TEMPORAL AND SPATIAL COMBINATORICS IN GAMES FOR DESIGN

ABSTRACT
This paper will outline the techniques and language that games use to give design agency to a player. By identifying the discrete combinatorial ontology of games, as opposed to a continuous post-rationalistic approach from general design tools, we hope to develop a framework for the design of ‘games for design’, or sandboxes that allow players to develop an output that is unexpected to the game developer and contingent to a player. This research has been the foundation for the development of Block’hood, a city-building video game that explores ideas of ecology and generative urbanism.

Figure 1
Block’hood screenshot. Video game developed for architecture research and ecological education.
INTRODUCTION

While a video game does not necessarily require a player to produce any output, we can observe that there are some genres of video games that do. The output of a game session could vary from the development of a character, through many hours of progression, to the meticulous design of a city. What we consider a game has more to do with the experience of the player while achieving a goal, whilst the production of any kind of output is considered disposable, because a player might move onto a new game and forget how many hours of development and work were spent in a previous session. Even if such sessions and material is saved, it only serves as a benefit to the player or owner of said session.

The agency of a player in a game can be understood by the actions that player performs. Such actions are discrete blocks of expression that, when combined, can define or trace back the character or player's expression within a game. I would argue that such discrete blocks of expression are a native mechanic of every game, and the act of combining such actions, what many games call 'combos', are a defining feature of the medium. The design output or production output of a game is, in this way, characterized by a process of accumulation and combination of discrete building blocks, mapping the accumulated legacy of a player in the game world. The nature of such creations is different than any kind of design output that could be conceived in other media, where the notion of discrete combinatorics is not necessarily a dominant feature.

This paper attempts to develop a framework for 'games for design'—games that explicitly look to develop a non-residual output, one that could be an object of study, education, invention or further enhancement of the game experience for other players. The paper will begin by explaining the notion of how we can consider 'combos' a native game language for players and how we can understand the depth to which combinatorics is embedded in that language. As a second step, I will define the taxonomies of combos as temporal and spatial structures; in this section I will use examples of games to understand what is considered a spatial combo versus a temporal one. Finally, I will use examples of spatio-temporal combos to understand the degree of complexity and richness of the language offered to players.

Having developed a framework for combos, I will move on to identify and give value to non-disposable game outputs, again using game examples. In the concluding chapter, I will look at how this idea applies to the development of the video game Block'hood, a game currently being developed by Jose Sanchez within University of Southern California. Block'hood draws from game culture to develop a rich ecological simulation for the design of a neighborhood. By utilizing temporal and spatial combinatorics, the game attempts to become an educational tool for architects and designers and also an open sandbox for exploration and invention. The output of a game session is a diagram of relations of actual physical objects, as Block'hood attempts to utilize real data for each of the diagrammatic blocks available in the game. In this way, the act of sharing with a
community and discovering different combinations becomes an act of crowdsourced design for micro urbanism and civic participation, putting systemic thinking in the hands of every player.

1 TEMPORAL COMBOS

The word ‘combo’ is a colloquial expression short for combination. Such an expression has been popularized by fighting games in which a character can perform a series of moves in a particular sequence in an attempt to win over the opponent. These combinations vary in their degree of difficulty based on length and frame data. Each move in a fighting game is characterized by specific frame data, or the amount of time it takes to perform an action. The frame data can be broken down into different stages: startup time (frames required before the attack starts); active time (frames on which the attack is being executed); and recovery time (frames that the player needs to wait after an attack to perform another action). This data characterizes an action that is performed over time, and what I will call a ‘temporal combo’. Each action, as a discrete entity, contains its frame data and data based on the reaction of an opponent, describing a catalogue of potential moves to be used during the course of a match.

In this way, temporal combos are the sequencing of such discrete building blocks that define all the possible moves of a character, and how certain actions enable or disable the progression of potential movement branches.

Such games in the hands of expert players, become a complex dynamic chess game of movements that are ‘safe’ (do not allow frame data advantage from another player) or ‘punishable’ (leave the player exposed to negative recovery frames where the opponent can perform an attack). This requires that players study and understand the data of each one of the action blocks available to them.

2 SPATIAL COMBOS

While temporal combos can be understood as the arrangement of discrete units over time, ‘spatial combos’ can be understood as the arrangement of discrete units over space. When we look at games such as SimCity or Minecraft, we can identify that the action of a player can be characterized as an action in space, and the location of such an action (usually taking the form of a physical manifestation in the game) has relevance for its context. In the case of SimCity this could be easily understood in the placement of police stations to control crime, an action that is characterized by strategic location based on the ability to affect units that are in proximity. I would argue that the combinations of discrete building blocks over space can be considered a spatial combo, as the sequence of units is mainly determined by adjacencies and proximities rather than temporal correlations. This idea can be easily understood when we look at Minecraft’s Redstone system. Redstone, is a unit within Minecraft that allows data transfer among adjacent blocks that become that game’s version of electricity.
The diagrams in Figure 3 show patterns, or spatial combos, of players developing logic gates within Minecraft using the Redstone system.

The particular arrangement of blocks in space enables players to produce repeatable recipes or patterns that contain a new meaning or function within the game or simulation.

3 SPATIOTEMPORAL COMBOS

Arguably, every combo is really a spatiotemporal one; however, I have focused on how certain games assign more hierarchy to some aspects over others. It is the case though that certain games or simulations require a perfect balance of temporal and spatial attributes of an action to the extent that the temporal attributes become feedback to spatial ones and vice versa. I refer here to a particular strand of building games that focus on units that perform actions over time, making their position and orchestration regarding other units a spatio-temporal puzzle. Games such as SpaceChem, Factorio or Infinifactory fall into this category. In fact the work of Zach Barth of Zachtronic Industries (Barth, n.d.), and creator of SpaceChem, is a significant influence when exploring these complex spatiotemporal simulations.

4 COMBOS AS A LANGUAGE FOR GAMES

The idea that discrete blocks could form larger units of expression is the precise way in which our vocabulary and language work. As Christopher Alexander has explained (Alexander 1968), the arrangement of discrete letters give rise to words and those to sentences. In a similar way, I argue that combos define a universal mechanic of games, where all actions of a player have been discretized to building blocks of a player’s expression. This is a characteristic that needs to be well understood at the moment of considering the use of games for design, as most of the software or design models for designers operate within the paradigm of a continuous model, where there is no necessity of modularity and transformations can quickly melt any discreteness present in an output. It is widely accepted that such continuous models are the modus operandi for design today, whilst looking to discrete strategies could be considered regressive in the field, however, there are a series of benefits that discrete models have brought to the table in the age of crowdsourcing and democratized game engines.

Games as a medium have the ability to involve a large user base of players that explore the search space of a simulation, as demonstrated in games like Fold-It and Eterna (Cooper et al. n.d.). The use of games can be instrumental in the design and discovery of real world problems, but I would argue that their discrete combinatorial nature needs to be taken into account, if we are to seriously engage any game output outside the realm of games.
5 GAMES IN ARCHITECTURE

There have been several attempts to use a game framework for use in architectural design, perhaps inspired by the seminal work of Will Wright and the iterations of the Sims game series. From the initiatives coming from architects, Space Fighter by MVRDV could be identified as one of the most comprehensive implementations of games for design. For Space Fighter, Winy Maas and a group of researchers developed an evolutionary city game to simulate and forecast transactions in a city. Central to their approach is the use of game theory in a quantifiable evaluation of outputs (Maas et al. 2007):

"What role can games play in urban planning and architecture? This role is at least (as a concept) generating increased insight applicable in analysis. Considering the agents that make up a complex adaptive system as parties with conflicting interests maximizing their individual fitness, may increase an understanding of the system’s degree of complexity."

and

"Design can be seen as the simultaneous search in both problem space and design space for matching couples."

While this approach is presented in a rigorous way in the Space Fighter book, the attitude towards games is that of formal games:

"The word ‘game’ is used in two separate meanings in this book. On the one hand we have games like Monopoly and computer games like Pac-Man. On the other we have formal games, the central concept of game theory. Formal games are situations involving parties with conflicting interests. In a formal game, a player is by definition, an entity with preferences. The utility function (von Neumann & Morgenstern, 1947) in one part of a formal game and denotes a measure of subjective psychological fulfilment, and assigns a score to each strategy the player can adopt. Players act so as to maximize their utility, which is better known as payoff" (Mass et al. 2007).

Game theory serves the purpose of predicting or anticipating the dominant strategy in such a conflict of interest but is far from a framework that is useful for the development of novelty and innovation. This is the reason why this argument will not focus on the use of formal games, but rather on video games as a cultural medium. I would argue that video games possess unique characteristics to challenge the creative process and allow for a new kind of contingent design that emerges from specific communities. The problem in these games is not the maximization of payoff but rather the pursuit of idiosyncratic desires. With this in mind we will look at contemporary game strategies for user engagement that allow player expression by fleshing out in great detail the players combinatorial language.
6 THE GAME AND THE GAME MAKER

A phenomenon that we can observe throughout the history of videogames is the culture of ‘modding’ or the player’s modification of a particular game to expand its universe; players hack games to alter the content or add new levels. Many games embraced this culture and offered their own modding kit, in which players are encouraged to become game designers and expand what the game had to offer. This initiative is particularly interesting as we can see the two-folded process of games—development and playing. We often think only of play as the element of a game that can engage a large audience and generate emergent behaviors from the community, but much of the interaction of dedicated players can evolve into an engagement to dramatically alter the experience provided by the framework of a game.

An interesting example can be seen in the popular video game Mario Bros. A Japanese hacker decided to hack into the code to create a much more difficult version of Mario, one which was significantly more challenging for expert players. The hacked version, known as Kaizo Mario, utilizes the same elements from the original but arranged in a different manner. Kaizo Mario challenges players to perform extremely tight maneuvers by the spatial combinatorics of the blocks.

Based on the popularity of this hack, and realizing the potential behind crowdsourcing at the design level (or spatial combinatorics of blocks), Nintendo, the game developer, decided to create Mario Maker, a sandbox that would allow anyone to develop a new level for the Mario game that could be shared on the internet. Again the tendency here is to capitalize on a crowdsourcing initiative, one that is well structured, and allows the more advanced players to enjoy the classic Mario Bros. game with virtually infinite content. The idea of the sandbox level is not new to Mario, in fact Mario was one of the late players to enter this trend, but it certainly demonstrates a fundamental change in the industry’s perspective on authoring content and the value of user created content.

Figure 5
Kaizo Mario hack and Mario Maker.
7 CONCEPTUALIZING AND DESIGNING BLOCK’HOOD

Having defined combos as an intrinsic game mechanic, and the value of user authored content, we can dive into the ideas behind the development of Block’hood.

Block’hood is a video game in development by Jose Sanchez at University of Southern California. The game is a city building game that focuses on ideas of ecological urbanism by allowing players to explore the interdependencies of discrete urban units. Based on the framework we have developed, Block’hood attempts to be a spatiotemporal sandbox where the placement of units in a particular location in a three-dimensional grid (voxel) triggers unit interactions and activates actions over time.

The modeling of building units in Block’hood is based on real world data; for example, you can install a solar panel for 350 USD and obtain 360 watts of electricity, which are the equivalent actual world values. In a way, the game is a catalog of objects and ideas available for designers in the real world, much like the Whole Earth Catalog, a publication initiated by Stewart Brand in 1968, with the intention to document tools and democratize the access to them. The catalog included farming technologies, building technologies and everyday objects, along with the prices and places to buy them.

Architects like Buckminster Fuller were strong supporters of the catalog, contributing to several publications. Kevin Kelly describes the catalog as the precursor to the current maker movement and DIY revolution. While the Whole Earth Catalog is a great source of inspiration, the medium of the paperback publication seems to fall short within the utopian intentions of the project. Even later embodiments of the catalog idea—e.g. Kevin Kelly’s Cool Tools publication—revisit the idea in a similar format updating its content to a contemporary database.

In this context, Block’hood intention is to recreate the properties of games as a large-scale connected medium, and to introduce simulation and crowdsourced design, to a digital catalog of physical objects. Players would not only be able to hear about new technologies and their properties but also tinker by placing different combinations of objects within a simulated environment. Players will also be invited to share their creations (combos or patterns) with other players, allowing for a community to continuously learn and improve upon the ideas and inventions from other players.

8 THE BLOCK’HOOD ENGINE

At the moment of defining how the calculations in a videogame like Block’hood work, one has to decide what the world ontology is: what is the world made of? Games like Minecraft conceptualize a world that is purely defined by blocks, representing all the possible materials or living animals available, and players are agents that interact and terraform the block landscape. Block’hood on the other hand, defines a world populated by blocks, resources and agents. Blocks represent any programmatic entity in the city: a house, a shop, a bar, a park, etc. They are productive units that can produce any kind...
of resource. Resources are the currency: they are the data that blocks use to communicate. Examples of resources could be water, waste, food, energy, etc. Each resource is considered as an absolute quantity without identifying if such a resource is positive or negative. For example, pollution is a resource generated by certain blocks, such as industry, however it is not assigned any negative value; it is simply a resource that you either have or do not. The relation of blocks and resources is very versatile as resources become inputs for a block to produce outputs over time. Abstract resources such as social capital can be generated by having enough inputs.

The third category of objects in Block’hood are agents: simulated inhabitants of the city. They could be human or non-human. Agents exist to demonstrate how certain environments or patterns within the game can give rise to particular social behaviors. Agents are described by the activities they perform on certain blocks and how they support the production of resources. Agents are differentiated by several attributes such as gender, age or profession if they are human; other properties, like species, are saved for non-human agents allowing a player to discover how the city block they are designing could also impact in animals or ecosystems present in the area. The interdependence of blocks, resources, and agents enables a cyclic simulation that makes Block’hood not only a game of spatial combinatorics but a spatiotemporal one.

9 DEMOCRATIC CONTINGENT CONSTRUCTIVISM

The notion of crowdsourced urbanism presented in this video game might suggest a criticism of current urban theories, as the game in itself does not present a model of how a city should function. The game only provides the building blocks of current urban life without enforcing a particular arrangement. There is no correct way to play the game; it is just a simulation of interactions.

Games like SimCity have the opposite approach; they do offer a very clear position or hypothesis of how a city works or what a city is. The algorithms in the game calculate if your citizens like or dislike the actions that you perform as mayor, therefore, whilst much of the model is open-ended, the results or output of a player always converges in the taxonomy of a city. In Block’hood, there is no such demand. The simulation could be used to generate a park and simulate the ecology of species, or it could be used to design a dense city block, with hybridized programmatic activities. The lack of a specific model of what a city should be enables crowdsourcing such an idea, and allows a player to imagine new scenarios for what urban space should or could be. Additionally, the scope of Block’hood is to understand the problem of the city as always a partial and relative one, rather than generating a complete urban proposal. Intentionally, Block’hood only allows a player to develop one city block, provoking the player to think at the scale of a rich micro urbanism that could take place within a small neighborhood. The limitation on space encourages hybridization of ideas and elements that are otherwise unlikely to be conceived adjacent to each other.
It is in this way that Block’hood becomes a game of urban speculation, encouraging players to discover emergent behaviors through the language of combinatorics. Units compute based on adjacencies (much like a cellular automata), and the precise patterns created by each player reflects the idiosyncrasies of that player, rather than an attempt to search for an optimum or a maximum utility.

The model of urbanism presented in Block’hood is one of democratic contingent constructivism where the use of an online community develops opportunities for knowledge sharing under the same computational infrastructure. Here we need to understand constructivism in relation to Piaget’s philosophy of education. Seymour Papert (Papert 1993) explains:

“If we really look at the “child as builder” we are our way to an answer. All builders need materials to build with. Where I am at variance with Piaget is in the role I attribute to the surrounding cultures as a source of this materials. In some cases the culture supplies them in abundance, thus facilitating constructive Piagetian learning.... But in many cases, where Piaget would explain the slower development of a particular concept by its greater complexity or formality, I see the critical factor as the relative poverty of the culture in those materials that would make the concept simple and concrete.”

The current state of the game is that of a digital sandbox that allows players to interact with previously defined blocks, however the developmental trajectory is pointing towards player authored content that would allow anyone to create a new block, a resource or an agent attribute.

While this paper has presented the theoretical underpinnings for the development of a game like Block’hood, it is yet to be documented and studied as to the results such an engine could / will have over a community. Today, the feedback from players is very positive and promising, demonstrating that notions of ecology and decay can be addressed by a wider audience, and no expert users are needed to address complexity. The development team is developing the tools to track player’s data and share results from the platform in a further publication.
REFERENCES


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Jose Sanchez is an Architect / Programmer / Game Designer based in Los Angeles, California. He is partner at Bloom Games, start-up built upon the BLOOM project, winner of the WONDER SERIES hosted by the City of London for the London 2012 Olympics. He is the director of the Plethora Project (www.plethora-project.com), a research and learning project investing in the future of on-line open-source knowledge and the creator of Block'hood, a city simulator video game exploring notions of crowdsourced urbanism. Currently he is Assistant Professor at USC School of Architecture in Los Angeles. His research 'Gamescapes', explores generative interfaces in the form of video games, speculating in modes of intelligence augmentation, combinatorics and open systems as a design medium.