Evolution of Spatial Configurations In Videogames

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ABSTRACT
This paper deals with the basic spatial configurations in videogames from early games until today, focusing on how they position the player with respect to the playfield, and how they affect gameplay. The basic spatial configurations are defined by a few basic features (cardinality of gameplay, cardinality of gameworld and representation) which combined can account for most videogame spaces.

Keywords
videogames, spaces, spatial configuration, theory, historical evolution, spatial representation, cardinality

INTRODUCTION
Any game takes place within a space, so that its rules are in force within its boundaries; Huizinga called this 'the magic circle'(a phrase recently revived by [1]). Spatiality is one of the fundamental properties of digital environments, as defined by Murray [2]. Videogames take place within a digital environment, and make use of the spatial properties of digital environments to create new types of spaces [2, 3]. The representation of this virtual space has always been constrained by technological affordances; as technology advances, the configuration of those spaces has also developed and become more complex.

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We are aware of a similar analysis, carried out by Wolf [4], to which this paper presents an alternative. Wolf compares videogames with other media, mainly film, and considers the influence of technology on the creation of spaces. However, his analysis lacks a historical perspective, and the strict comparison to film misses what the intrinsic properties of the digital medium bring to videogames. The analysis will focus on the main gameplay spaces of every game, disregarding types 11 and 9 in Wolf's classification—maps, which the player can call up on the screen or overlay the main space, and the split screen methods that some multiplayer games use.

The scope of this paper is limited to how computers generate visual spaces procedurally, rather than how they import spaces from other media, such as digitized videos or photographs. Thus games such as text adventures, *Dragon's Lair* or *Mad Dog McCree* will not be accounted for by the terms defined here; these games deserve types and analyses of their own, which are indeed related to constructions of space in written prose or cinema.

The present analysis is based on concepts and terminology within the Game Ontology Project [6]. This project intends to generate a language and vocabulary for the critical analysis of games. Rather than developing definitions for what a game is, or aiming at a generic classification of games, the ontology focuses on the analysis of design elements cutting across a wide range of games, in order to describe their design space and inform their critical analysis.

SPATIAL CONFIGURATIONS: FEATURES

Gameplay and space are related by cardinality of gameplay, which defines how the player can move around the gameworld. Cardinality of gameplay refers to the degree of freedom the player has with respect the control of movement in a game. The cardinality is defined by the number of axes that the player can use to move entities around. (X, Y, Z), i.e. side to side, up and down, back and forth. This term only refers to the movements the player can perform, independently of other actions or the effects they may have in a different dimension (e.g. shooting), because it does not affect the way the player moves within the gameworld.

- One-Dimensional gameplay: the player can move along a single axis, X or Y.
- Two-Dimensional gameplay: the player can move along two axes, X and Y, or X and Z. We have not found any instances of a game that allows Y and Z cardinality.
- Three-Dimensional gameplay: the player can move along the three axes, X, Y and Z.

Cardinality of gameplay is related to, though different from, cardinality of the gameworld, which refers to the way in which the player can navigate the space. At the same time, they are both different from the spatial representation, which can be either in two dimensions or in three, but it does not mean that the player can move around in those same dimensions. As we will see in the examples, the differences between both cardinalities and the representation can have a direct influence on the gameplay.

Another basic feature of the spatial configurations is the dichotomy between discrete and continuous spaces. The screen is the basic unit of space in videogames, since it frames the interface. This dichotomy considers how the virtual space is contained within that frame, whether the gameworld is encompassed within a single screen, or extends beyond its limits. In the second case, the representation must be segmented, and the player will experience that space in a fragmented way.

This segmentation can be realized either in a discrete or a continuous way. Discrete segmentation occurs when the screen contains one fragment of the gameworld, which the player navigates; when she reaches the limits of that fragment, the screen refreshes to a different segment of that space. Usually every segment contains a challenge of its own, which may be to overcome the obstacles to reach the next screen. (For a more detailed discussion on different types of gameplay segmentation, see [5]). This segmentation may also affect the gameworld, e.g. the player character can move from one segment to another, but the enemies will not follow the character to the next segment (e.g. *Prince of Persia*, PC, 1989). On the other hand, the space is represented continuously when the screen is showing with a scroll – Wolf compares this to a tracking shot [4], p. 58 – or moving the point of view of the player as she moves around.

After defining these three basic concepts, let us continue with the different spatial configurations *per se*. Table 1 shows how these concepts combine to define different spatial configurations in 2D, while Table 2 shows the configurations in three-dimensional representations of space.

Table 1: Spatial Configurations in 2D representations of space

	SINGLE SCREEN	**ONE-DIMENSIONAL GAMEPLAY**	**TWO-DIMENSIONAL GAMEPLAY**
DISCRETE	*Galaxian* *Centipede* *Frogger* *Donkey Kong* *Pacman* (wrapped) *Asteroids* (wrapped) *Time Pilot*	*Athletic Land* *Pitfall* (1.5 cardinality)	*Adventure* *Prince of Persia* *Metal Gear* *The Legend of Zelda: Link's Awakening* *The Legend of Zelda: Oracle of Seasons* *The Legend of Zelda: The Minish Cap*
CONTINUOUS	*N/A*	*Spy Hunter* *Operation Wolf* *Defender*	*Nemesis / Gladius*(Locked scrolling) *1942*(Locked scrolling) *Yoshi's Island* (Including locked scrolling in some levels)

Two-dimensional Spaces

These spaces are represented on a two-dimensional plane, the point of view of the player moves up and down the surface. There are only two axes of representation (X, Y), which mark the cardinality of gameplay – those are the axes that the player can move along. The cardinality of the gameworld, as we will see, depends on how these two concepts interact.

2D, Single Screen

In single screen games, the dimensions of the gameworld coincide with the size of the screen. This is the most basic configuration used by early gaming technologies, e.g. early arcade games such as *Galaxian* (1979), *Centipede* (1980), *Frogger* (1981), and *Donkey Kong* (1981), and the early Atari consoles. The player has a complete view of the state of affairs at one glance, which allows developing global spatial strategies; this is why this type of spatial configuration is singled out. This would be later the mode of the first strategy games (e.g. *Sim City* (PC, 1989)), since it provides a god-like point of view.

A technique used to enrich two-dimensional spaces is the wraparound (also see [4], p. 56), which affects the cardinality of the gameworld. This is a feature of two-dimensional spaces, by which when an entity reaches the limits of the gameworld, it reappears on the opposite side. It is a convention rather than an actual representation of a space. In single-screen arcade games such as *Asteroids* (1980) and *Pac-Man* (1981), wraparound is a way to "extend" the space, and make orientation more complicated.

Time Pilot (Arcade, 1982) presents a special configuration within this type. The player controls an airplane in the middle of the screen; the objective is to destroy every wave attacking the airplane. The space scrolls towards the direction the player chooses, making the space virtually unbounded, since the enemy airships will follow the player wherever she goes. The gameworld is what is displayed on the screen, there is no external space to be mapped out, and that is what makes the space in *Time Pilot* different from other spaces extending beyond the limits of the screen.

2D Space, One-Dimensional gameplay

In most videogames, the gameworld is larger than the screen, so it has to be shown in segments. Most of the definitions below deal with the how this segmentation can take place, and its effects on gameplay.

a) Discrete

The most basic way to extend the space beyond the screen is by making different screens adjacent to each other; the player accesses the next screen when the entity she controls gets to the exit of the previous one. It is a direct evolution from the single-screen space, since every screen will contain a challenge (instead of the whole level), which will have to be overcome to reach the next one. In the case of one-dimensional games, the screens are usually linked horizontally. The player can only go to either side; once a direction has been chosen, the player can only go in that direction. Jumps may be allowed, but that only compensates the fact that there is no point on going back. *Athletic Land* (MSX, 1984), a *Pitfall* rip-off, is a strong example of this type of space. *Pitfall* (Atari 2600, 1982) itself is a weak example, since every screen has two levels, and the player may opt to advance to the right either on the surface or through the tunnels, which adds half an axis to the cardinality of gameplay. In either case, the enemies in each screen never follow the player character to the next one.

b) Continuous

The space is usually presented continuously in a scroll, bestowing the gameplay with a sense of progression. The cardinality of gameplay dictates that the gameworld must be arranged either vertically or horizontally. Race games with a vertical point of view, such as *Spy Hunter* (Arcade, 1983), are a strong example of this. The player moves from side to side of the road; accelerating and braking affect the speed of the scrolling movement, but not the direction of the car—the only way to go is forward.

This configuration can also have wraparound, as in *Defender* (Arcade, 1980), to represent a two-dimensional space wrapping around in a cylinder (see Figure 1), where the player's point of view revolves around the Y axes. In *Operation Wolf* (Arcade, 1987), an early first person shooter, this configuration gave a static position to the player, who would move from side to side to kill her enemies.

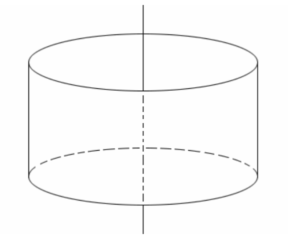

Figure 1

2D Space, Two-Dimensional gameplay

When the cardinality of gameplay includes moving along both the X and Y axes, the gameworld can extend to the four directions, complicating the space and demanding the player to use her sense of orientation.

a) Discrete

A strong example of this type of space is the original *Prince of Persia* (PC, 1989), where the dungeons extend to the four directions. The maze-like configuration of the space was complicated because it was segmented, and even though the enemies would not follow the player from one screen to the next, some fulcrums would open gates in another screen, breaking the self-containment of earlier games.

Metal Gear (MSX, 1986) combined the fragmentation of the gameworld with gameplay. A pioneer stealth game, if the soldiers were alerted of the presence of the player character they would raise the alarm start chasing him, but only within the boundaries of every screen. The segmentation of the representation affected the events in the gameworld—if the player went on to another space, the alarm would be immediately called off.

Earlier games combined a segmented maze with wraparound to complicate the cardinality of the gameworld. *Adventure* (Atari 2600, 1980) as analyzed in [4], p. 62, is a strong example of this, featuring mazes impossible to map on 2D.

Some games in *The Legend of Zelda* saga (*Oracle of Seasons* (GBC, 2001), *The Minish Cap* (GBA, 2004)) also take advantage of this segmentation to create a maze. This maze is a series of screens, where the player has to choose the correct direction according to a set of instructions, but which cannot be drawn in a map. For example, the player has to go left in the first screen, then right, which does not take her back to the previous screen, but is actually the next step in the maze. This is an impossible space in the real world, possible in videogames by the segmentation of the gameworld.

b) Continuous

The earliest form of this type would be an evolution of the single-screen shoot-‘em-up, where gameplay was one-dimensional; e.g. in *Galaxian* the ship could only move side to side. Games such as *Nemesis* (MSX, 1986), the origin of the *Gladius* saga, extended the cardinality of the gameworld gameplay, so that there was an enhanced sense of traveling. This configuration, however, also brought about what we call locked scrolling: the gameworld is advancing constantly forward, the ship can move in the four directions within the screen, trying to keep up with the scrolling but the player cannot speed up that scrolling.

1942 (Arcade, 1984) is another example of this type of space, with a twist—apart from moving in the four directions, the player has a limited number of loops which allows her airplane to jump briefly to another height, adding half an axis to the gameplay, so to speak.

Two-dimensional spaces scrolling in the four directions would be a later technical development, allowing larger spaces to be navigated in a continuous fashion. *Yoshi’s Island* (SNES, 1995) successfully combines different 2D configurations to provide diverse gameplay in every level. The first levels use one-dimensional gameplay with scrolling screens, evolving into two-dimensional gameplay in subsequent levels; it even adds locked scrolling to two-dimensional gameplay every few levels, making the progress in the game more difficult.

Table 2: Spatial Configurations in 3D representations of space

	SINGLE SCREEN	ONE-DIMENSIONAL GAMEPLAY	TWO-DIMENSIONAL GAMEPLAY	THREE-DIMENSIONAL GAMEPLAY
DISCRETE	*Technic Beat*	N/A	*Myst*	*Metal Gear Solid*
CONTINUOUS	N/A	*Gran Turismo*	*Battlezone* *Myst III: Exile* *Wolfenstein 3D* *Doom*	*Unreal Tournament*

3D Spaces

One basic representation of three-dimensional spaces is using isometric perspective, which allows the player to have a general view of the gameworld at a glance, as in *Marble Madness* (Arcade, 1984). This type of representation is usual in strategy / simulation games, such as *Sim City 2000* (PC, 1995), or *The Sims* (PC, 2000).

Another three-dimensional representation is the use of perspective, resorting to 3D rendering to calculate the vanishing points. Early videogames, such as *Battlezone* (Arcade, 1980), used wire-frames to represent the objects in the space; polygonal 3D rendering took longer to latch on to videogames, when processing speeds allowed refreshing rates fast enough to provide smooth gameplay.

Three-dimensional gameworlds invite navigation and exploration, since they take place within a 3D real-time environment. The concept of “camera” as the point of view has an important role in the gameplay, e.g. when looking around to locate one's enemies or find the way out of a building. Thus 3D games may offer multiple points of view (first-person, third person, floating camera) that the player can choose.

Most times, 3D gameworlds extend beyond the limits of the screen, although there are some examples of single-screen 3D games. *Technic Beat* (PS2, 2004) allows the player to move the camera around and choose her preferred point of view.

3D Space, One-Dimensional gameplay

We have not come across any examples of discrete representations of space within this category, so this configuration is continuous by defect. The natural example seems to be the three-dimensional version of racing games, such as *Gran Turismo* (PS, 1998), which have the same controls and therefore same cardinality of their 2D counterparts. The point of view limits the view of the player's opponents; therefore racing games usually show an overlaying 2D map of the gameworld, to facilitate the player's orientation and relative position with other racers.

3D Space, Two-Dimensional gameplay

3D representations usually take advantage at least of two of their axes for gameplay.

a) Discrete

   This is a special configuration, by which the gameworld is shown in captions that fade in / cut to the next image as the player chooses a direction in which to move. It slows down the pace of navigation, therefore it seems suited for puzzle games such as *Myst* (PC, 1995). We are including these games here because the captions being reproduced are procedurally generated first, and then captured and used as a static image (with overlaid animations when relevant).

b) Continuous

   Continuous 3D representations allow the player to navigate a 3D real time environment. This is the format that *Battlezone* took; more recently, it is also a refinement from the previous space, such as in *Myst III: Exile* (PC, 2001).

   Wolfenstein 3D combined these spaces with shoot-'em-up mechanics so successfully it sparked off the First Person Shooter genre. The player could move backwards and forwards, side to side and shoot with different weapons. The enemies would also move in those same directions, so that the cardinality of the gameworld was also 2D.

   Doom (PC, 1993) improved the formula, by actually making the cardinality of gameplay clash with the cardinality of the gameworld—there were several floors, and the player had to find the way to climb up, because she could not jump. However, the gameworld physics allowed the player to fall to a lower floor, expanding the cardinality of the gameplay down the vertical axis.

3D Space, Three-Dimensional gameplay

Because the cardinality of the gameworld and gameplay are the same, the freedom of movement is larger; on the other hand, this configuration also requires a better sense of orientation, since the point of view of the character is always contained within the screen.

a) Discrete
The cardinality of the gameworld can be hampered by segmenting the 3D representation, using different camera views. This is the case of *Metal Gear Solid* (PS, 1998), where the point of view imitates that of surveillance cameras in some areas, which seems adequate enough for a stealth game. This is also a natural evolution of the discreet spatial segmentation of the first game, with a twist—the gameworld is continuous, so that if the alarm is triggered in one area, the soldiers will chase you wherever you go, the alarm will only turn off after one minute if they do not find you.

b) Continuous
This type of space seems to be appropriate for action games, where the player can move around doing acrobatics if needed. A first person shooter such as *Unreal Tournament* (PC, 1999) seems to benefit specially from this type of spatial configuration, where dodging the opponents' shots and reaching places to take cover are fundamental in the gameplay.

CONCLUSION

Our discussion of spatial configurations highlights how the development of technology allows spaces increasing in size (extending beyond the single screen) and complexity. We have also noted how the cardinality of the gameplay space is usually minor than that of the gameworld and its representation, e.g. a space represented in 3D may only be navigable in two dimensions. As technology has progressed, an increasing amount of games have achieved spatial configurations where the cardinality of the representation is equal to that of the gameworld, and finally to that of the gameplay.

Technical development does not cancel out previous spatial configurations, but rather expands them, and even allows contrasting the different gameplay models that they allow. *Pacman Vs.* (GC, 2003) is an example—it allows one player play the classic Pac-Man on a Gameboy Advance connected to the Gamecube, while up to four other players play the game on the TV-screen as the ghosts, within a 3D labyrinth. The cardinality of gameplay and gameworld are the same, but the different spatial representations demands different gameplay strategies depending on whether the player is playing Pac-Man or a ghost. The goals will be different for either character, but also the way in which the player orientates herself—the labyrinth appears fragmented to the player-ghost, and therefore feels more confusing than to the Pac-Man player, who can see her relative position within the space and from the other players. How different configurations may be used in the same game, as in this case, may be the topic of another paper

We have defined the basic features defining spatial configurations in videogames. Technology is not likely to bring about new ones, since we have reached a point where the cardinality of gameplay and gameworld coincide with that of the representation. What may happen is that technology may thrive in the creation of new gameworld cardinalities, by exploiting the segmentation of the representation (as in the *Zelda* maze) in 3D, generating spaces which change on the fly as the player navigates them, or reproduce three-dimensional models of Escher-like spaces. The way is open to create new gameworlds that are impossible to conceive in the real world.

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