Towards the Definition of a Framework and Grammar for Game Analysis and Design

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Abstract— **The present paper defines an original approach to game analysis and design able to characterize a given game in a simple, yet efficient, way. Inspired by models widely used across the gaming industry, the proposed framework named A.G.E. is built by defining and layering different concepts: core player Actions, resulting Game-play and emotional Experience of players. These are all linked to each other by the game's own rules and goals to form a cohesive unit that can help in exposing the inner workings of any game. The model is then elaborated further into a regular grammar to provide a more formal and rigorous justification of the proposed framework and overall approach.**

Keywords: game analysis; emotions; regular grammars; fun

I. INTRODUCTION

Videogames, as a medium, have evolved considerably during their still young life: from basic monochrome squares on a CRT display to complex virtual worlds able to deliver highly spectacular and deeply emotional experiences.

As games become more and more pervasive in our modern society and are used not only to entertain but also to teach, convey complex messages and even as a medium for self-expression in the hands of talented indie developers, different analysis tools are needed for game designers to organize their ideas and creative processes. This is not only of paramount importance in a professional environment but even more so within the context of game development curricula where students need to be guided in the process of formalizing their ideas while also developing their analysis skills to understand different game genres for study purposes.

After a review of a few well known analysis models that served as a basis and inspiration for the proposed approach, an original framework will be presented and further elaborated into a regular grammar. By elaborating the same model under different forms that can be integrated together in the analysis process, we will be able to provide a comprehensive overview of the inner workings of a given game at different levels of abstraction to be used both in the classroom and in an actual working environment.

II. RELATED WORK

In this section, an overview of several different approaches related to game analysis, fun, and emotions experienced in games is presented as these build up the foundational knowledge upon which the present work is built. Most of the models here introduced have a strong background in psychology and focus on the study of subjective experiences inferred from the behaviour of participants so it is not surprising that different and complementary approaches have been proposed in the last few years to analyze games and explain why they are fun and engaging.

Lazzaro proposes a framework called "Four Fun Keys" [1] where the experience lived by the player is seen as different types of fun that are associated with a range of emotions. The first fun, called Hard Fun, is related to frustration and pride as the player can be proud when she overcomes a challenge and achieves its goal while she may feel frustrated by repeated failure. The second fun, named Easy Fun, is related to curiosity, with the player is willing to explore the possibilities offered by the game. The third fun is Serious Fun and is related to relaxation and excitement. Last we have the People Fun, which is related to the feeling of delight at being entertained and it is something best experienced in multiplayer games through interaction with other people.

In [2] Freeman proposed a vast collection of about 1500 rules and techniques grouped into 32 categories for evoking emotions in games. The whole collection was named Emotioneering™, which the author defined as "a vast body of techniques for evoking a breadth and depth of emotion in games, as well as for immersing a player in a role or in a game's world". Examples of techniques are "role induction" or "player chemistry towards NPC" to facilitate player's immersion into the virtual world.

Instead of proposing rules a-la Freeman, Jesse Schell's approach to game analysis and design involves a set of one hundred Lenses [3]. These "lenses" outline a set of questions, gathered from fields as diverse as psychology, architecture, music, visual design, film, software engineering, theme park

design, mathematics, writing, puzzle design, and anthropology, that game designers should ask themselves to analyze their games and, ultimately, gain a better understanding of what makes games fun and interesting to play.

The MDA Framework (Mechanics, Dynamics, and Aesthetics) proposed in [4] is a well known approach among game designers that formalizes the consumption of games and their design counterparts by breaking them into three distinct components as shown in Fig. 1.
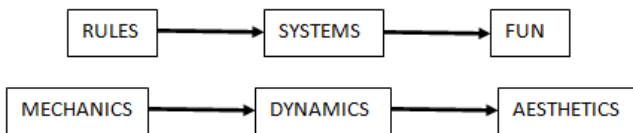

Figure 1: Consumption (top) and corresponding design structure of games (bottom) according to the MDA framework.

As defined by its authors, "Mechanics describe the particular components of the game, at the level of data representation and algorithms. Dynamics describe the run-time behavior of the mechanics acting on player inputs and each others' outputs over time. Aesthetics describe the desirable emotional responses evoked in the player, when she interacts with the game system".

Aesthetics are clearly the most challenging part to analyze as they relate to the subjective experience of "fun" among players and, for this purpose, the MDA model proposes a specific taxonomy named "Eight Kinds of Fun". Specifically:

- Sensation: *Game as sense-pleasure*
- Fantasy: *Game as make-believe*
- Narrative : *Game as drama*
- Challenge: *Game as obstacle course*
- Fellowship: *Game as social framework*
- Discovery: *Game as uncharted territory*
- Expression: *Game as self-discovery*
- Submission: *Game as pastime*

So, for example, a game like "The Sims" [5] tends to elicit different types of fun including Fantasy, Narrative, Expression, Discovery, Challenge and Submission.

The 6-11 Framework [6] suggests that games can be so engaging at a subconscious level because they successfully rely on a subset of basic emotions and instincts which are common and deeply rooted in all of us. Specifically, the framework focuses on six emotions and eleven instincts shortlisted from those recurrent in psychology and analyzed in a number of well known treatises, like [7],[8],[9].

In particular, the six emotions are:

- Fear: one of the most common emotions in games nowadays. Thanks to the newest technologies, it is now possible to represent realistic environments and situations where fear can easily be triggered: think of all the recent survival horror games or dungeon explorations in RPG games for plenty of examples.
- Anger: A powerful emotion that is often used as a motivational factor to play again or to advance in the story to correct any wrongs that some evil character did.
- Joy / Happiness: Arguably, one of the most relevant emotions for having a fun gaming experience. Usually this is a consequence of the player succeeding in some task and being rewarded by means of power ups, story advancements and so on.
- Pride: rewarding players and making them feel good for their achievements is an important motivational factor for pushing them to improve further and advance in the game to face even more difficult challenges.
- Sadness: Despite being an emotion that doesn't seem to match with the concept of "fun", game designers have always been attracted by it as a way to reach new artistic heights and touch more complex and mature themes.
- Excitement: most games worth playing should achieve this and it should happen naturally as a consequence of successfully triggering other emotions and/or instincts.

While the eleven core instincts taken into considerations are:

- Survival (Fight or Flight): the most fundamental and primordial of all instincts, triggered when we, like any other living being, are faced with a life threat. According to the situation, we will have to decide whether we should face the threat and fight for our life or try to avoid it by finding a possible way of escaping. This is widely used in many modern videogames, especially FPS and survival horror games.
- Self Identification: people tend to admire successful individuals or smart fictional characters and naturally start to imagine of being like their models.
- Collecting: a very strong instinct that motivates players to form patters of objects by completing sets with a common theme. It also relates to our hunting instinct and has been widely used in games since the early days of the medium.
- Greed: often we are prone to go beyond a simple "collection" and start amass much more than actually needed just for the sake of it. Whether we are talking about real valuable items or just multiple sets of goods and resources we need to build our virtual

empire in a strategy game, a greedy instinct is likely to surface very early in many players' gaming habits.

- Protection / Care / Nurture: arguably the "best" instinct of all: the one that pushes every parent to love their children and every person to feel the impulse for caring and helping those in need.

- Aggressiveness: the other side of the coin, usually leading to violence when coupled with *greed* or *anger*. It is exploited in countless of games.

- Revenge: another powerful instinct that can act as a motivational force and is often used in games to advance the storyline or justify why we need to annihilate some alien or enemy.

- Competition: deeply linked with the social aspects of our psyche and one of most important instinct in relation to gaming, e.g. leaderboards. Without it, games would lose much of their appeal.

- Communication: the need for expressing ideas, thoughts, or just gossip, was one of the most influential for human evolution and it can be used to great effect in games too, while seeking information by talking to a non-playing character (NPC) or while sharing experiences with other players in chatrooms and forums.

- Exploration / Curiosity: all human discoveries, whether of a scientific or geographical nature, have been made thanks to these instincts that always pushed us towards the unknown.

- Color Appreciation: scenes and environments full of vibrant colors naturally attract us, whether it is an abstract or a photorealistic setting. Note, though, that this is not necessarily linked to technology prowess but it is more about the artistic use of colours to make graphics attractive regardless of the actual number of pixels.

Overall, the main idea behind the 6-11 Framework is that these emotions and instincts interact with each other to build a network or sequence that should, in general, end with "Joy" and/or "Excitement" to provide players with a meaningful and fun experience.

More formal and mathematical approaches to game analysis and design have also been proposed, for example in [10] where games are represented as abstract control systems in the form of a triple *(F,S,M)* where *S* is a set, *M* is a monoid and *F* is a (possibly partially defined) action of the monoid *M* on the set *S*, i.e., a map $F : S \, x \, M \rightarrow S$

In this model, *M* represents the input from the players, *S* represents the states of the different objects in the game and *F* all the possible ways player can manipulate and interact with those objects, in other words, the rules of the game.

III. THE A.G.E. FRAMEWORK

Game design studies are still a very young field, often in between academia and the industry with academics and designers trying to analyze similar problems but from different perspectives and motivated by different needs. Unfortunately, this variety of approaches led to a complete lack of a common vocabulary and terminology, with commonly used terms like "mechanics", "rules", "dynamics" and "aesthetics" being interpreted and re-interpreted in slightly different, but significant, ways by different people.

For example, game designers like Brathwaite and Schreiber consider mechanics as synonyms of rules, spanning every phase of the game from the initial setup of game tokens onwards [11], while others, like Järvinen [12] or, more recently, Koster [13], tend to draw a clear distinction between the two. Similar disagreements can be found when trying to strictly differentiate between "mechanics" and "dynamics".

In the end, there is no common agreement on a definition for almost any term currently in use and different ones are being proposed and adopted in different contexts, as highlighted in [14].

Due to this very reason, instead of re-interpreting for the nth time the very same terms and risk further confusion, a new set of definitions will be used here to start anew and avoid any possible misunderstanding due to the lack of a common vocabulary.

Like the MDA model, the proposed approach breaks a game into three different layers of abstraction. Namely:

- **Actions**: the core, atomic actions that a player can perform in a game, usually described in terms of verbs. Examples are moving, jumping, kicking a ball, punching, shooting, taking cover etc.

- **Game-play**: the resulting play that players achieve by using and combining the available "actions". These can be either verbs or higher level concepts, for example: fighting, race-to-an-end, territorial acquisition etc.

- **Experience**: the emotional experience that engages players during the game. This will be described in terms of the 6-11 Framework.

As shown in Fig. 2, each layer can be linked to the next by a set of "Rules", linking Actions to Game-play, and a set of "Goals", or challenges, linking Game-play to the Experience.
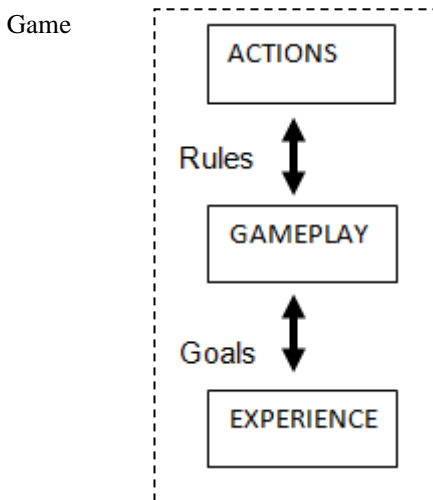
Game

Figure 2: A schematic representation of the Actions, Game-play, Experience (A.G.E.) model to describe a generic game.

IV. CASE STUDIES

To understand how the A.G.E. theoretical framework can help us in practice to analyze and understand how successful games build up an engaging and enjoyable experience, we can apply it to a classic yet very simple arcade game named Frogger [15]. In Frogger the player controls a small frog that has to survive a set of different hazards across a trafficked road and river before finding a safe haven.

Our analysis starts from the Actions. To identify these, we should play the game and ask ourselves "what can we do in the game?". The answer here is very straightforward: the player can only move around the screen in four directions: left, right, forward and backward.

Once the Actions have been listed, the analysis can proceed to the Game-Play. Now we need to ask ourselves "What are the game rules allowing us to do? How do they allow us to interact with the game world?" or, in other words, "What are we actually doing in the game? What are we using the Actions for?"

In the case of Frogger, the game world is set to be a very hazardous environment with several dangers we need to avoid to reach the top of the screen. In game design terms, we can refer to these as originating a game-play about "avoidance" and "race-to-an-end". Indeed, reaching the end of the path is the game goal, which leads the analysis to the last stage: the Experience, where we have to make explicit how accomplishing the game goal make us feel.

Analyzing the Experience is clearly the most difficult part of the whole process since anything involving emotions can be very subjective. Anyway, by relying on the 6-11 Framework, it is possible to determine a most likely scenario. In this case, players would likely feel "excited" by the fast avoidance game-play, requiring high hand-eye coordination skills to

avoid collision with the incoming vehicles and falling in the water. Players have to "survive" across the level. Once this is achieved, they would likely feel "proud" of having reached the end of the level safely and, henceforth, "happy" for their accomplishment. The analysis is exemplified in Figure 3.
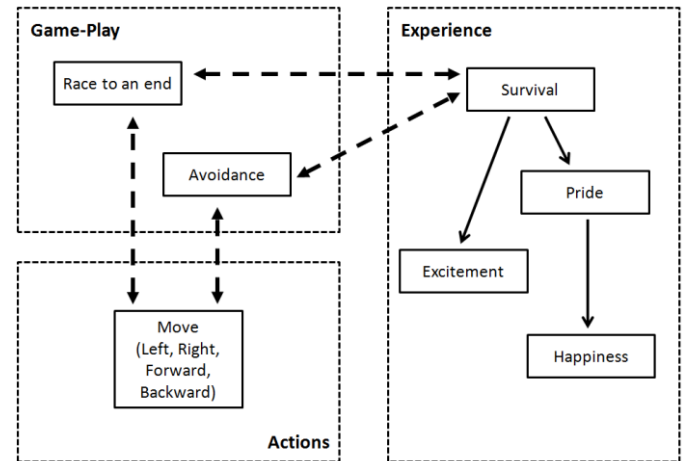

Figure 4*: A.G.E. analysis for the classic arcade game Frogger (Konami, 1981)

As another example, in a platform game like "Super Mario Bros." [16], by repeating the previous analysis steps we can easily identify the core actions as "running" and "jumping" and realize how the rule "the player can kill enemies by landing on top of them" links the jumping or falling action to the "fighting enemies" game-play while the rule "player will progress to the next stage by reaching an end-level flagpole" links the core running and jumping actions to the race-to-an-end game-play.

Similarly, the ultimate goal of saving the princess serves as a motivation to link the fighting and race-to-an-end game-play to the emotional experience of players, namely "excitement" for the mission and "curiosity" for exploring new and secret areas while being the sole protector of the beautiful and elusive damsel in distress. Moreover, the analysis can also make us realize how, finding more and more coins while exploring the game worlds, can also trigger players' "greed" instinct, adding to the overall excitement for playing the game and, ultimately, lead to a fun and engaging experience.

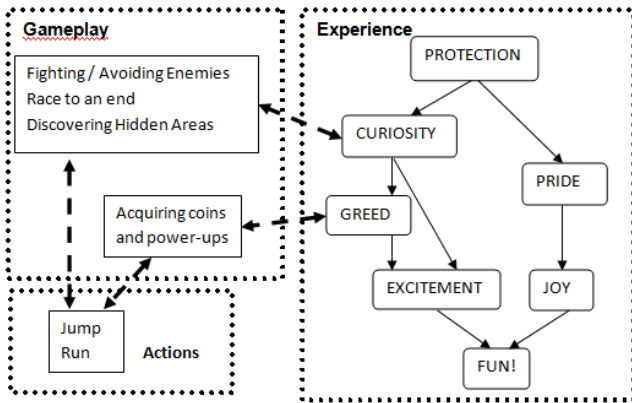A possible diagram for Super Mario Bros is shown in Fig.4.

Figure 4*: A.G.E. analysis for the original "Super Mario Bros"(Nintendo, 1985): Protecting Princess Peach is the first instinct to motivate the player. This, followed by Curiosity and Greed, can then effectively drive the platforming game-play to keep the exploration going.

V. DEFINING "GAMES"

It is also worth noting that, through the proposed model, it is possible to outline a general definition of what a "game" actually is:

"a game is a system where one or more players perform different actions according to a set of predefined rules. These give a meaning, or purpose, to the former, leading to a game-play aimed at reaching some goal or overcoming some challenge. In doing so, different instincts and emotions can potentially be evoked in the players, making them emotionally involved and engaged".

Where a 'system' is defined as a set of parts which are in relationship to each other to create a complex whole.

While many definitions of the word "game" exist, the one suggested above is in accordance to or, at least, does not contradict, many of the most popular ones like:

"A game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome" [17]

or

"A game is an activity among two or more independent decision-makers seeking to achieve their objectives in some limiting context" [18].

VI. GAMES DESCRIBED THROUGH A REGULAR GRAMMAR

The A.G.E. model can also be formalized in terms of a simple regular grammar $G = \{N, \sum, P, S\}$, where N and $\sum$ represent a set of non-terminal and terminal symbols respectively, P is a set of production rules and S is the start

symbol. G would describe a language of gaming defined as follows:

$$L(G) = \{ a^n\ g^m\ e^q \mid n,m,q \geq 1 \} \tag{1}$$

where $N = \{ A, G, E \}$ and $\sum = \{ a, g, e \}$ with 'a', 'g' and 'e' being the individual actions, game-play and experience elements respectively. The starting symbol S and set of production rules P are defined as follows:

$$S \rightarrow aA \tag{2}$$
$$A \rightarrow aA \tag{3}$$
$$A \rightarrow gG \tag{4}$$
$$G \rightarrow gG \tag{5}$$
$$G \rightarrow eE \tag{6}$$
$$E \rightarrow eE \tag{7}$$
$$E \rightarrow \varepsilon \tag{8}$$

According to the actions, game-play and experience elements included in figure 3 and 4, games like Frogger and Super Mario Bros would then be described respectively by strings like:

{ move, avoidance, race to an end, survival, pride, happiness, excitement } (9)

{ run, jump, acquire coins and power-ups, fight/avoid enemies, discover hidden areas, race to an end, protection, curiosity, greed, pride, joy, excitement } (10)

It is worth noting that, in this model, while the possible actions 'a' and game-play elements 'g' may possibly include hundreds of different items according to different game genres, the set of possible experiences 'e' can only include the 6 basic emotions and 11 instincts as originally identified by the 6-11 Framework. In the end, a game, to be properly formulated, should start with at least one action, followed by one or more game-play elements which are then used to elicit one or more specific emotions. All of which being related and linked to each other by the game's specific set of rules and goals.

VII. A.G.E. FOR GAME DESIGN AND TESTING

By breaking a game into clearly separated levels of abstractions which can, nonetheless, be easily related to each other, it is not only easier to analyse games and understand how they manage to engage players but also to plan and conceptualize new ones. Game designers may start their creative processes by working on any specific level first and then expand on to the others. For example, we could start from a set of actions, like running and jumping, and then build some rules around them to draft the game-play, set challenges and goals and see if an emotional experience can actually develop into something coherent and engaging. Alternatively, other game designers may be more inclined to start by defining the type of game-play (eg. develop a platform game with plenty of

hidden areas to explore) and then create goals, rules and actions accordingly or even start by drafting a desired experience first to motivate players and drive an interesting game-play, which will then be implemented by defining proper rules and actions. In the end, it is not really important in which specific conceptual level the game designer starts in but it is fundamental to be aware of the overall picture and know how to link the different layers by crafting appropriate rules and challenges to create a cohesive unit as shown previously in figure 2.

Describing a game through the A.G.E. framework could also be beneficial during the testing phase: not only specific tests can be planned for verifying each action and see if they relate correctly to the game-play by abiding to the corresponding rules but, more interestingly, also valuable insights on the emotional experience can be gained. For example, testers could be asked to provide feedback on the emotional experience and point out specific emotions and instincts: would they emphasize the same ones as intended by the designers or something else? Indeed the 6-11 Framework has already been successfully used for game testing within the serious gaming field with encouraging results [19].

VIII. CONCLUSIONS

The proposed model allows for a schematic yet comprehensive view of a game and its inner workings in a rigorous and coherent approach that can be described both in an easily understandable graphical form and, more formally, as a regular grammar. Through the A.G.E. framework, games can effectively be referenced in terms of their core actions and game-play elements, leading to the arousal of a specific set of emotions and instincts that ultimately characterize their emotional appeal and engaging qualities.

Finally, the possibility of formalizing the analysis process into a grammar can also be useful for categorizing games in different ways, according to specific actions, game-play or emotions and see how these relate to different game genres. A classification and categorization of games following this approach is a possible area for further study and investigation.

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