PLAYING IN 7D: AN ACTION-ORIENTED FRAMEWORK FOR VIDEO GAMES (A SUMMARY)

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Keywords
Action
Chronology
Depth
Design
Framework
Focus
Responsiveness
Thinking and Actuation
Transcoding
Traversal
Video Games

This paper is summary of our Ph.D. thesis, a work that proposes an analysis on the player-game system relationship through the perspective of an action-oriented framework. This framework is centred on the existence of actors, which are the entities through which action is enacted in the game, and in which the player and the game system are a part of. The grounding principles of this framework are seeded on a transition of action into experience, based on communicational systems that structure the dynamic formation of networks of actors from which distinct behaviours emerge, which, in their turn, promote the enactment of diverse sequences of events establishing narrative, which is a source of experience of the player.

Chronology, responsiveness, thinking and actuation, transcoding, focus, depth, and traversal are the 7 dimensions we unveiled by focusing on the relationship of the player-game system pair through the lens of this action-oriented framework, a framework that, despite seeing both as actors, is able to consider their distinct natures and roles.

We do not consider this work to be an ultimate theory of action. Above all, it is a proposal that video games can be regarded as action-based artefacts, a call to awareness for game designers that when designing for action they are working with the fundaments on which video games are built upon.

2016.
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Computation
Communication
Aesthetics
& X
Bergamo, Italy

1 ACTION: A DEFINING TRAIT IN VIDEO GAMES

The graphical capabilities of early video games primarily consisted of rarefied figures acutely constrained by the technical limitations of the computers of that era. Since those machines were unable to process complex graphics along with the interactive features expected from a video game, the priority was directed to gameplay (Rollings and Adams 2003, 292). Even in contemporary video games it doesn't matter how good a given video game looks if it is not playable. Therefore, and since a game's primary prerogative is to be playable, without action it would become passive entertainment. As Brenda Laurel states: "action is indeed the primary component of human-computer activity" (1991, 135). And that is why, according to her, *Spacewar!* (1962)—to some the first video game in history—was the natural thing to build with computers (2014).

With this in mind, the player has the ability to take part in the "central conflict of the game's narrative" (Wolf 2001, 114), acting within the game world and influencing it in the most varied ways. Therefore, contrarily to a traditional spectator, we may say that the player is an active participant. Action is then the means by which the player is able to alter game states influencing the game system (Björk and Holopainen 2005), which reacts back at the player, in a cybernetic feedback loop (Wiener 1954, 1948). And, as Jesper Juul (2001) states, "this experience is so strong that most people will involuntarily change bodily position when encountering interactivity, from the lean backward position of narratives to the lean forward position of games." Considering the indispensability of action, Alexander Galloway states that: "Without action, games remain only in the pages of an abstract rule book" (2006, 2), meaning that games only occur when they are actually enacted.

Departing from this and taking into consideration an analysis of 1) Mark Wolf's theory of interactivity-based genres (2001); 2) Richard Bartle's (1996, 2004) player taxonomy in which he tackles with a distinguishable difference between *action* and *interaction*; 3) Staffan Björk and Jussi Holopainen's (2003, 2005) implicit distinction between *action* and *actuation* in their activity-based framework for video games; 4) Galloway's (2006) definition of *gamic action* through an action-based model in which he evidences the distinction between the actions of the *player* and of the *game system*, as well as those actions within the *diegetic* and *non-diegetic* realms, attesting that *action* and *inaction* are both important phenomena in the player-game system relationship; 5) the capabilities of *modularity* and *recursion* found in the

gameplay-based classification model of video games proposed by Julien Alvarez (2004, 2006) and Damien Djaouti et al. (2008a, b, 2007a, b); 6) the properties of *emergence* present in Jesse Schell's definition of operative and resultant actions (2008, 140); 7) Ernest Adams's view that a "player experiences a video game through its input and output devices"[1] (2014, 255), an experience that is regulated by the user interface, which, contrarily to that in utilitarian software, is not supposed to promote the efficiency of the player's actions but the challenges in which the game is based on (38); 8) Chris Crawford's perspective on interactivity as a conversation, "a cyclic process in which two actors alternately listen, think, and speak" (2003, 5), evidencing a communicational structure composed by *input*, *processing*, and *output*, along with Eric Zimmerman and Katie Salen's (2004) similar view on Brian Sutton-Smith's model focused on the psychological processes by which digital games are experienced (1986), and the also concurrent perspective of Djaouti et al. (2008) on the structural parts of a video game; 9) Crawford's position about conflict in video games (2011), along with the idea that for Marc LeBlanc "[a]ll drama originates from conflict" (2005, 444); and 10) Wolf's perspective that the player is sometimes forced "to momentarily take on the author's way of thinking" (2001, 4) in order to succeed in the game, which is explicitly depicted in the MDA framework (Hunicke, LeBlanc, and Zubek 2004), allowed us to find that *to act* in the context of video games is an activity that can be summarily characterised as follows:

To act is to engage on a cybernetic relationship with the game system; a relationship that is both dialogical (in the sense that it is focused on establishing a communicational feedback loop between the player and the system) and dialectical (because the player and the system act as opposing forces).

- *To act is to actuate in order to alter or maintain game states or player states,* in the sense that, in order to be realised, the actions of both the player and the game system require some kind of operation, regardless of whether they are successful or not in accomplishing their goals.
- Since, when perceived, the player's and the game system's actuations are interpreted as signals, *to act is to emit signals, and thus to communicate.*
- Because the player-game system relationship is not always based on continuous feedback, *to act is also not to act.*
- And because behaviours are complex actions that emerge from simpler actions, *to act also means to influence behaviour.*
- Overall, *to act is to shape the experience of play,* in the sense that it is the player's and system's actions that determine the course of the game.

1. "[A]s well as (possibly) through interactions with other players in the same room." (Adams 2014, 255)

2 AN ACTION-ORIENTED FRAMEWORK

2.1 FROM ACTION TO EXPERIENCE

Based on diverse systems of ideas, the framework we propose is attentive to both the player's and the system's actions, following a very particular line of thought that can be summarily described as a multistage transition that goes *from action to experience:* from action stems communication, communication originates networking, networking creates emergence, emergence gives rise to narrative, and narrative constitutes experience.

From action stems communication in the sense that the relationship between the player and the game-system is based on a communicational feedback loop rooted on a cybernetic relationship "involving both organic and nonorganic actors." (Galloway 2006, 5) These communicate through actions, that are interpreted as signals, in a similar fashion as what we find in Shannon's (1948) and Weaver's (1949) model for communicational systems. Hence, in this framework the player and game system emit signals directed at each other, signals that need to traverse through the environment to reach their ultimate destination.

Communication originates networking since actors[2] constantly establish links with each other that are frequently interrupted as well, severed by their own will or by decision of others, constituting dynamic networks, a perspective influenced by Bruno Latour's actor-network theory (1987, 1988, 1993, 1999, 2005, 2013), Graham Harman's object-oriented philosophy—mainly his perspective on Latour's work as a contribution to metaphysics (2009) —, and Ian Bogost's *unit operations* and *tiny ontology* (2006, 2012). For example, both the player and the game system are composed of networks of other actors. Even the environment is composed of other actors.

Networking creates emergence because it is from the fluidity of these networks, from their ever-changing nature that behaviour emerges. And it is this behaviour that the player mainly witnesses as the rules of the game in motion. Even unanticipated behaviours on behalf of human players—such as cheating, hacking, modding, etc.—, caused by other software—viruses included—, or even by means of the hardware itself give rise to alternative behaviours.

Emergence gives rise to narrative in the sense that the sequence of events generated by these behaviours is what constitutes narrative. Bear in mind that we are not necessarily talking about the storyline of the game but about all the events that result from internal procedures of the game system and from the player's interactions with it that are expressed in runtime during a game.

2. Actors are the elemental unit of this framework and can be briefly defined as the elements through which actions in the game are enacted — the player and the game system are both actors. We expand this definition in the next section of the text.

That is what LeBlanc calls the emergent narrative (Salen and Zimmerman 2004, 383) and what Tom Bissel names as the ludonarrative (2011).

And finally, *narrative constitutes experience* because it is these sequences of events that emerge from these behaviours promoted by these networks of actors—that unfold while playing the game—that constitute the action-based experience of the player. An experience that is dependent on processes, on procedures, on action, and that is not related with iconography or theme.

This perspective—grounded on action—is then able to look at the specificities of video games as ergodic media as defined by Espen Aarseth (1997). And this chain of procedures seems to be in tune with the MDA framework (Hunicke, LeBlanc, and Zubek 2004), depicting how the dynamics level links the mechanics and the aesthetics levels.

2.2 ACTORS AND METHODS OF OPERATION

Since this is an action-oriented framework, we propose it to be grounded on the existence of elements we defined as *actors*, and through which actions in the game are enacted. In sum, everything that is able to act in the game is considered to be an actor, whether that is the player, the game system, a playable or non-playable character, a power-up, the arrow cursor, an item, the camera, etc..

Actors act by emitting signals that may be sensed by other actors and/or by its originator.[3] In order for a given signal to travel between the emitter and the receiver it must traverse the *environment*. The environment is what allows the creation of links of communication between them, but at the cost of altering the signal, a phenomena that can be classified as *noise*. However, since the environment is nothing more than a network of other actors that stand between the original emitter and the receiver, we may say that noise is nothing more than the effect of translation or mediation that a given signal suffers when going from one actor to another.

By further inspecting actors, we found the following traits: topology, mereology, access, milieu, I/O structure, and behaviour.

Their *topology* is based on a recursive structure, in which actors are constituted by networks of other actors, which in their turn are also constituted by networks of other actors, and so on. Considering this, the nature of the actions within a given actor's micro levels may be different from the ones it enacts, but they utterly affect its behaviour, in the same way that its actions will affect the behaviour of an actor from which it is a part of.

3. The form and modality of the signal are dependent on the capabilities of the actor that emits it. The capability to perceive the signal is also dependent on the modality of the receiving actor's sensors.

With this in consideration and regarding their *mereology*, actors present themselves as having either an open topology — in which their components are accessible to others — or a closed topology — in which their components are inaccessible to others, appearing to them as black boxes.

We may define an actor's connections with other actors as its social grounds, its *milieu.* This is what plays an essential role in determining its influence and function in the network.

As we have seen, actors are entities with the ability to generate, alter, convey, and exchange signals. And with that in mind, we were able to discern three separate activities that actors engage on: inspection, a moment of sensing the environment; signal processing, a moment in which the signals are processed and decisions made; and actuation, a moment focused on disturbing the environment in order to emit specific signals. Reckoning these activities, we consider actors to possess a basic *I/O structure* constituted by sensors, processing core, and actuators.

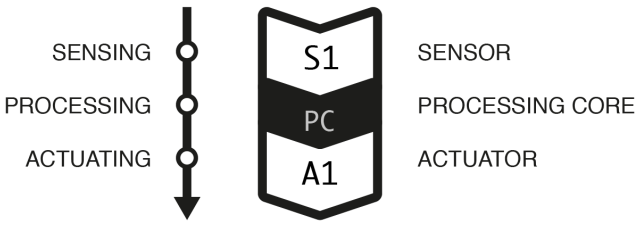


Fig. 1. A schematic representation of the I/O structure of an actor.

Through the course of the game, actors may assume diverse *behaviours* that can be divided into four distinct classes — drawn from Stephen Wolfram's (2002) classes of computational procedures, although adapted to take into account the ontological diversity of actors by taking into consideration thoughts and deliberations articulated by Rudy Rucker (2005) and Miguel Carvalhais (2010) on the subject. Considering this, the actions of actors that exhibit *class 1* behaviours express a uniform, deterministic and predictable behaviour. Actors within *class 2* act according to nested patterns of behaviour, which can be perceivable depending on the time that their cycle takes to restart.[4] The output of actors with *class 3* behaviour may present random or pseudo-random results.[5] And actors exhibiting *class 4* behaviour are those that have a complex, sometimes unpredictable, structured but not necessarily deterministic behaviour, being able to plan various strategies to accomplish their goals. A human player is a good example.

4. Usually the player has to understand these patterns – sometimes by trial and error – in order to interact with them.

5. Despite that, they are usually accepted as being part of the challenge of the game.

By further inspecting the methods of operation of this framework, we encountered three distinct types: mediated, direct, and delegated operations. *Mediated operations* are those in which the signals that emanate from the player and/ or the system are processed by another actor that stands between them, such as in the practice of tool-assisted speedruns.[6] Despite the fact that every operation in this framework is considered to be mediated, *direct operations* are those where the effects of mediation (noise) are considered to be irrelevant. And lastly, a *delegated operation* occurs when an actor acts in representation of another, such as when the player delegates her role as operator of the game system to a bot, to an artificial intelligence agent, or even to another organism.

6. A speedrun is a play-through in which the player tries to achieve the game's closure or particular objectives in the speediest way possible, in which some are performed with the use of tools beyond the original setup of the game. At the time of writing http://tas-videos.org is a good resource.

3 PLAYING IN 7D

From this perspective and focusing on the relationship between the player and the game system, we were able to find 7 distinct dimensions of action.

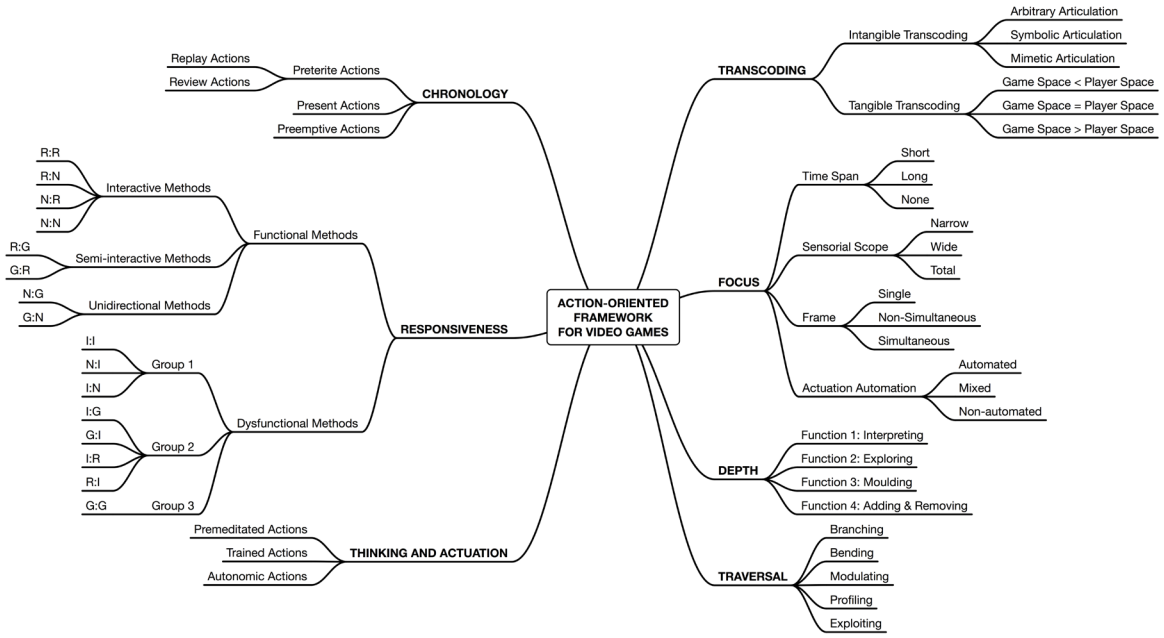


Fig. 2. Overview of the seven dimensions, featuring all the variables.

In the following sections we will focus on brief descriptions of each dimension. Hence, for a more in-depth insight we recommend reading our articles mentioned in each section, or preferably the updated versions in our thesis (Cardoso 2015).

3.1 CHRONOLOGY

By establishing a reasoning that video games are fundamentally chronological, we may classify *chronology* (Cardoso and Carvalhais 2012c) as a dimension that is focused on understanding variations in the sequences of events, attentive to the manipulation of *objective time*—the time the player takes to play—and *event time*—the time related with the diegesis of the game world (Juul 2004).

Preterite actions are those that are focused on past events, accessing the memory of the computational system in order to invoke stored data. Here, we have found two subtypes:

- *Replay actions* allow the player to return to a certain moment in the chronology in order to change its outcome. We find this a lot in trial-and-error based videogames, such as *Lunar Lander* (1973), *Pac-Man* (1980), *Manic Miner* (1983), *Ghost 'n' Goblins* (1985), *Super Mario Bros.* (1985), *Contra III: The Alien Wars* (1992), *The Unfair Platformer* (2008), *Braid* (2008), *Super Meat Boy* (2010), *VVVVVV* (2010), *Blades of Time* (2012), *Donkey Kong Country: Tropical Freeze* (2014), *Plants vs. Zombies* (2009), *Angry Birds* (2009), *Flappy Bird* (2013). We also find them in more cinematographic or narrative-based games such as *Life is Strange* (2015).
- *Review actions* allow the player to access past events without being able to influence their outcome, useful for evaluating one's performance. The ghost ship feature in *Wipeout Pulse* (2007), the ghost Mii feature in *Super Mario 3D World* (2013), and the blood stains in *Demon's Souls* (2009) are examples.

Despite all actions being enacted in the present time, *present actions* are those that are solely focused on the really short time span that is the immediate present time. These are usually fast actions and are often not consciously enacted. Therefore, although sometimes they are not executed taking into account one's best interest, they are essential since conscious thought takes time. *Robotron: 2084* (1982), *Unreal Tournament* (1999), *Geometry Wars: Galaxies* (2007), *Bayonetta* (2009), *Vanquish* (2010), *Sonic Lost World* (2013) are examples due to their fast-paced nature that promotes quick decision-making.

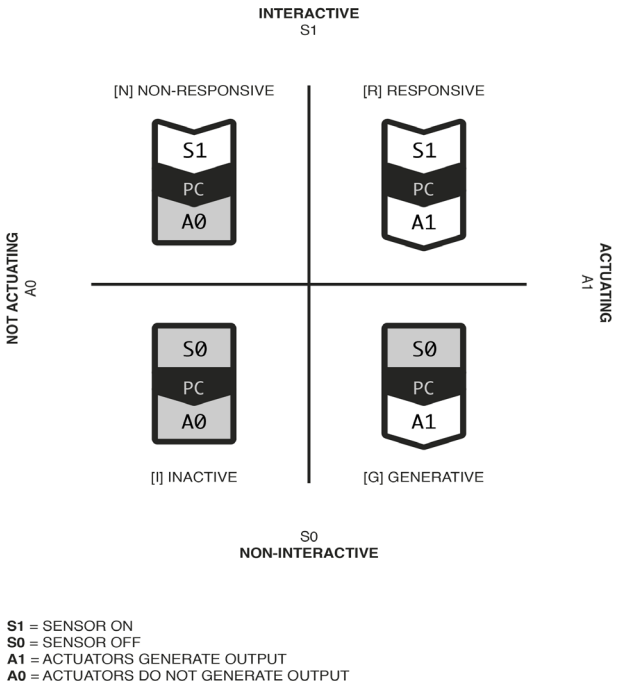
Preemptive actions are those that work towards the preparation for a determined foreseen situation. This an ability that not only depends on the experience and astuteness of the player but also on the predictability and determinability of the game system. The 'zapping system' in *Resident Evil 2* (1998) that allows the player to sequentially play two complementary scenarios within

the game, and the case of the sniper 'The End' that can be killed at an earlier stage of the game in *Metal Gear Solid 3: Snake Eater* (2004) in order to bypass it later as a boss are examples.

3.2 RESPONSIVENESS

Responsiveness (Cardoso and Carvalhais 2012b, 2014a) is a dimension that looks at the fundamental input and output structure of the player and of the game system (sensors, processing core, and actuators), discerning their basic input and output states in order to draw the possible permutations between these. With that in mind, we determined four I/O states: non-responsive (N), responsive (R), generative (G) and inactive (I).

Fig. 3. Actor's I/O states.



We then calculated all possible permutations between these states in systems featuring two actors (player and game system), uncovering functional and dysfunctional methods. *Functional methods* are those where at least one of the actors is receptive to the other's output. *Dysfunctional methods* are those that are unable to establish a direct pathway of communication between both actors.

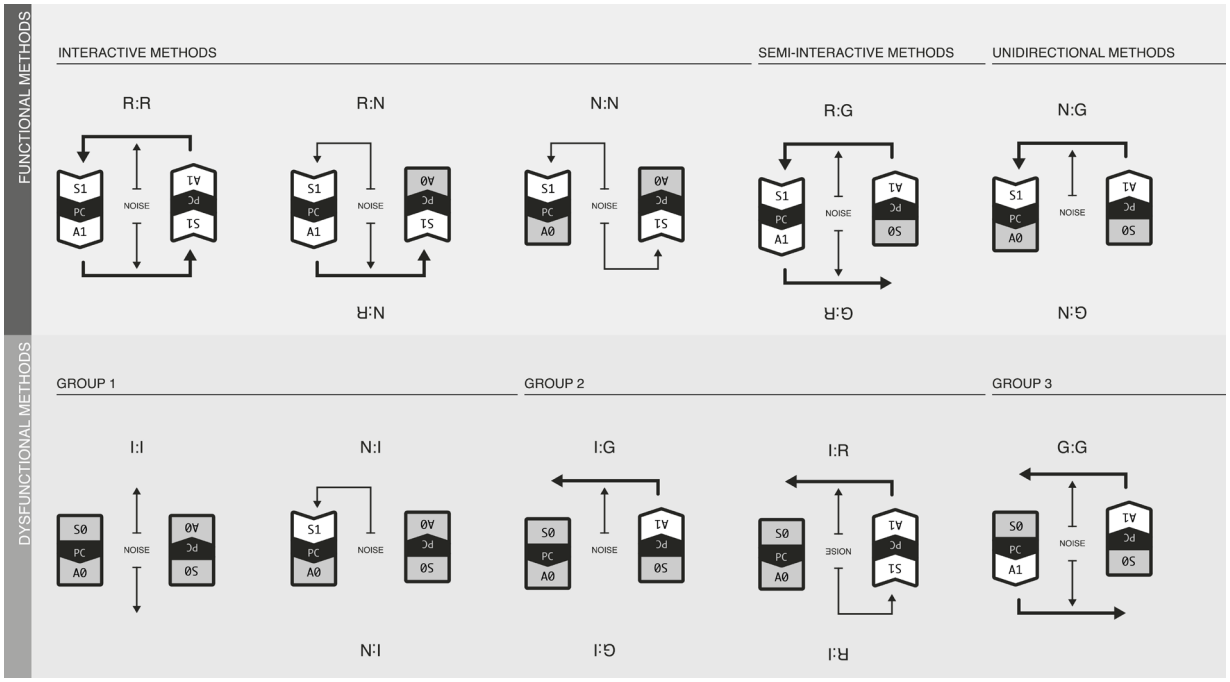


Fig. 4. I/O methods.

Overall, in this dimension we have asserted that variations in responsiveness promote the emergence of different play experiences, also demonstrating that dysfunction in communication plays a major role in the action-oriented nature of video games.

Here we studied the diverse nuances of the communicational system that is the relationship between actors, between the player and the game. We then confirmed that theirs is a relationship not always in constant flux, in which inaction is as valuable and important as action itself, and therefore that dysfunction is not necessarily a synonym of uselessness or error.

3.3 THINKING AND ACTUATION

This is a dimension that is observant of the player as an entity of biological origins and is focused on discerning diverse types of player action found between conceptualising and enacting an action (Cardoso and Carvalhais 2013a).

Premeditated actions are those in which the player is required to invest conscious mental effort in their planning, taking time to deliberate. *Populous* (1989), *Warcraft: Orcs & Humans* (1994), *Age of Empires* (1997), *Black & White* (2001), *Supreme Commander* (2007), *Starcraft II: Wings of Liberty* (2010) are examples since these games enforce the player to make plans in order to achieve long-term goals.

Trained actions are those that the player executes unconsciously, and that are learned and mastered by rote, becoming automated and choreographed. These actions are voluntarily initiated and terminated by the player, but they are not under her conscious control, as they are conditioned and depend on the training the player as undergone. *Super Mario Bros.* (1985), *Sonic the Hedgehog* (1991), *Super Street Fighter II* (1993), *Tekken* (1994), *Wipeout* (1995) are some of examples of games that commonly resort to styles of gameplay that require the player to make use of these actions in order to overcome their challenges.

Autonomic actions are those that are dependent on the physiological operations of the player's body, and that occur without her direct control, will, or even consciousness. *PainStation* (2001), *Tekken Torture Tournament* (2001), *Nevermind* (Early Access 2015), *Brainball* (2001) are examples of games that resort to these kinds of actions in order to be played.

3.4 TRANSCODING

Transcoding (Cardoso and Carvalhais 2014d) is a dimension focused on the relationship between the performance of the player and of her proxy in the game world, and by considering the corresponding events in *player space*—the physical space where the player's body is actually situated—and in *game space*—the space where the game world resides. With this in mind, we uncovered two major types of transcoding: intangible and tangible.

Intangible transcoding occurs when player space and game space are different. In this case the player needs a proxy in game space in order to act within the game world, and it's their relationship that is relevant here. We found three distinct types of articulation between them:

- An *arbitrary articulation* occurs when there is no direct correlation between the actions of the player and those of her proxy. It is an articulation that is subjected to instruction—even for trivial routines—due to its arbitrariness. Jumping and firing in *Super Mario Bros.* (1985), the 'fatality' combos in *Mortal Kombat* (1992), or even punching and kicking in *Tekken 3* (1997) are good examples here.
- A *symbolic articulation* occurs when there is a partial correlation between the actions of the player and those of her proxy. With this articulation their actions bear some similarity, but they are not the same, they only bear resemblance. Executing the 'hadouken' in *Super Street Fighter II* (1993), shifting between first-person and third-person side view in *Metroid: Other M* (2010), or executing many of the on-screen prompts in *Fahrenheit* (2005), *Heavy Rain* (2010a), *Beyond: Two Souls* (2013) and *Asura's Wrath* (2012) are good examples here.

- A *mimetic articulation* happens when the actions of the player and of her proxy are homologous. Here the proxy imitates the player's actuations to the best of the system's capabilities, or vice-versa. Attacking or raising the sword in *The Legend of Zelda: Skyward Sword* (2011) is an example, similar to that in *Dragon Quest Swords: The Masked Queen and the Tower of Mirrors* (2007), *Red Steel 2* (2010), *Kinect Star Wars* (2012) or even in *Wii Sports* (2006), as well as particular moments in *Heavy Rain: Move Edition* (2010) where the player has to execute very specific movements indicated by the game which are replicated to a certain degree of fidelity by her avatar.

On the other hand, *tangible transcoding* happens when player space and game space are the same, which implies that the player's proxy is dismissed. Here we also found three subtypes:

- *Game space is smaller than player space* when the actuations related with the actions of the player only involve part of her body. *Angry Birds* (2009), *Fruit Ninja* (2010), *Fingle* (2012), *Finger Tied* (2012) are some examples since the player mainly uses her fingers directly on the game world, which is featured on a small touch-sensitive screen (the size of a tablet or smartphone, for example).
- *Game space is equivalent to player space* when the totality of the player's body is involved in game space. *Dance Dance Revolution* (1998) or *Johann Sebastian Joust* (2010) are good examples of games where the player needs to make use of her whole body to be able to play.
- And, *game space is bigger than player space* when the player is forced to travel in order to play, something that is evident in *Coderunner* (2012) and *Ingress* (2013), games that track players' location through Global Positioning System equipped devices.

3.5 FOCUS

Focus (Cardoso and Carvalhais 2014e) is concerned with the player's attention span and how the game system challenges her by overload or deprival. We emphasize three states—*focused, defocused,* and *unfocused*—that are transversal to the four uncovered sub-dimensions.

Time span is focused on the exploration of the temporal durations that the player is granted to act, enforcing pace and speed.

- A *short time span* promotes fast-paced action and quick decision-making. Examples are found in quicktime events in games such as *Shenmue* (1999), *God of War* (2005), *Metal Gear Rising: Revengeance* (2013), *Resident Evil 4* (2005), or in particular moments of decision in *The Walking Dead* (2012) or in *Octagon: A Minimal Arcade Game with Maximum Challenge* (2013), *Super Hexagon* (2012), or even in *Tetris* (1984) to mention an entirely different genre.

- A *long time span* grants the player a limited time to plan her actions. *Worms* (1995) is a good example because each player turn is due in a particular amount time, as well as in *Pikmin 3* (2013). *Max Payne* (2001) even transforms the previous type of actions into these longer time span actions in what became known as 'bullet time', as well as *Super Mario Bros.* (1985) when the 'hurry-up' theme plays.
- And when a given *time span is not enforced on the player* she is able to relaxedly act on the game world. Exploring the world in *The Elder Scrolls V: Skyrim* (2011), in the *Grand Theft Auto* series, or in more experimental games such as *The Endless Forest* (2005) is an example. The temporal experience in most dialogues in *Mass Effect* (2007), *Fallout 3* (2008) and *Deus Ex: Human Revolution* (2011) is also an example. *Superhot* (2013) is even more interesting since in game time only advances when the player's avatar moves.

Frame refers to the 'windows' through which the player witnesses the game world and its events. Although it is easier to describe it in visual terms, this dimension may also regard non-visual phenomena. Frames can be fixed—increasing a sense of entrapment or confinement—or scrollable—allowing the player to travel to a currently hidden part of the world, consequently hiding another.

- A *single frame* promotes the player's undivided attention to it. Some of the many examples are *Pong* (1972), *Asteroids* (1979), and *Super Mario Bros.* (1985).
- *Non-simultaneous frames* permit the player to witness diverse parts of the game world or the same part from diverse perspectives, sequentially. Examples are found when alternating between Aiden and Jodie (two playable characters) in *Beyond: Two Souls* (2013), when using a 'Hyoi Pear' in *The Legend of Zelda: The Wind Waker* (2002) in order to control a seagull, or when exchanging control between teams in *Pikmin 3* (2013) or characters in *Thomas Was Alone* (2012).
- And when *simultaneous frames* are displayed the player is able to witness diverse events occurring on the game world at the same time, or the same events from alternative perspectives. For example, games like *The Legend of Zelda: Phantom Hourglass* (2007) for the Nintendo DS, and *Assassin's Creed III* (2012) for the Wii U take advantage of systems that use two screens. *Fahrenheit* (2005) and *Siren: Blood Curse* (2008) frequently divide the screen in various frames, simultaneously presenting different events in the game world. *Screencheat* (2014) is a game based on screencheating, something that happens in competitive games when players peek at the opposing player's frame, usually to determine their location. Elements

featured in the heads-up display such as maps—as the one in *Metal Gear Solid* (1998)—or the health bar in *Street Fighter* (1987) or *Tekken* (1994) are also examples.

Sensorial scope is related to how much of the game world the player is able to simultaneous perceive. In some video games this scope changes along the traversal, and may be controlled by the player or automatically managed by the system.

- A *narrow sensorial scope* forces the player to be attentive to her immediate surroundings, promoting quick reaction since it conditions the amount of time available between the perception of a particular event and the time that that event actually gets concretised. Horror games like *Dead Space* (2008), *Resident Evil* (1996), *Silent Hill* (1999) are excellent examples here since those usually entrap the player in small and/ or dark spaces.
- A *wide sensorial scope* permits the player to perceive beyond her immediate surroundings, granting her some leeway between planning and actuating. Games like *The Sims* (2000) and *Starcraft II: Wings of Liberty* (2010) are good examples because they provide a partial overview of the game world.
- And a *total sensorial scope* allows the player to perceive the entirety of the game world. *Pong* (1972), *Asteroids* (1979), *Tetris* (1984) are a few examples.

Actuation automation regards the variations that occur between automation and non-automation of certain actuations when the player has to realize two or more operations simultaneously. This is the case of *Brothers: A Tale of Two Sons* (2013), in which the player simultaneously controls two characters, one with each hand with a single game controller.

- When the *actuation is automated*, the player is involved in repetitive actions, whose actuations can be trained, patterned and transformed into automated processes.
- A *mixed actuation* consists of the execution of both automated and non-automated actuations, something that is rendered possible because automated actuations can be kept going without being constantly monitored.
- *Non-automated actuations*, on the other hand, involve the player in constant improvisation and adaptation to the events in progress, requiring their attentive monitoring.

3.6 DEPTH

Depth (Cardoso and Carvalhais 2012a)[7] is a dimension that is attentive to the influence of the player on the game system's behavioural structure. Here we uncovered four player functions that describe how deep that influence is.

While developing *function 1*, the player is only concerned with interpreting the game, which is essential for the player to

7. We advise consulting the respective section in our thesis (2015) instead of the mentioned article because it has been seriously reviewed since it was first published.

understand the system's behaviour, which, in turn, will be the fundaments for her subsequent actions. Function 1 is in constant development and is grounded on an internal processing of the signals emitted by the system, where the player interprets the network of actors. It is also developed when vicariously learning about the game world.[8]

A player developing *function 2* interacts with the game system within the boundaries of fixed and unmodifiable rules, without changing its underlying behavioural structure, exploring it by choosing from a predetermined list of options, exploring the network of actors. *Super Mario Bros.* (1985) or *The Last of Us* (2013) are few examples of the many games that resort to this very contained form of interaction.

A player developing *function 3* is granted the possibility to reconfigure the game system's behaviour but always within the boundaries of predeterminate parameters and values, rearranging the network of actors. It is here that questions of co-authorship start to arise, but novelty is only achievable through the reconfiguration of what already exists within the game world. The player develops this function either by reconfiguring the arrangement of the game world—such as in *Lemmings* (1991) or in *From Dust* (2011)—or by generating actors from a predetermined set of constitutive elements—such as in *Spore* (2008), in *Scribblenauts Remix* (2011) or in *Besiege* (Alpha 2015). *Super Mario Maker* (2015) is a more distinct example since the player is able to create entirely new game levels from a set of particular game elements.

A player developing *function 4* is not constrained by the original set of rules, being able to expand or break them by adding new actors to the game and/or permanently removing existing ones. We believe that this is the moment where the player stops acting as a traditional player to start acting as a designer—in Hunicke's terms (2004)—, defining initially 'unprogrammed' behaviours. *Hack 'n' Slash* (2014) is an example here, since it is a game in which the player plays by hacking the actual code in which it runs.

3.7 TRAVERSAL

And finally, *traversal* (Cardoso and Carvalhais 2013c, b, 2014c) is a dimension related with how the player journeys through the game, by considering diverse intertwinements between the *hardcoded narrative*—the narrative that is fixed and predetermined—and the *emergent narrative*—the one that is fluid and dynamic, arising from the behaviours of the player and of the game system.

8. See Carvalhais and Cardoso (2015).

Branching is enacted when the player is asked to choose between mutually exclusive paths. *Super Mario Bros.* (1985), *Bioshock* (2007), *Infamous* (2009), *Silent Hill* (1999) are some examples.

Bending occurs when the player accesses optional non-mutually exclusive events, lengthening the game, either to increase her knowledge on the game world or to experience parallel narratives. *Super Mario World* (1990), *The Legend of Zelda: A Link to the Past* (1991), *Final Fantasy VII* (1997), *Mass Effect* (2007), *Grand Theft Auto IV* (2008), *Borderlands* (2009), *Heavy Rain* (2010a), *The Elder Scrolls V: Skyrim* (2011) are some examples since they recurrently invite the player to engage in optional activities.

A *modulating* traversal consists of moulding and crafting relationships between actors, and by regulating their disposition towards the player and each other. *The Sims* (2000), *Façade* (2005), *Fallout 3* (2008), *The Elder Scrolls IV: Oblivion* (2006), *Prom Week* (2012), *Middle Earth: Shadow of Mordor* (2014) are games that possess systems that take advantage of this.

In a *profiling* traversal the game system analyses the player's behaviour, interprets the emerging patterns, and establishes courses of action. *Silent Hill 2* (2001) system for selecting the ending, the acrobatics skill system in *The Elder Scrolls IV: Oblivion* (2006), the system that dynamically adjusts the location and number of adversaries the player faces in *Left 4 Dead* (2008), or the dynamic game difficulty balancing in e.g. *Super Mario 3D World* (2013) and *Metal Gear Solid V: The Phantom Pain* (2015) are good examples here.

And an *exploiting* traversal occurs when the player resorts to errors and malfunctions present within the system, travelling through an overlooked side of the algorithm. Here examples are found in almost all games, with some errors or glitches being harnessed while in development and implemented in the final product.

4 ANALYSIS

After defining these dimensions, we proceeded towards establishing various methods of analysis that at the moment are constrained within a scope that encompasses *core actions* (the actions that emerge from the core mechanics of the game) and *local actions* (the actions that derive from local, particular mechanics of the game). With this in mind, we determined three different approaches, which in other words consist of the method of analysis per se, and that can be divided into descriptive, comparative, and relational—which can be focused on an inter-dimensional or on an intra-dimensional analysis.

- A *descriptive analysis* consists in listing the variables for each and all 7 dimensions, giving us a general perspective on the action-based composition of a given game.
- A *comparative analysis* is focused on comparing the different core actions, pinpointing their differences and commonalities, operating on the results of a descriptive analysis. This analysis evidences which variables are constant and transient between core actions, giving us a perspective of the field of possibilities to which the player is constrained to in the game.
- A *relational analysis* is focused on the relationships between the variables on an inter-dimensional or intra-dimensional level, also operating on the results of a descriptive analysis. An *inter-dimensional relational analysis* is focused on the relationships that exist between the variables in each dimension, which can be characterised as conflictual or as non-conflictual. An *intra-dimensional relational analysis* is focused on pinpointing eventual changes in the variables of a given dimension, therefore presenting the transiency of behaviour within the same dimension.

Considering these types of analysis, due to its focus on action, and despite the fact that it still requires further study, this model already showed us that it allows us to peek into a game's procedural rhetoric[9]—something that greatly contributes the relationship between the game designer and the player.

9. For more information on procedural rhetorics see Bogost (2007). For video game rhetorics see Frasca (2007).

5 LIMITATIONS

Considering some of the limitations of this work, we may say that since our primary goal was to uncover each of these dimensions, and although they were thoroughly inspected, each requires further exploration. We believe that that pursuit has the potential to result in various complementary and more in-depth research studies.

There is an interesting asymmetry in the relationships between variables within each dimension, and this also requires further study. For example, the variables in the first level of *focus* are not mutually exclusive, while all the variables in *chronology* are. The ones in the former work towards a particular combination to originate a specific state in *focus*, while in *chronology* that result is achievable by direct selection. Maybe that happens because in *focus* we were able to find the underlying characteristics that lead to particular states in that dimension. Perhaps we were aware—even if unconsciously—that there are too many states of focus to enumerate within the scope of this work. However, this leads us to an even more pertinent question: Can we do

the same for *chronology* and for all the other dimensions? And by doing that will we be able to uncover even more variables/states? And is this a good way to expand our knowledge on them?

There is much to be done regarding a study focused on the articulations between these dimensions, as well. They were scrutinised as independent phenomena, however that also didn't left enough space and resources for a more detailed inspection on their articulation, something that we only became aware of during the final stages of our research.

Another issue is that although this framework is simple in its essence, the model needs a certain level of synthesis in order to increase the likelihood of being used. However, this fact is compensated by its versatility, as a model that allows one to focus on the whole or on the constitutive parts.

Through this framework, the complexity of the actions being analysed dictate the complexity of their own analysis. Therefore, if an action is too complex, its analysis will follow. The model seems to respond well when analysing simple games and actions by means of descriptive analysis. However, in more complex situations or to have a deeper insight, the assessment also becomes more elaborate, resorting not only to descriptive but also to comparative and relational analyses. This may eventually hamper its use.

And, a real world use of this model within the context of game design and development is yet to be done. We don't see this as a problem to the theoretical establishment of the model itself, but a rather welcome subsequent study.

6 FUTURE WORK

We do not believe we have uncovered neither all dimensions nor all variables; therefore there is room for further inspection on this subject.

We also suspect that there may be larger groups embracing various dimensions—something that may be uncovered by further inspecting possible articulations between them. For example, we believe that the dimensions of *focus* and *transcoding* are more related with matters regarding the interface between the player and the system than any of the others: while the former is concerned with the output of the system and input of the player, the latter does practically the opposite. Also, *focus* and *thinking and actuation* seem to be dimensions very attentive to processes much enacted on the side of the player. So, these situations can be indicative of an organisational system yet to uncover, something that may eventually become more evident as more dimensions are unveiled.

A study on the conceptual proximity and farness between variables in disparate dimensions now seems necessary in order to pinpoint eventual redundancies and levels of compatibility between dimensions. Understanding whether diverse dimensions operate in common grounds or not is something that may help us comprehend if a particular action is seeded on an internal conflict or not—something that is particularly important in the relational analysis we proposed.

Furthermore, this is also a study we consider to be moving towards an understanding of aesthetics, since that conflict will be deeply experienced by the player. This is something that was expected and that we see as a natural and progressive development of this work.

In the same way, a study focused on how the articulations between these dimensions may lead the player towards distinct emotional states also seems relevant now. Therefore designing for emotion is also one of the natural courses for future developments, a complex endeavour that we believe should not be undertaken before a reasonable understanding of the matters mentioned in the previous point.

On another subject, a statistical analysis on the player-system relationship through the course of time and across diverse genres may pinpoint how that relationship evolved, as well as what shapes it may assume in the future.

And finally, focusing on a more practice-based research we intend to use this model to study the video game player as musical performer. Here, we not only intend to explore the diverse behaviours promoted by distinct combinations of the dimensions in this framework but also to see what kinds of games and musical expressions emerge, in hopes of contributing to further widen the notions of musical performance and, most of all, to expand the gameplay of musical video games. This is a study that not only directs its focus towards performances, concerts, and installations but also in the direction of applied research on the design and development of innovative video games and musical instruments.[10]

10. We also published an article that is focused on these matters – see (Cardoso and Carvalhais 2014b).

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