second element is the algorithm that describes a set of rules. These rules are a key component of every cellular automaton, and define the means by which each cell in the grid may come to life or die (or remain the same). These rules are cycled through repeatedly. At the end of each cycle, a unit of "time" has passed (see Packer & Wolfram, 1985, for the mathematical description of this process). In terms of the *Game of Life*, the following three rules are observed (modified from McIntosh, 2010, p. 19):

For each cell in the grid, do the following:

1. If the cell is alive, and exactly two or three of the eight neighbouring cells are alive, the cell remains alive
2. If the cell is alive and does not have exactly two or three live neighbours, it "dies" (i.e. becomes empty)
3. If the cell is dead, but has exactly three live neighbours, it is "born" (i.e. filled in).

Once this process is completed for every cell in the grid, a new "generation" of cells is produced. This new generation will then be modified according to the same rules, producing the next generation, and this process may continue indefinitely.

Figure 1 demonstrates a *Life* cell grid in action. The first image shows the initial grid, with five living cells in the middle. The second image shows the same grid after five iterations of the game rules. Notice that the pattern has become more complex. In the next iteration, however, the grid collapses into the pattern shown in the third image, which then proceeds to

turn into the fourth pattern. After this, the third and fourth images repeat indefinitely. From a simple initial pattern, then, we produced a more elaborate pattern, but then the system falls into stasis.

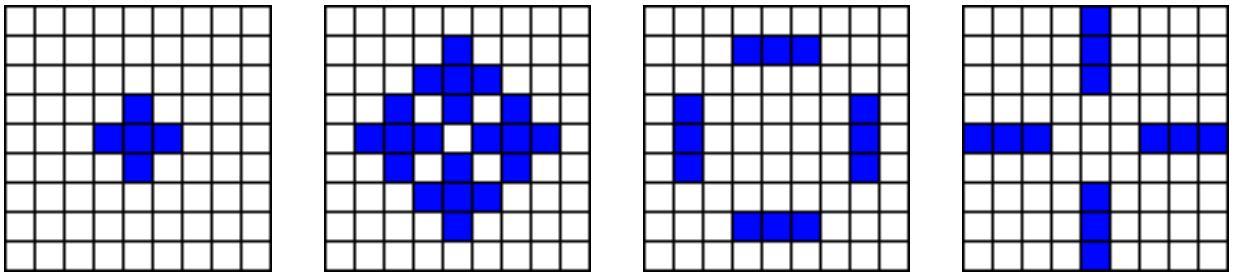

Figure 1. The *Game of Life* in action.

To get out of this situation, we would have to manually add more living cells to the grid, and then let the rules play out so that another complex pattern emerged. At this point, stasis might once again occur, and we would have to interfere once again. It is this sort of assisted evolution that propels the gameplay in *SimCity* and other software toys.

SimCity, of course, is more complex than *Game of Life*. As Wright indicates, the game works with a variety of variables, including crime, traffic, and pollution. Envisioning the game using the cellular automaton model, imagine that each of these variables occupies one of a series of grids, so that crime is represented on one grid, traffic on another grid, and so forth. Now imagine that these grids are sitting one on top of the other, forming a stack of grids. Since each layer in the grid lies on top of the other, the squares in one grid correspond exactly with the squares in all the other layers. This is important, because the bottom layers correspond with the images the player sees onscreen. The lowest layer is the terrain upon which a *SimCity* city rests.

In some versions of the game, the lines of the terrain grid even appear on screen, so the player can easily identify each individual square. On top of this terrain layer are the other layers that make up the city itself: the roads, power lines, and other infrastructure, as well as all the buildings, parks, and monuments.[4]

It is in the upper layers, however – those that remain largely invisible to the player[5] – that the game code does most of its work. Crime, pollution, traffic, and every other variable are represented in each square of their respective grids as quantities. The amount of pollution in one cell on the pollution grid, for example, might be represented by a number ranging from 0 to 100. Therefore, rather than simply labelling cells as "alive" or "dead", as we did in *Game of Life*, *SimCity* assigns each cell a value that represents the "quantity" of each particular characteristic (see figure 2; note that blank cells represent values of 0).

Since *SimCity*'s code creates and works with all of these different grids, its central paradigm is a classic example of a *multi-layer cellular automata*. In a multi-layer automata, every layer is linked to all the others – that is, the values in one grid can influence the values in other grids (see Sitzenfrei, Fach, Kinzel, & Rauch, 2010, for the technical details). A simple example of this in *SimCity* is the relationship between the traffic and pollution grids. Simply put, a positive value in any cell of the traffic grid will increase the pollution value in the corresponding cell in the pollution grid, and also in neighbouring cells, since pollution tends to travel (see figure 3).

[4] I have omitted some of the finer details of the game in this description. Most of the later *SimCity* versions require the player to build water pipes underground, and offer the option subways, adding a subterranean layer to the game. The terrain is also composed of rivers and other waterways, as well as forests and foliage, requiring additional grids. The model I describe here would still remain fundamentally the same when all of this extra detail is added in, which I why I omitted it from the discussion.

[5] A map feature allows the player to see each of these variables represented graphically, but this is an optional feature.

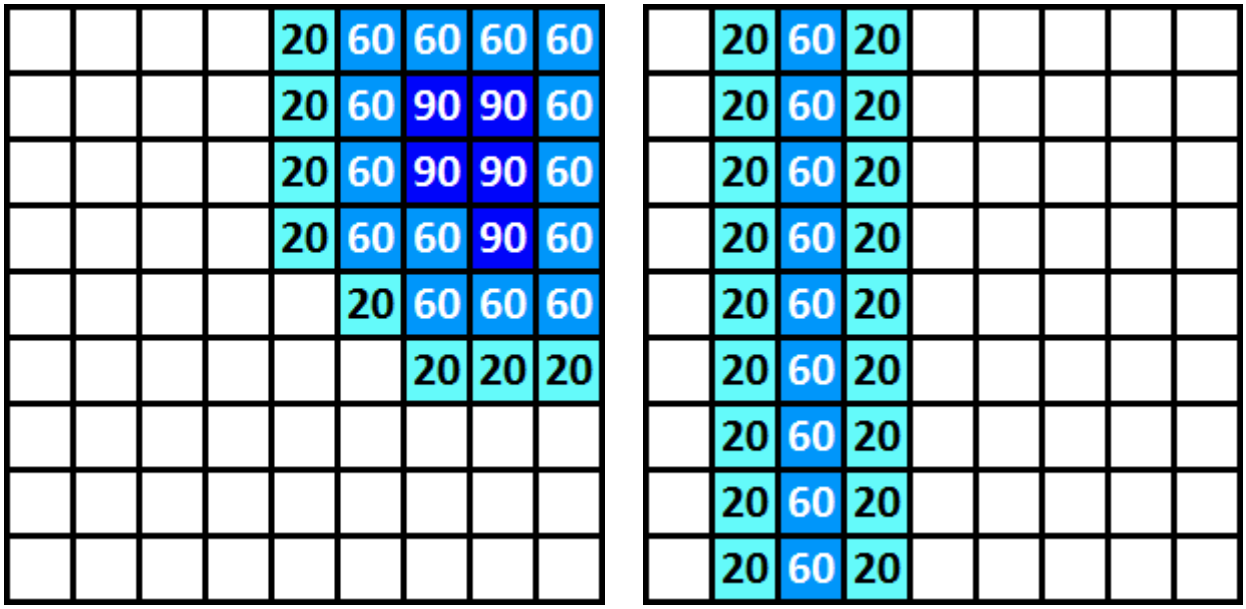

Figure 2. Cellular automata using quantities.

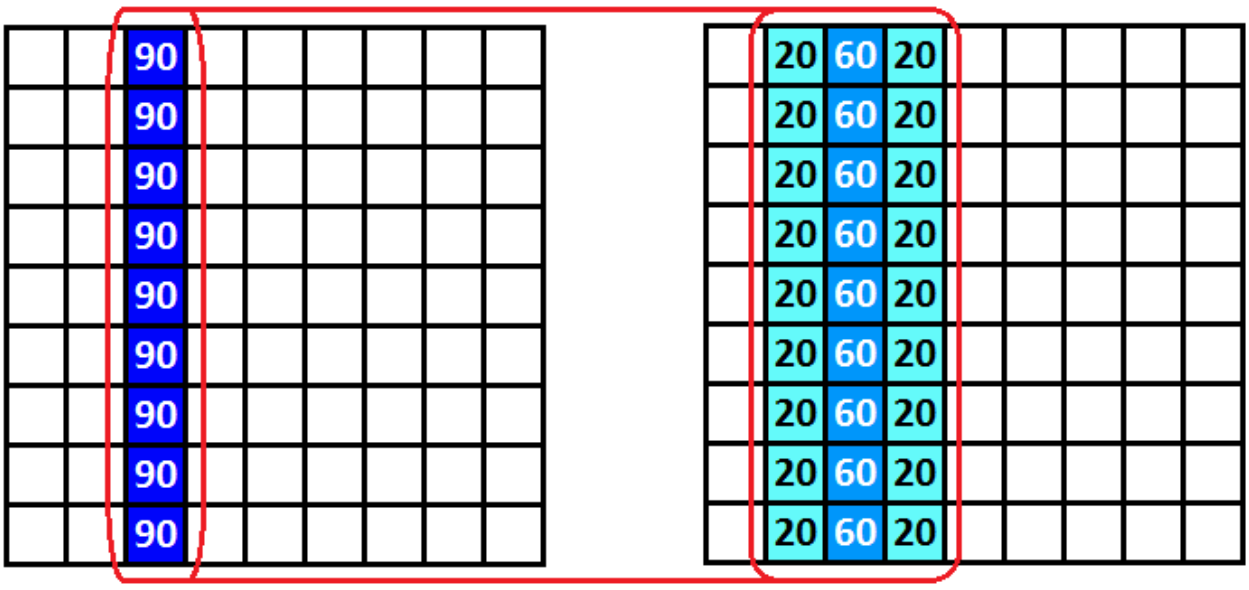

Figure 3. High values in the traffic grid affect values on the pollution grid.

In order to function as a game, *SimCity* requires that the player be able to interact with this series of cellular automata. These interactions, of course, occur when the player builds a city. Each version of *SimCity* provides a toolset of various buildings and infrastructure pieces that may be added to the terrain, as well as "zone" designations – residential, commercial, and industrial – where buildings will under the right conditions. Unlike the cells in *Game of Life*, these buildings and infrastructure do not reproduce and spread to neighbouring cells. What they do, however, is influence all the other layers in the cellular automata. More residential zones lead to more traffic on neighbouring roads, for example, while more industrial zones increase pollution and crime in their specific localities. Police stations reduce crime within their spheres of influence, while careful placement of light rail may reduce traffic.

Ultimately, the values in all of these grids drive the values in a grid that determines the population of the city. For example, if a certain cell on the crime grid is low, and the corresponding cells on the pollution and traffic grids are also low, and if the same cell on the infrastructure grid is zoned for residential use, then the game will likely increase the value of the cell in the population grid. This would be represented to the user graphically with the appearance of a house, apartment building, or whatever living space coveys the underlying population value. *SimCity* performs the same tasks (with different rules) to populate the industrial and commercial zones, and the city as a whole appears on screen for the user. This population then functions as a tax base, generating (if all goes well) the revenue needed for the player to keep adding to and refining the city.

The rules that power *SimCity*'s are incredibly complex, as is fitting for such a complex situation. The cellular automaton itself, however, is the game's fundamental building block, just

as it is in the comparatively simple *Game of Life*. Knowing this, we may begin to examine this construct as an important agent of discourse in *SimCity*.

The Cellular Automaton as Agent of Discourse

Digital games are increasingly described and discussed in the languages of discourse analysis and semiotics. A significant proportion of the research in this area has focused on multiplayer spaces and the practices of the communities that meet in virtual worlds (Wright, Boria, & Breidenbach, 2002; Steinkuehler, 2006). But other work has examined single-player titles and the interactions between players and digital texts. In their study of meaning-making processes of at-risk youths playing *Grand Theft Auto: San Andreas*, DeVane and Squire claim that the game is a "dynamic text" (2010, p. 265). Elaborating on this mater, they later state that "games are not just texts that can be interpreted in different ways but rich semiotic spaces that are specifically designed to have multiple layers of meaning, which in turn appeal to different audiences" (p. 279). So here we have the digital game functioning as a text, but one in which the content is never fixed. Moreover, the meanings expressed by digital texts are subject to a number of different interpretations. The agent that both alters and receives these texts is, of course, the player. With respect to player interaction as a form of meaning-making, DeVane and Squire state the following:

> The semiotic space is rich and varied so that the player has more productive agency than even the usual reader does. Not only can players contest the dominant meanings in the space, they can also continually reconstruct the game as text through their choices in play (p. 281).

Relating this back to discourse theory, what is being described here is what Gumperz termed *contextualization*, in which contextual circumstances change the ways in which signals are transmitted and received (Gumperz, 1992; see also Blommaert, 2005). In a single-player game,

however, only the context of the receiver (i.e. the player) is considered. Bakhtin also commented on this issue, stating that "the person who understands...becomes a participant in the dialogue... The observer has no position outside the observed world, and his observation enters as a constituent part into the observed object" (1986, pp. 125-126).

The notion of game as "space" also features in Squire's earlier work (Jenkins & Squire, 2002; Squire, 2006). In the model he develops over the course of his work, the interactions between game and player become something of a feedback loop. The semiotic space of the game serves as a dynamic text, transmitting fluctuating messages to the player. The player receives these messages, but also contextualizes them, so that the player's response to each message is shaped both by the content of the message and their own contextual frame. These responses then reshape the text presented by the game, but only as much as the game allows. Referring once again to *GTA: San Andreas*, Squire states the following:

> We can talk about *San Andreas* as a *world*, and it is a world with particular rules that give consequence to actions. To survive in this world, players need to learn the underlying rule systems and how they interact (2006, p. 20).

Wardrip-Fruin, writing from the context of the emerging field of *software studies*, states something similar about *SimCity*:

> A gardener doesn't need to understand chemistry, and a *SimCity* player doesn't need to understand programming language code, yet both can come to grasp the elements and dynamics of complex systems through observation and interaction (2009, p. 310).

In both of these cases, the authors do recognize the importance of a game's mechanics, as well as its content. Both also emphasize that these mechanics are shaped by the biases of the game developers. Squire describes the world of *San Andreas* as "a stylized rendition of 1990s California, containing a mixture of authentic and fictitious California landmarks and

neighbourhoods" (2006, p.20), while Wardrip-Fruin (2009), as I discussed earlier, addresses the common criticisms of *SimCity* with respect to its representation of urban planning.

There is still something missing from these discussions, however. While it is important to recognize that the rules that dictate gameplay in *San Andreas* affect player reception, and that *SimCity* presents a politicized model of urban planning, this work does not take into account certain critical discourses: those that are expressed by a game's algorithmic substructure. In the case of *SimCity*, this substructure is composed primarily of the layers of cellular automata that control most aspects of the game. It is true, as Wardrip-Fruin (2009) indicates, that a skilled *SimCity* player will come to understand the mechanics of the system simulated by the game. In the language of cellular automata, this means that the player will learn the rules that govern how values are changed in each automaton layer. But if we focus only on the rules, and the discourses that they express within the digital text, we ignore the discourses expressed by the cellular automata within which they are embedded. It is these discourses, moreover, that define some of the most important characteristics of the *SimCity* series.

Thematic Analysis of Cellular Automata

Given that cellular automata can express discourse, we can analyze the discourses that appear in *SimCity* that reflect the game's internal structure. The discursive themes that I consider here are similar to those that have been discussed in other critiques of the game, but this discussion will be informed by this new perspective. The cellular automata that control the *SimCity* games express a rich discursive narrative that is rooted in the socio-cultural history of the cellular automaton itself. The automaton is both a discursive resource and agent of discourse. For this reason, the themes that I list here apply both to the cellular automaton and to

SimCity, but I will focus on the implications for the digital game text as presented to the player. I am influenced in my approach by the work of Bhatia on political press conferences (2006). Bhatia cites Wodak's *discourse-historical* approach as the primary inspiration for her methodology, stating that, in her analysis, she considers discourse to be "historical – related to events which have happened or are happening" (2006, p. 178; see also Wodak, 2001).

I have identified four dominant themes that shape gameplay. The first is *complexity*. Those who engage with cellular automata tend to prize the most intricate and complex designs, and they dismiss those that remain simple and stable. In *SimCity*, players are similarly encouraged to build large and complex cities. The second theme is *achievement*. The best automata designs are celebrated and shared by online communities. *SimCity* also celebrates achievement in several ways, even though its parent company ostensibly shuns goal-driven gameplay. The third theme is *determinism*. There is no random activity in a cellular automaton: the state of each cell changes according to a set of rules, and the same initial state will always evolve the same way. The same is true for the state of each unit of a *SimCity* city. The final theme I will explore is *positivism*. Fans of cellular automata believe that they can be used to explain and replicate all manner of real-world phenomena, from biological processes to the systems that shape societies and civilizations. *SimCity* reflects this same ethos through its marketing and also in the manner that its content is presented.

(1) Complexity

Wright, in his talk with Brian Eno, presents a number of highly complex examples of the *Game of Life* in action (The Long Now Foundation, 2006). Among these examples are kaleidoscopic patterns that repeat elaborate, intricate movements, as well as instances that

resemble assembly lines, in which small clusters of cells are "born" and move slowly off of the grid. These are instances in which the initial grid was set up in particular – and typically elaborate – configurations of live and dead cells, with the resulting evolution producing interesting results. Such complex patterns are prized by those who work with *Game of Life*, and countless examples of them may be found online. Among the most famous configurations are those designed by Paul Rendell that emulate the functionality of a *Turing machine*, a theoretical construct invented by Alan Turing that is capable of performing all of the basic functions of a modern CPU. Rendell has made his examples available on his website, and also describes them in a textbook devoted to *Game of Life* (Rendell, n.d.; Rendell, 2010). For less elaborate examples, a vast network of interlinked websites, such as "Mark D. Niemiec's Life Page" (Niemiec, 1998)[6] archive hundreds of patterns that produce animated characters – the most common of which are called "gliders" – as well as emulations of real-world machines and processes. Similar, though smaller, communities may be found for other cellular automata that follow simple rules that differ from those of *Game of Life*.

As discussed earlier, one of Lauwaert's three major criticisms of *SimCity* is its emphasis on the creation of sprawling, perpetually expanding cities. We can see here that this ethos is shared by *Game of Life* hobbyists, as well as those who work with other cellular automata. Since *SimCity* is composed of several automata working together, it stands to reason that this discourse of complexity is expressed through its content and gameplay. There are, in fact, many websites such as *Simtropolis* where avid players show off their most elaborate creations via *city journals*, which generally include both screenshots and descriptive text (Community city journal list, n.d.). *SimCity* rewards players who strive to make their cities large and complex. The nature of its

[6] Interestingly, many of these sites date from the earliest years of the Web, perhaps reflecting the enthusiasm of *Game of Life* hobbyists to share their creations.

gameplay encourages players to keep adding on to their creations. If a player decided that their city was perfect in terms of size and organization and did not require any further additions, there would be little to nothing for them to do in terms of interacting with the game. Almost every tool available to the player involves the construction of new infrastructure or buildings.

Lauwaert and others have interpreted these aspects of the game as deliberately political, but it would appear that games built from cellular automata, including the very simple *Game of Life*, encourage experimentation with increasingly complex creations. The resultant evolutionary sequence is generally more interesting with a large, intricate pattern as compared to one that is small and simple. Because virtual time is always moving, those who play with cellular automata often feel the need to produce creations that evolve in interesting ways through time.

(2) Achievement

In any cellular automaton, however, only certain patterns result in pleasing outcomes, regardless of their complexity. In the case of *Game of Life*, Riddell's Turing machine is an impressive achievement, but only because it succeeds at a larger goal: the emulation of fundamental computational processes. If not built properly, the resultant evolution would not yield tangible results. On a more basic level, a pattern that results in a complex kaleidoscopic sequence is pleasing to watch, but an asymmetrical arrangement that resulted in unpredictable changes would not earn much praise. Wright, in his talk with Eno, demonstrated how harmonious *Game of Life* patterns could be destroyed by just a few errant live cells (The Long Now Foundation, 2006). Fans of *Game of Life* and other simple cellular automata have created a systematic language of categorization to label various entities – arrangements of live and dead cells – that exhibit predictable behaviour when placed on the grid. "Spaceships", for example,

which appear to travel across the grid, come in a variety of configurations, and feature in many larger patterns. Avid players are always looking to discover new recognizable and classifiable patterns.

With its *SimCity* series (as well as other series such as *The Sims*), Maxis promotes an ethos of open-ended play, in contrast to most console games which have defined goals to achieve and "end" when they are complete (though this has become less true in recent years). While there is perhaps some truth to this, the *SimCity* games still find ways to celebrate player achievements. In the original game, achieving certain population targets would result in the rebranding of your creation: 10,000 people made it a "city", while 100,000 people made it a "metropolis". In subsequent versions of the game, this system was replaced by one in which the player received tangible "reward" structures – including a statue, a city hall, and a courthouse – to place in the city when population numbers reach certain milestones. On a more subtle level, the game rewards success by offering valuable infrastructure pieces at premium prices. Subways, for example, reduce traffic and pollution significantly, but are exceedingly expensive. The same is true of high-end power plants, including fusion plants when the in-game calendar reaches far into the 21st century. If a player's city is small, or generates little in tax revenue, roads and dirty power plants that use coal and oil are the only realistic options. A successful city allows for even greater success, while a poor city will continue to suffer.

Besides contradicting Maxis' claims that *SimCity* is just a "software toy", these game elements reflect many of the criticisms directed at the game. *SimCity* promotes the collection of trinkets to decorate and improve a city, as Kolson noted. The game clearly focuses on the material at the expense of the social. This can be explained when we consider *SimCity* from the cellular automata perspective. An automaton grid needs "living" cells within its grid in order to

do anything interesting or useful. This is reflected in *SimCity* by the construction of buildings and infrastructure on the terrain grid. A social solution would have to be built from a very different model, likely one that would consider a host of variables linked in ways far more complex than what appears in a cellular automaton. The materiality of *SimCity*, then, is a consequence of its underlying structures.

(3) Determinism

Cellular automata work on a simple cause-and-effect premise. Every generation of a grid is the product of the pattern that appeared in the previous generation and the rules that were executed for every cell in the pattern. No other factors ever intervene to alter the grid. This is a classically deterministic system. This means that the virtual cities in *SimCity* behave like elaborate mechanical clocks. The state of the city at any particular point in time deterministically produces the city as it will appear in the next unit in time.[7] As scholars such as Wardrip-Fruin have noted, mastering the game requires the player to learn the rules that determine how and when a city grows and prospers.

Determinism even influences the ways in which *SimCity*'s politics operate. A deterministic model relies on variables that are easily quantifiable, which can then be put into equations to generate new values. This largely explains *SimCity*'s reliance on *realpolitik* over a more nuanced approach. As Lauwaert indicated, success in the game requires the player to maximize variables such as land value while minimizing other variables such as tax rates and crime. It could be argued, I believe, that Maxis could have incorporated a more complete set of

[7] The one notable exception to this rule are the disasters – fires, earthquakes, nuclear meltdowns, and so forth – that occur randomly over the course of a game. Disasters are something of an outlier in terms of game functionality, however. They can be switched off, and most serious players disregard their presence. Their appearance in the game serves primarily as a fun diversion.

variables into the game that considered such issues as homelessness and income disparity. A deterministic cellular automata system, however, could not incorporate a more compassionate model that considered, for example, the various relationships between powerful groups in the city, such as the police and high-income earners, and those with little to no power, such as the homeless, the unemployed, and the mentally ill. These complex interpersonal interactions are too complex to express concisely with variables and equations. Later versions of the game do allow the player to enact various community outreach programs, but these only have the effect of altering the major game variables that Lauwaert criticizes. Cellular automata simply aren't powerful enough to simulate these more complicated issues.

(4) Positivism

For nearly a decade, cellular automata have starred in an elaborate public relations campaign initiated by one of the most famous minds in science. In 2002, Stephen Wolfram, formerly a professor at Princeton's Institute of Advanced Study but out of the public eye since the early 1990s, self-published a sprawling work entitled *A New Kind of Science*. In this highly personal work, Wolfram declared that cellular automata were not just a valuable computational model, but actually the foundation of every process in "the entire cosmos, from quantum particles to the formation of galaxies," as Levy describes it (Wolfram, 2002; Levy, 2002). Wolfram made these claims based on his own work with cellular automata which he had started in the mid-1980s. Starting from simple rules and initial states, he created what he believes are realistic depictions of complex natural processes, such as the formation of snowflakes and patterns on seashells. Since the publication of this work, Wolfram has created a dedicated

website where he posts his follow-up work and offers "summer school" events for those who would like to learn more.[8]

Wolfram's work is highly controversial, and his most vocal critics accuse him of practicing "pseudoscience". In a 2003 article for *Skeptic*, Naiditch neatly summarized the criticism on this front:

> Skeptics will notice that Wolfram displays many attributes associated with being a pseudoscientist – he (1) makes grandiose claims, (2) works in relative isolation, (3) bypasses the normal peer-review process, (4) published his own book, (5) does not adequately acknowledge the contributions of his predecessors, (6) rejects or belittles the work of eminent scientists, and (7) reinterprets criticism as support (Naiditch, 2003).

Despite this, Wolfram enjoys a vast and loyal following, and Wright makes it clear that he also believes in the power of cellular automata to replicate real-world phenomena (The Long Now Foundation, 2006). It should also be clear by now that this philosophy is wholly positivist, in that it subscribes to the notion that the observed world may be explained entirely by mathematical models.

The positivism in *SimCity* is more implicit than overt, but it does play a significant role in how the game is received. Some versions of the game have been subtitled "The Ultimate City Simulator", and throughout its life, the game has never hinted that its depiction of a real-world city was not entirely accurate. That is not to say that Wright himself has made such a claim. Rather, it is the nature of gameplay itself that implies this. Since the game is a commercial product, it does not provide any documentation describing its limitations, as you would likely find with a simulation produced in a university lab. And even if it is clear that a particular version of the game is missing features, the continual release of sequels, each containing a richer feature set than the one previous, projects the impression that every aspect of a real city could

[8] http://www.wolframscience.com

potentially be incorporated into such a simulation.[9] This is true of every simulation/strategy game, of course: these are products that need to advertise their strengths in order to stand out in the marketplace. But this only means that the positivist ethos is invisible due to its ubiquity, which may make it even more insidious.

Discussion

I will not try to make the case that *SimCity* is or is not a valuable educational tool, but I believe that this essay should help clear up some misconceptions about the game. Reading the work of Lauwaert and others, it might seem as if Maxis was deliberately pushing a rather objectivist agenda within the content of its products. Based on Wright's own words and on the discourse analysis provided here, I do not believe this to be the case. Wright, in fact, professes to admire New Urbanist values. The problem is that he also believes in the power of cellular automata, and therefore built *SimCity* around a complex set of automata. The game then presents discourses expressed by this construct through the lens of a city-building game. So the theme of determinism, for example, as filtered through the game's content and gameplay, presents a model that privileges a detached, impersonal version of municipal politics. The game's focus on materiality may also be traced to its reliance on cellular automata. While some elements of the game were certainly political choices, much of what appears was simply a consequence of design choices.

This does not mean, however, that *SimCity* is apolitical. Indeed, the game might be even more political than its critics give it credit for. Wright likely did not intend to embed what many

[9] I should note here that *SimCity 4* , released in 2003, is actually the most recent Windows-based version of the game, and Maxis has never indicated that it is working on a fifth version. Moreover, it has hinted that the fourth iteration was likely too complicated to attract a wide audience. It is only for commercial reasons, then, that the complexity of the *SimCity* series has become somewhat stagnant in recent years.

see as American fiscal conservative values into his game, but *SimCity*'s content and gameplay seem to suggest otherwise. Ultimately, intentionality is irrelevant. The cellular automata that drive the game project their politicized discourses into the digital text, and a disregard for this process (I have yet to hear Wright discuss the political implications of cellular automata) only serves to further enable this process. Maxis does not include any subversive elements into the game's feature set that would suggest that a city is not simply a mechanical device that runs on tax dollars and high property values.

I hope that this research demonstrated that, when considering a CDA approach, it is as worthwhile to study the theoretical substructure of a digital game as it is to study its content and rules. I believe that I have been able to clarify the true source of certain discourses in the *SimCity* series, as well as uncovering new discourses. A digital game is a computer science product as much as it is an entertainment product, and it is worth studying these games from both perspectives.

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