

Emergence in Game Design: Theoretical Aspects and Project's Potentialities

Nivia Ferreira , Priscila Trovo, and Sérgio Nesteriuk

Anhembi Morumbi University, São Paulo, Brazil
niviaboz@gmail.com, priscila.a.trovo@gmail.com,
nesteriuk@hotmail.com

Abstract. Games are propitious environments for the appearing of new behavior patterns (emergence). It's necessary to comprehend the nature of these changes taking into account demands and their modifying potential on this process. To support this trajectory, concepts of emergence were presented back from classical sciences to contemporary studies which touch metadesign and game design. This paper aims to investigate the phenomenon of emergence in digital games, encompassing the utilization of projective resources that can increase the interactivity and trigger this process. The research involves literature review, articulation of concepts of complex adaptive system (CAS), emergence incidence in game design and the analysis of three selected objects: Tibia, PokemonGO and The Sims. The perspectives of metadesign usage and artificial intelligence are highlighted as propeller resources of new behaviors. The context, phenomenon and tool relation is discussed concerning: adaptive complex systems, emergence and artificial intelligence. This paper concludes that the usage of methodologies which incorporate metadesign and the gamer as co-designer are more appropriate when dealing with the emergent character of games. Furthermore, the use of artificial intelligences expands the possibilities of interaction in the game, multiplying the amount of active agents in the system.

Keywords: Game design · Emergence · New behavior · Adaptive complex system · Metadesign · Artificial intelligence

1 Introduction

The phenomenon of emergence entails the appearing of new behaviors coming from interactions between basic units of a system, i.e., when two or more parts perform attempts of arrangement and auto-organization, originating an action which is superior to the mere sum of its parts [1]. Although the manifestation of this phenomenon may be observed in different epochs, contexts and fields of knowledge, it became more evident and relevant in contemporaneity with the appreciation of a post-enlightenment thinking based on complexity and interdisciplinarity. We identify the relevance of this research at a moment of game industry ascent [2] and at a time when diversity and complexity of scientific publications in this area increase [3–7].

We realize this investigation from the perspective of game design, converging the fields of complex adaptive systems, emergencies and artificial intelligences. In this way, we can highlight that elements that previously integrate the system in interaction allow the emergence of something new, modified, uncertain, unexpected, qualitatively differentiated.

This article's aim is to contribute to the development of games by furnishing theoretical aspects to designers and developers in the project of emergences in games, insofar as it's possible to foresee and project them. Therefore, this entails maximizing the experience of emergence since they, per se, belong to the domain of the unforeseen.

We'll investigate the hypothesis that the more a game allows interactions between units of the system, personal or not-personal (NPCs), the more it's capable to adapt and adjust faced with particularities of developed relations. We observe the use of artificial intelligences related to supporting roles – yet not unimportant roles – mediating and promoting interactions with players.

Among the main chains of investigation, the following authors stand out. To contextualize the environment where the phenomenon of emergence occur it becomes important to employ the concepts of complex adaptive systems from the perspective of Holand [8]. As for the appearing of new behaviors and its relation to digital games we utilize Sweetser [9], Salen and Zimmerman [10] and Schell [11] allied to the metadesign conceptions of Vassão [12], Baranauskas, Martins and Valente [13]. To discuss the perspectives of the AI usage in games, we adopt Russel and Norvig [14] and Champandard [15] as main references.

Methodologically, we recognized games as complex adaptive systems and analyzed three of them for identification of patterns of emergence incidence. Lastly, we identified the perspectives of metadesign and artificial intelligence usage in games as project's potentialities. We selected the objects of study following the criteria of adaptive relevance, innovation and emergent contemporaneity, fertility of emergent events, utilizing as examples the games Tibia [16], PokemonGO [17] and The Sims franchise [18].

2 Emergence in Games

To comprehend emergences in games it's necessary to understand the context in which this phenomenon arises. The general systems theory is an analytical approach that seeks to represent the world as a set of fluxes regulated by a variety of feedback processes [19]. This approach is conceived with mathematical content in order to obtain points in common about the system's behavior, allowing, for instance, the reproduction of certain patterns or the simulation of given situations through the manipulation of variables. The complexity demands our possibility of understanding and molding the interaction between things and processes many times of very different nature, under pain of non-capture of what is fundamental in these systems [20].

The work of Avenir Uyemov [21] attempts to mathematically express a system. According to the Russian school [21], system is defined as a set of things (m) of any nature, among which relations R exist, in such a way that the elements of this set end up sharing properties P (Fig. 1).

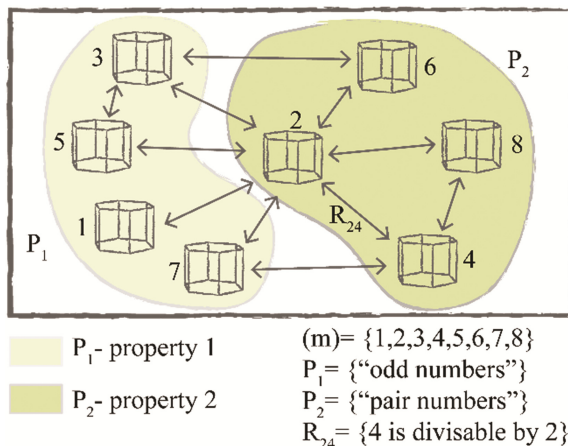


Fig. 1. Representation of system and its elements.

$$(m) S =_{\text{def}} [R(m)] P \quad (1)$$

m = an ensemble of agents

S = system

R = set of relations

P = shared properties

Some researchers [8, 22, 23] who deal with complexity prefer to propose in the place of a more closed definition a set of criteria which conceives a given system as a complex system. Some of these criteria are:

- Great number of constituent elements which interact in a non-linear manner;
- Interdependence between the elements of the system;
- Emergent behavior;
- Combined action of cooperation and competition;
- Capacity to store information and transmit it/pass it forward.

All these elements can be identified with clarity in digital games, even though some (genres of) games prioritize or emphasize more or less each of these. We can comprehend "agents" as players and NPCs (Non-Player Characters), "attributes" as rules and mechanics which regulate the experience of playing, "relations" as interactions between agents and "environment" as the game context, always limited by its rules.

Considering that design is the process by which a designer creates a context to be found by a participant and from which the meaning emerges [10], the main facets on which the game designer must focus are: (a) the context (system), which entails spaces, objects, stories and behaviors found in the game; (b) participants, players (agents) who act on the game context in an exploratory or manipulative way and (c) meaning (emergence), interaction and action results during gameplay. Thus, it's possible to understand games as systems [24, 25] for they're an enclosed environment, governed by rules and

a stage for interactions among agents. Regarding these interactions, we'll discuss the properties and patterns at different levels in the next chapter – emergence.

In the ambit of games, when two or more agents (players or NPCs) interact with each other and generate new behaviors, we're faced with the phenomenon of emergence. Specifically, in the study field of games, Sweetser [9] develops an investigation about emergence in games and suggests that emergences occur at different levels of depth in the system, making important the distinction between the manifestation of local and global emergences. In order to understand the project variables and the emergent potential in games, we analyzed Tibia [16], PokemonGo [17] and The Sims franchise [18], selected because of their abundance of emergences as we have previously identified.

2.1 Tibia as a Stage for New Behaviors

Local emergences occur when a collective behavior of the system's entities appears in small, localized parts. It is the case in which a group of players (guilds) get together to fight a war in Tibia¹. This action initiates consequences near the local of the war. High-level players are convoked to take sides, while low-level players feel obliged to get out hunting, altering certain predicted behaviors for a "normal day" just for that local in the game.

Global emergencies occur when the collective behavior of the system's entities relates to the system as whole. We can perceive this when considering that, on one occasion, some Tibia players began to commercialize items in a parallel market² and this action started to be so relevant that afterwards the developer company itself [16] decided to incorporate these functions to the game. To Sweetser, [9], a system must be sufficiently abundant, with highly independent entities in order to the global behavior to exist, as happens in a brain, in human being and in societies.

Still trying to comprehend the different emergent manifestations, Sweetser [9] presents three potential emergency orders in games. We can denominate these levels as being of first, second and third order.

Sweetser [9] considers first order emergencies local interactions that have dragged effects or that generate a chain reaction. The player's actions spread throughout the whole game, affecting not only the immediate target, but also the nearest elements. In Tibia, we may consider as first order emergencies the changes in the construction of structures, where players use items in the scenario for users beyond the respawn area³.

The appearing of second order emergences occur when the players use the basic elements of an environment of the game to make their own strategies and to solve problems in a new way – not always conceived by the game designer. Game characters can equally be able to utilize or combine their basic actions to expose new behaviors

¹ Tibia, Massive Multiplayer Online Role-Playing Game (MMORPG), developed by CipSoft. It is one of the oldest games in the genre (1997), counting on a community that surpasses 500.000 players, 40% of these being Brazilian.

² Websites and virtual communities in diverse platforms that sold items.

³ Respawn: programmed reappearing of items or enemies in the game that usually follow a pattern of time and space.

and strategies. These types of emergence are still local effects, for they have a limited range of implications and do not influence the gameplay as a whole. However, they offer to the player the freedom and creativity to change his way of playing.

In *Tibia*, we also find the use of items beyond their original utility projected by the developers. An activity easily found in the game is the “trap” applied by players in order to confine a character in a square and then attack them, diminishing or even putting an end to their mobility and possibility of escape, blocking a passage. This trap can happen using a parcel, that is, a mailbox that originally serves to send items to others or to yourself. Some players identified its stacking and unsurmountability properties and started to take them inside their backpacks to promote traps. With the amplification of what was possible to do with the item, players had to adapt in order to defend themselves from such tricks⁴ or take advantage of them to confine enemies.

Still on the emergence orders, a third order refers to the game as whole, where the phenomenon occurs on a global scale. The game offers flexibility that permits players to find new and exclusive paths, promoting divergence in the narrative, in the game flux, through the interactions between characters or social organizations. Manifestations of third order are abundant in *Tibia*: the players began to articulate groups, called guilds, with clan-like, family-like or gang-like behaviors. The bonds developed by guild members promote missions to the missions to accelerate the achievement of levels, items and money. Guilds can also be called to wars and situations of revenge, when a character of the group is killed during the game.

Guilds are groups of characters created to gather people who think/play in a similar or complementary manner. They are very popular, since they normally offer a better protection for its members, besides a feeling of belonging. Powerful guilds aggregate players with higher levels and generally have more influence on events and politics than a single lonely player usually has. As in collective sports or teams in general, with the passage of time guilds develop co-working skills and perfect their techniques and game strategies.

Tibia presents an open narrative that allows the player to interact with other players in a different way, making and attributing new utilities to items, having dragged effects⁵, tracing unpredictable strategies and generating new behaviors. Piccini [26] recognizes in the narrative of a digital game a complex universe that propitiates to the players the possibility to promote different interpretations and contributions to the construction process of the system value in the game.

Since its conception, *Tibia* followed the monetization model that would still take years base itself in the gaming market. It allowed fans to play gratuitously, in “freemium” accounts, having the option to pay for additional functions and other benefits later in a premium account. However, a rich parallel market has emerged over the years, where players sold items in “extra-tibia” currencies, paid mercenaries to escort their

⁴ Events of re-determination of function of items reinforce Flusser's [27] approach on the designer's deceptive nature. In this case, however, players performed the event. (Further ahead, we will consider them as being codesigners.

⁵ Dragged effects: the ones that appear in a certain location on the map, but extended and incorporated as culture from the interaction between players.

characters – defending or healing them in missions – hired assassins and other possibilities involving items and actions.

The fact that the designers of *Tibia* projected it with simple graphics, using the technique of pixel art, 2D, isometric projection with perspective in 135°, supplied the community with the possibility to design new items and to suggest complements to the game’s map. It is possible to speculate that this possibility instigated the players’ imagination, promoting more engagement and pushing the game’s evolution. Players became co-authors and the power to express their desires and making them realized came to fruition with new updates of the game.

Baranauskas [13] sees the player’s involvement with the project’s development in a positive manner. The author presents the concept of co-design, a shared design process in which the designer acts like a sort of facilitator, planning and allowing the participation of other agents in the creation process. The term co-design has been utilized with the sense of “community design, collaborative design and cooperative design”, meaning a set of tools used by designers to engage subjects who are not designers in the creation process and in the development of projects.

Another example of the influence of this player/collaborator in *Tibia*: characters needing to express their social and affective bonds, such as love relationships and even marriage. The developers accepted this resource and implemented it with the mediation of ceremonies by the NPCs (non-person characters) and with the availability of items to personalize the ceremony.

The fact that *Tibia* has an open narrative, allowing the engagement of its players in processes of co-design facilitated the adaptive capacity of the game – just like an anthill – surviving to the adversities over time, being a stage of innumerable emergences. The dialogue resources that appear in the log⁶ and on the screen permit conversations with several characters and the observation of conversations between other characters in order to get little pieces of information about events, people and places in the game. By permitting this flexible dialogues and tangles, *Tibia* became a favorable stage for the appearing of emergent narratives.

Although we have presented a summary on the emergences in *Tibia*, the present analysis did not have the intention to catalog and elect all possible emergences in any games; it would be too pretentious to attempt to predict all these aspects. However, we traced the essence of what promotes this behavior focusing on the case study of *Tibia*. This choice has to do to its “survival” in the gaming market and the fidelity to its community over more than 20 years, disputing with titles of the same genre that presented better graphics, improved technologies and more resources. We estimate that this occurred thanks to its adaptive potential.

The necessity of considering complex adaptive environments is thought provoking. When the game is capable of adapt itself to the adversities, just like the ants of Holland [8], it will potentially acquire more resources for a longer period of time.

After analyzing the potentialities of emergent phenomena in *Tibia*, it is possible to affirm that the proposal of open, co-design narratives promote more adaptability to the game faced with necessities that appear over time. There is still the necessity and

⁶ Log: event registration on the chat box.

relevance of investigating other games with this adaptive capacity in depth. This may influence in the game's lifespan, in its engagement level with the player community and in its potentialities.

2.2 PokémonGO

PokémonGo [17] is a game released for mobile devices in the Android and iOS platforms. The game proposes the experience of transiting between the real and the virtual from resources of the augmented reality, in which elements are projected on the screen in real-time by the device's camera [28]. The game encourages the player to explore the surroundings through a system of localization via GPS so as to capture new Pokémon around the map.

PokémonGO allows the connection between players of the community and the formation of teams where the players can meet and explore physical and virtual environments. The game broke download records, reaching Apple Store's⁷ top in less than 24 h after its⁸. Some estimate that this success is due to the fact that it belongs to a franchise entailing games, TV cartoons and other successful products.

A question raised by the success of the game is its dissemination that mobilized people of many ages and social classes and revealed the habit of playing in public, since the players were easily recognizable by their movements and eyes on the screen. The relevant factor is that, until then, even millions of people played a game, this culture was restricted to isolated environments and to platforms with less mobility. However, Pokémon reach its height and then had its number of players diminished⁹, the reasons for this fall were not identified, but platforms of analysis such as Sensor Tower, AppTopia and SurveyMonkey reveal drop in downloads, engagement and quantity of time playing the game¹⁰.

Furthermore, it is possible to relate the influence of project decisions regarding the game mechanics with the appearing of emergent behaviors. The game was the leading figure in a series of curious events. The mechanics demand players to move to capture new Pokémons or items.

This rule aroused, in a first moment, a wave of people in the streets, walking or running to find Pokémons or new PokéStops, eyes fixed on their cellphones. The inattention of some users caused a series of accidents recorded by newspapers. Afterwards, part of the gamer community began to develop strategies to make the gamer easier, hunting by car. Niantic inserted warnings in the game, speed limits of navigating on the map etc.

⁷ IOS Platform Application Store.

⁸ (Techmundo, 2016) <https://www.tecmundo.com.br/pokemon-go/108115-novidade-pokemon-go-numero-1-app-store-24-horas.htm>.

⁹ Data presented in: <http://g1.globo.com/tecnologia/games/noticia/2016/08/pokemon-go-comeca-ter-queda-de-jogadores-e-de-popularidade-nos-eua.html>.

¹⁰ Available in: <http://www.opovo.com.br/app/maisnoticias/tecnologia/2016/08/24/noticiatecnologia,3651900/numero-de-jogadores-do-pokemon-go-cai-15-milhoes.shtml>.

These attitudes demonstrate a concern and responsibility regarding emergent phenomena. The ways players interact with other agents influence layers of the system following a propagation flux through feedbacks that can transpose the limits of the system. When the agents propose new rules and new utilizations to the elements projected by the developers, then it becomes clear the existence of new roles, players and collaborators.

The incremental innovation presented in PokémonGo, characterized by the incorporation of resources of augmented reality and GPS navigation, triggered a series of emergent phenomena. This resources offer new ways of playing and boost the appearing of new, unpredicted behaviors.

2.3 The Sims Franchise

The Sims franchise, projected by Will Wright, had its first edition released in 2000 and just like Tibia adapted to the wishes of the players, releasing expansions packs and new versions throughout the years. The series is configured as an everyday simulator, in which the player controls one or various avatars capable of working, earning money, building houses, raise pets, marry and many more actions. Some aspects of the mechanics of the game were inspired in Maslow's [29] pyramid to orient the necessities and priorities in the Sims' lives. Therefore, even though every Sim wishes to achieve personal realization, they will have to dedicate themselves to the lower levels of the pyramid (their necessities).

In the first editions of the franchise, the avatars had a limited range of items for customization. This influenced the mobilization of the player community to develop new items that were incorporated to the game packages through manual interventions in the folders. This happened to skin colors, tattoos, clothes, haircuts.

The interventions made by players are known as mods (abbreviation for modifications) and, in many cases, reveal wishes and new necessities of the gamer community. This mods are examples of the multiple roles of the gamer, being able to act as users and co-designers. This characteristic offers to the developers various opportunities to identify the necessities and wishes of users in relation to what was already produced. Mods highlight the agents' restrictions of making some interactions in the system. Thus, the agent alters the system to adapt it to their intention [30]. In some cases, players search for bus or gaps to express their wishes or even the necessity to defy the limits of what have been previously planned.

The Sims franchise was a stage for an emergent phenomenon of appropriation and of generation of transmedia narratives. The gamer community detected the opportunity to record a series of episodes from screenshots of the game and to create the register of narratives that each one produces. The website SimsInMotion¹¹ registered the 10 best series and soap operas created by players, revealing the engagement of the community with the game's proposal and the game's adaptive potential according to the player's wishes.

¹¹ Access in: <http://simsinmotion.com/>.

3 Project Resources in Design of Emergences

From analysis of the games and from the propellant resources in the project of the three investigated objects, we highlighted some events and identified points in common in relation to the project resources, present in Table 1.

Table 1. Summary of emergences in Tibia, PokemonGo and The Sims

Practice	Emergence	Type
Co-design	Changing of the scenario through items	Local
	Creation of new items	Global
Open narrative	Appearing of guilds	Global
	Creation of social ties	
	Rents for achieving quests	Local
	Creation of parallel market	Global
	Exploration of new contexts	Local
Augmented reality	Accidents with users	Local
Use of GPS (global positioning system)	Mobilization of the gamer community towards finding and promoting locations with rare items	Global
Use of GPS	Development of apps to circumvent GPS	Local
Open narrative	Utilization of items in an unusual way – example: to use a notebook inside the pool	Local
	Search for ways to cheat, deceive or perform unusual actions in the game – search for bugs. Examples: (a) go inside a pool, delete ladder and cause a suicide. (b) build environments without doors (c) make a male Sim get pregnant by an alien	
Co-design	Production of narratives and soap operas	Local
	Development of new items – clothes, tattoos, skin colors	

Hunicke, LeBlanc and Zubeck [31] also recognize games as systems and propose a formalization, not exactly a methodology, but a way of seeing the game from two perspectives, one being the designer's and the other being the player's (Fig. 2). Comprehending the game as:

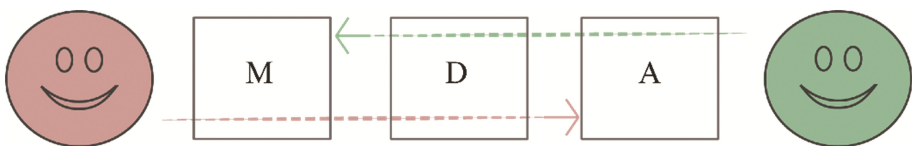


Fig. 2. MDA framework

According to the authors, the player perceives the aesthetic first, followed by dynamics and mechanics, whereas the designer works the other way around. The designer projects first the mechanics and then he constructs the dynamics and aesthetic. MDA is a tool to assist designers to evaluate how choices can affect the whole. In this

sense, when thinking about the player's composition of experiences, it becomes necessary to foresee the emergent potential of the game.

This perspective allows the relation with the project methodology of metadesign [12] and Fischer and Giaccardi [32] where the project needs periodical revision in order to absorb the constant changes in users' needs. This methodology is capable to embrace interdisciplinary fields and the inherent complexity of complex adaptive systems and thus the appearing of new behaviors in games should not be considered a problem but as an opportunity to comprehend the user's necessities.

Metadesign is a project framework that considers and supports new forms in which collaborative design can have more space [32]. This proposal brings users closer to the project, making them co-designers and accepting the adaptive process inherent to the project, as observed in Tibia, PokemonGo and The Sims franchise.

The use of the methodology or metadesign resources has its bases on the principle that not all future problems are predictable during the project, when the game is developed. The agents, while playing, will discover mismatches between their expectations and the experience that the game can offer. The moments of crises and mismatches are important because cause new reflections and possible improvements in the project and suggest some potentialities compared to the traditional methodologies [32].

We consider a closed and absolute methodology for game creation impossible, even more when taking into account complexity and emergence. However, it is possible to observe that the approach of the player as co-designer is beneficial and generates shortcuts in the development. For this purpose, we conceive the usage of methodologies that are more flexible to this changing character inherent to games and its active community. In order to continue the research of other ways of potentiate interactions, we point out the use of artificial intelligences and their emergent potential.

4 Artificial Intelligence Usage in Games and New Behaviors

The artificial intelligence is one of the fields explored in the development of games, able to boost and give life to virtual worlds. In spite of hiding itself in deeper layers of development, according to the elemental tetrad [11], the AIs are highly capable of influencing the way a gamer can interact along their journey. One of the most conventional forms of its manifestation in games is the NPCs, whose goal is, in most cases, perform a similar behavior of an avatar controlled by a human.

In this sense, the challenge of developing agents able to interact and learn with inputs from players, responding to stimuli in an individual fashion, enable the personalization of experience, minimize frustration and ensure an experience in flow levels [33] along the game.

Allied to the theory of GameFlow, the usage of artificial intelligences can assist in a field that has not been so explored yet, collecting data from each user, treating them individually and delivering personalized experiences to each one – having the potential to repeat the process in several moments of a same match/play. When this gap is identified, we visualize the implementation of AI techniques in NPCs aiming to use these

agents in the game as receptors, interactors and facilitators/deliverers of new behaviors, working actively in the system, as can be observed in Fig. 3.

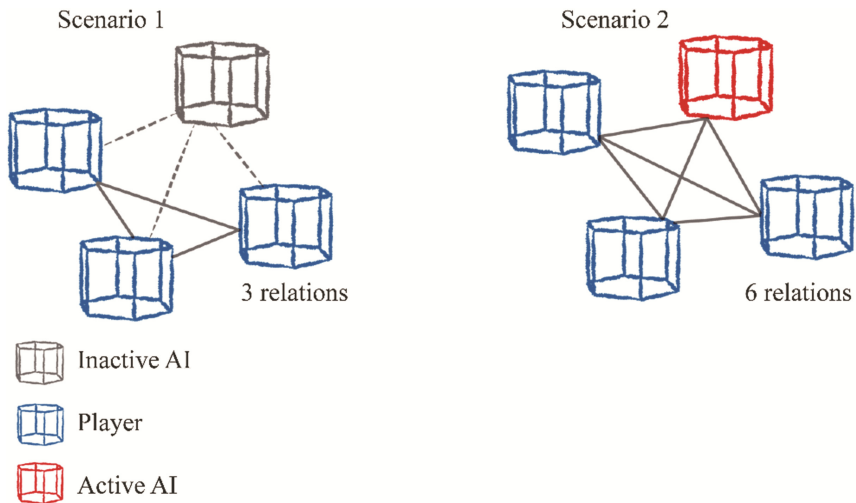


Fig. 3. Scenario 1 – A collection of personal agents and one NPC. Scenario 2 – A collection of personal agents and one NPC endowed with AI.

5 Methods

- Understanding of games as complex adaptive systems and identification of emergences.
- Exploratory case studies where we examined the games Tibia [16], PokemonGo [17] and The Sims franchise [18] which offered parameters for relating project resources and incidence of emergences.
- Articulation of concepts from the theoretical reference and case studies with perspectives of usage of both metadesign and artificial intelligence techniques in game development.

6 Results and Discussions

In this article, we investigate the hypothesis that the more a game allows interactions between system units, personal or not-personal (NPCs), the more it presents the phenomenon of emergence and that characteristic would be linked to its adaptive potential over time, in relation to the wish of players. For this purpose, we investigated the context in which these emergences occur, recognizing games as complex adaptive systems and as stage for appearing of new behaviors. In this perspective, it's still necessary to remark the alternation of roles between agent and agency depending on the observation level and distance at which the entity is situated in relation to the system.

We may conclude that emergences occur and they are not always aspects cherished by game developers, chiefly when not understood. However, these emergences provide a strong adaptive character to the game, revealing in many cases the wishes of players and they can be important sources of information to the developers as how to trace changes in new versions, updates or expansion packs.

We could observe the possibility of conceiving multiple roles to the player, allowing him to be an agent in the game, interacting and generating new behaviors and being an active agent in the conception of new resources, characterizing co-design and metadesign methods. When we observe the characteristics present in *Tibia* and *The Sims*, we find that these ample emergent capacities contributed to the games' success and longevity.

From the *Tibia* gameplay analysis, we observed that the open narrative and co-design resources stand out as responsible for the game's high adaptive level throughout the years and in conformity to the *Tibia* community necessities. Other resources like the chat box and visualization of other agents' conversations may have influenced this high adaptive potential.

In the case of *PokemonGO*, the players' interactions generated the emergences while using the incremental innovation of augmented reality + location via GPS. This combination expanded and personalized the game's map for each player, culminating once again in an open narrative. Although the game doesn't offer official resources for dialogues between players the community took action at other platforms, mobilized forums, created apps, arranged meetings and suggested the implementation of new rules, thus generating an environment of collaboration and co-design.

The Sims franchise contributed to the investigation by pointing out desired behaviors from the players, since it is a sort of everyday simulator. The search for opportunities to test the game's limit, to utilize items in an unusual way, revealed wishes of players that could be slowly incorporated by the developers in new package expansions. Another interesting factor was the engagement of the gamer community with the creation of narratives by capturing video clips from the game. This action also transposed the limits of the system and began to compose a universe of transmedia narratives.

The investigation of these three contexts revealed the incidence of some relevant characteristics to the appearing of new behaviors: open narrative and co-design. However, it is possible that this analysis is premature and needs more objects of study and depth for its consolidation. Therefore, it is necessary to investigate a wider range of games as well as to perform counterproof tests in order to certify the actual responsibility of implementing these types of features in games.

Compared to traditional methods, metadesign accepts and promotes the diversity in complex systems. The method proposes detachment from controlling actions and from a single designer authorship. In this case, we assume all members in the system as potential collaborators and co-designers, what indicates a considerably more adapted methodology to the emergent potential of games, since it recognizes this feature and foresees changes after the usage or publication. This scenario is pertinent to the game industry and corroborates with the elements found in the analysis of *Tibia*, *PokemonGO* and *The Sims* franchise, where the gamer community interacted and got involved with the system, modifying it and making it responsible for the interactions, emergences and

for alterations in the game mechanics. We can understand the development scenarios, which present fluidity and constant mutations, as metaprojects, chiefly for its dynamic character. This proposal contrasts with conventional methodologies and contributes to the constant reflection on complex, changing scenarios.

We recognize that the use of artificial intelligences make NPCs active in the interactive processes, mediating, promoting and increasing the number of interactions with players. In the field of game design the idea of having one apparently intelligent agent is already enough to provide a fun and personalized experience. However, the use of a correct technique (deterministic or non-deterministic) allied to the theory of GameFlow can contribute to the difficult game adjustments and thus in its adaptive potential in relation to the player's wishes level of aptitude.

7 Conclusions and Future Work

Regarding the methodologies used, we discussed where, when and how we can project emergencies. We also pointed out the necessity of thinking about them already during the project phase, treating the development as a metaproject that is going to be constantly incremented according to the emergence indications revealed by players during game play or even in auxiliary platforms created by the gamer community itself. Collaborative development can be a way of solving complex problems in the field of design, leading users to the sphere of decision-making and contribution to projects. Furthermore, we hope that the present study may contribute to the development of games and future investigations regarding emergences in such contexts.

In relation to future contributions, this investigation opens a range of possibilities on how to analyze in depth each resource and phenomenon to find new patterns of incidence. It also points out the possibility of developing a game with the intention of reaching high levels of emergence, combining all the identified resources or the contrary, to remove all listed resources and verify if it is still possible to find a fertile environment for that reality. Another contribution would be investigating the adaptive capacity of agents endowed with different types of AI, how they develop it and its applications linked to the theory of GameFlow.

In this sense, we estimate that the research had an expiratory character regarding the possibility of promoting emergences in games, pointing out resources in three directions in order to potentiate this phenomenon: the usage of open narratives, co-design and AIs in NPCs. The research opened space for qualitative and quantitative investigation regarding interactions in the system, what deserves better investigation.

References

1. Bunge, M.: *Emergencia y convergencia*. Gedisa Editorial, Barcelona (2004)
2. Newzoo: *Annual Global Games Market Report*. NewZoo (2015)
3. Zuanon, R.: Game design and neuroscience cooperation in the challenge-based immersion in mobile devices as tablets and smartphones. In: Streitz, N., Markopoulos, P. (eds.) *DAPI 2016*. LNCS, vol. 9749, pp. 142–153. Springer, Cham (2016). doi:[10.1007/978-3-319-39862-4_14](https://doi.org/10.1007/978-3-319-39862-4_14)

4. Zuanon, R.: Design-neuroscience: interactions between the creative and cognitive processes of the brain and design. In: Kurosu, M. (ed.) HCI 2014. LNCS, vol. 8510, pp. 167–174. Springer, Cham (2014). doi:[10.1007/978-3-319-07233-3_16](https://doi.org/10.1007/978-3-319-07233-3_16)
5. Zuanon, R.: Designing wearable bio-interfaces: a transdisciplinary articulation between design and neuroscience. In: Stephanidis, C., Antona, M. (eds.) UAHCI 2013. LNCS, vol. 8009, pp. 689–699. Springer, Heidelberg (2013). doi:[10.1007/978-3-642-39188-0_74](https://doi.org/10.1007/978-3-642-39188-0_74)
6. Zuanon, R.: Usign BCI to play games with brain signals: an organic interaction process through NeuroBodyGame wearable computer. In: Huggins, J.E., et al. (eds.) Fifth International Brain-Computer Interface Meeting 2013, pp. 64–65. Graz University of Technology Publishing House, Graz (2013)
7. Zuanon, R.: Bio-interfaces: designing wearable devices to organic interactions. In: Ursyn, A. (ed.) Biologically-Inspired Computing for the Arts: Scientific Data Through Graphics, pp. 1–17. IGI Global, Hershey (2011)
8. Holland, J.: Hidden Order: How Adaptation Builds Complexity. Basic Books, New York (1995)
9. Sweetser, P.: Emergence in Games. Thomson, Boston (2007)
10. Salen, K., Zimmerman, E.: Regras do jogo: fundamentos do design de jogos, vol. 1. Blucher, São Paulo (2012)
11. Schell, J.A.: Arte de Game Design: o Livro Original. Elsevier, Rio de Janeiro (2011)
12. Vassão, C.: Metadesign: ferramentas, estratégias e ética para a complexidade. Blucher, São Paulo (2010)
13. Baranauskas, M.C., Martins, M.C., Valente, J.A.: Codesign de Redes Digitais: Tecnologia e Educação a Serviço da Inclusão Social. Penso, Porto Alegre (2013)
14. Russel, S., Norvig, P.: Inteligência artificial, 3a edn. Campus, Rio de Janeiro (2013)
15. Champandard, A.J.: AI Game Development: Synthetic Creatures with Learning and Reactive Behaviors. New Riders, London (2013)
16. CipSoft: Game Tibia (1997)
17. Niantic: Game PokemonGo (2016)
18. Eletronic Arts: Game The Sims (2000)
19. Bertalanffy, L.V.: Teoria Geral dos Sistemas. Ed. Vozes, São Paulo (2009)
20. Vieira, J.A.: Organização e sistemas. Informática na educação: Teoria e prática 3(1) (2000)
21. Uyemov, A.: Problem of direction of time and the laws of system's development. In: Kubat, L., Zeman, J. (eds.) Entropy and Information in Science and Philosophy, pp. 93–102. Elsevier Scient., Praga (1975)
22. Vassão, C.: Arquitetura livre: Complexidade, Metadesign e Ciência Nômade. Tese de Doutorado. Tese (doutorado em Arquitetura) Universidade de São Paulo (2008)
23. Cardoso, R.: Design para um mundo complexo. Ubu Editora LTDA-ME (2016)
24. Fullerton, T.: Game Design Workshop: A Playcentric Approach to Creating Innovative Games. Paperback, New York (2008)
25. Juul, J.: Half-Real: Video Games Between Real Rules and Fictional Worlds. MIT Press, Cambridge (2005)
26. Piccini, M.: O papel do jogador na construção de sentido em narrativas de jogos digitais: o jogo como forma de expressão do jogador. In SBC - Proceedings of SBGames (2012)
27. Flusser, V.: O mundo codificado: por uma filosofia do design e da comunicação. Cosac Naify, São Paulo (2007)
28. Lucena, M.C.: O Espaço Público e Pokémon Go: um diálogo entre o real e o virtual. Revista Científica ANAP Brasil 9(15) (2016)

29. Ferreira, A., Demutti, C.M., Gimenez, P.E.: A teoria das necessidades de Maslow: a influência do nível educacional sobre a sua percepção no ambiente de trabalho. XIII SEMEAD–Seminários em Administração (2010). ISSN: 2177-3866
30. Champion, E.: *Game Mods: Theory and Criticism*. Lulu.com, Morrisville (2013)
31. Hunicke, R., Leblanc, M., Zubek, R.: MDA: a formal approach to game design and game research. In: *Proceedings of the AAAI Workshop on Challenges in Game AI* (2004)
32. Fischer, G., Giaccardi, E.: Meta-design: a framework for the future of end-user development. In: Lieberman, H., Paternò, F., Wulf, V. (eds.) *End user development. Human-Computer Interaction Series*, vol. 9, pp. 427–457. Springer, Dordrecht (2006). doi: [10.1007/1-4020-5386-X_19](https://doi.org/10.1007/1-4020-5386-X_19)
33. Chen, J.: *Flow in Games – MFA Thesis*. University of Southern California (2008)