Design Techniques for Planning Navigational Systems in 3-D Video Games

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Navigation is an essential element of many high-budget games (known as AAA titles). In such products, players are expected to walk through and interact with aesthetically rich 3-D spaces. Therefore, designers should provide meaningful information to guide the users within a challenging environment. While there has been much research on both games and 3-D environments, there is very little research investigating design techniques used to guide players through 3-D game worlds. This paper is focused on proposing a set of navigational patterns or techniques currently used in commercial 3-D action-adventure titles. These design techniques are composed of [a] 21 patterns used to aid navigation, [b] three level design choices affecting navigation, and [c] eight game mechanics related to navigation. We uncovered these design techniques through a detailed analysis of 21 3-D action-adventure games. This contribution has several important facets. First, the set of design techniques and terminology proposed here can be used as a training construct to teach 3-D game and environment design. Second, it can also be used as a toolset for designers. Third, it will provide an important start for a formal vocabulary that can be used by designers and researchers discussing navigation in 3-D games.

Categories and Subject Descriptors: Design Techniques, Navigational Aids

General Terms: Navigation

Additional Key Words and Phrases: Navigation in games, level design, game design

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1. INTRODUCTION

The video game industry has significantly grown in sales and revenue in North America. For example, computer and video game industry hardware, software, and peripheral sales have jumped from $ 5.1 billion in 1997 to $ 24.75 billion in 2011 in the United States alone [The Entertainment Software Association 2012]. Also, according to the Entertainment Software Association [2012], "the average U.S. household owns at least one dedicated game console, PC or smartphone" and "59% of Canadians are gamers" [Entertainment Software Association of Canada 2011]. The population of gamers has also grown and become notably diverse. Nowadays, teenagers, adults and seniors, and males and females are video game consumers [The Entertainment Software Association 2010]. Clearly, as noted by game scholars, video games have reached a broader audience and become part of popular culture [Jenkins 2006; Turkle 2003]. As games gain popularity, designers start to feel the pressing need to adapt their designs to cater to such a big and diverse market. This creates an interesting design challenge, as designers

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will need to develop methods for communicating game actions and goals to a diverse audience, who may have never played a video game before.

In order to remedy this situation, research is needed to develop theories of game design techniques currently used. Creating successful 3-D games is a hard task. Such games should lead the player through the environment, establish a good method for telling the player what to do, and challenge the player at the same time. All these design requirements are directly or indirectly related to navigation. Thus, navigation is one of the most important and essential systems in the design of 3-D games [Nerurkar 2009; Rogers 2009; Rollings and Adams 2003; Taylor 2009]. It also has a notable effect on players' experience [Bidwell et al. 2007; McGregor 2008a]. For example, Taylor, a video game designer who has worked in several renowned game companies, including Sony Computer Entertainment Europe, Electronic Arts, Rockstar Games and Ubisoft, brings attention to the fact that players must navigate through the game world before performing any other action such as shooting, opening doors, picking up objects, defeating enemies, etc. [Taylor 2009]; therefore, it is crucial to support players' navigation to assist players' progress in games. Hence, in this paper we will focus on navigation with the aim to present a set of techniques and patterns that aid a player's journey in 3-D games.

According to Doug Church, a game designer who worked on several AAA award-winning titles such as Deux Ex (Eidos Interactive, 2000), Ultima Underworld (Origin Systems, 1992), and System Shock (Origin System and Electronic Arts, 1994), game design will inevitably improve if designers share the same vocabulary and concepts because they will be able to "communicate precisely and effectively with one another" [Church 1999]. This will allow them to accelerate both the process of brainstorming about new games and the process of suggesting the implementation or modification of elements within games that are already in development. In this work, we specifically focus on introducing a set of design techniques for aiding navigation that we observed in 3-D action-adventure games. Such design techniques repeatedly appear within the games and among several games; therefore, we call them patterns. In addition, we propose a terminology (or nomenclature) for each technique.

Previous research in this field is limited. There are few industry resources, such as game-specific discussions in specialized website articles [Nerurkar 2009] and presentations, such as Game Developers Conference talks on design lessons [Plourde 2010; Zoeller 2010]. Game researchers have experimented with few visual aids and their impact on navigation [Hoeg 2008]. Plus, in a previous study, Moura [2007] investigated what kind of visual cues were used to guide navigation within 17 games. However, none of these works present a framework or a set of design patterns that is extensible and can be used by researchers and designers of 3-D games. In this paper, we focus on this issue by investigating visual elements used in 3-D games to help, support, or interfere with the navigation process in 3-D action-adventure games.

Our research questions are: What design patterns have game and level designers included in action-adventure game worlds to influence the player's navigation process, and how can we abstract those patterns from a specific game or context? To answer these questions, we used a qualitative thematic analysis approach (which is a subset of content analysis) [Braun and Clarke 2006]. Specifically, we analyzed 21 3-D action-adventure games to identify what design techniques are used to guide players through the game environment. We then identified similar patterns, abstracted and named them, creating a set of design techniques for aiding navigation in games. These design techniques are composed of 21 navigational aids categorized based on their function (identify, direct, and orient characters and objects in the game world). We also found three level design choices that affect the design navigational systems. Finally, we identified eight game mechanics that relate to navigation. We present videos and screenshots showing these systems in action.

While some consider navigational aids a synonym for signage, in this study navigational aids refer to all the elements included in games that support and guide players' next steps, helping them to navigate toward the end of the game. That is, a navigational aid is an element that draws players to reach and solve every mission until they conclude all the tasks and finish the game. Note that we will not discuss architecture here, nor include it in our set of design techniques at this time. Although architectural design is an important element that can support or hinder navigation within games, we want to focus on patterns that are included within 3-D games or environments when the architecture by itself is not enough to inform users of where to go and what to do. Sound effects that work as navigational aids will also not be discussed in this paper. The only exception is Direction from characters (see our results), since such hints may come as verbal aids and/or subtitles. Besides, Direction from characters is strongly related to Missions, so this element is hard to ignore in this study.

This set of patterns or design techniques for aiding the navigation process, in addition to the three characteristics of the game world and the eight game mechanics related to navigation, constitutes the contribution of this paper. It is our first step toward formalizing the essential features that constitute navigational systems for 3-D games and the basis for developing a pattern language in the future. Subsequent evaluation of these patterns is necessary to examine the effect they have on different types of users and their success rate. This will be the subject of future work. Furthermore, the number of patterns examined in this paper is a subset, and thus more research is needed to augment the patterns discussed, which we will also tackle in future work.

This paper is organized as follows. We first discuss related work. Then we discuss the research question and methodology. Subsequently we discuss the results outlining the main contribution of the paper: the navigational aids, the characteristics of the game world, and the game mechanics related to navigation, identifying different navigation patterns and how they were used in different 3-D action-adventure games. We then conclude by summarizing the contribution and impact of this work and discussing future work.

2. RELATED WORK

The study of navigation in both real environments and 3-D games is an elusive topic involving studies in architecture, lighting, orientation, and signage, to mention a few. Previous studies in game navigation have discussed how architectural design may interfere with a participant's progress and experience [Licht 2003; Adams 2003; Güttler and Johansson 2003; McGregor 2006; McGregor 2007; McGregor 2008a; Moura 2006; Rollings and Adams 2003; Chen and D. Brown 2001]. For example, McGregor [2007] affirms that there is a relationship between the way spaces are architecturally planned in games and what players do in these spaces. She argues that architecture has a significant impact on our actions due to its function in providing navigable areas and boundaries. Also, according to Chen and Brown [2001], "level design is very architectural in nature"; levels are "spatial experiences of environments." The authors encourage the use of an architectural design methodology in the creation of game environments. In addition, Moura [2006] argues that designers should make use of Lynch's theory based on architecture for the design of 3-D games. In particular, Lynch identified five main elements that compose and give meaning to the image of the city: paths, edges, districts, nodes, and landmarks.

While the relationship between architectural design and level design has been discussed by several game researchers and designers [Licht 2003; Adams 2003; Güttler and Johansson 2003; McGregor 2006; McGregor 2007; McGregor 2008b; Rogers 2009; Samarinas 2009; Chen and D. Brown 2001], in some games, architectural design alone is not sufficient to guide players through the environment. Few studies have presented

significant work toward developing a theory enumerating the systems used to guide players through complex 3-D video game environment. For example, Samarinas [2009] focused on lighting and its role in aiding players' navigation and spatial decisions. Participants navigated through levels with similar layout but different light conditions. The author concluded that "light does not prove to be as strong in guiding navigation." We believe that it is the combination of several game elements (such as sound, color, motion, goals, etc.) that guides players' spatial decisions. Therefore, there is no single element guiding navigation, but rather it is a composition of elements used within specific contexts that provides this functionality.

Hoeg [2008] took a different approach from Samarinas' work. Instead of isolating one element such as lighting and testing how it influences navigation, he developed a complex level that mimics a commercial first-person shooter (FPS) game. Hoeg developed this level with the assumption that players would choose paths based on their play styles or motivations (e.g., achievement, exploration, or killing enemies). He then used eight different elements to analyze players' choices in 16 decision points through the level. The elements were: light contrast, dynamic light, rhythm, sound, narrow versus wide spaces, movement of objects or characters, resistance (i.e., a path that has obstacles), and color (associate to textures or lighting). Each decision point presented one of those elements guiding players toward a main or a side path (e.g., color attracting toward side path). While these elements had a role in navigation choices made by players, Hoeg found that motivational or play style was not the primary element influencing players' decisions during navigation. He concluded that due to the complexity of the level, it was impossible to verify if only those elements influenced navigation or the combination of multiple variables. According to the author, players take into account the cost of going back and forth before they move further. In his study, Hoeg found that players visited the rooms in sequence, the closest room visited first, regardless of the navigational aids presented there.

From an industry perspective, Rogers [2009] argues that games' architectural design should tell a story to the player. He regards architecture and narrative as strongly related aspects of game design. In his view, navigational aids guide players by inviting them to keep moving through the environment. In his discussion about navigational elements, he identifies landmarks and lighting as elements that can be used to attract and guide players through the game.

Taylor [2009] states that for some games (e.g., Mirror's Edge - EA, 2008) navigation is the most important interaction element. In his lecture, he outlines some navigational aids and categorizes them as explicit or implicit. Examples of explicit navigational aids include: objectives, compass, signposts and spoken directions, which are used to push the player. On the other hand, examples of implicit navigational aids are: landmarks, lighting, AI encounters, pick-ups and contrast, which are used to pull the player.

Similarly, Nerurkar [2009] identified a list of 14 elements used in games to guide players' paths. He categorized those elements as discrete tools: those separated from the game environment but part of the graphical user interface, or immersed tools: those elements that are part of the game environment. Examples of discrete tools are maps, markers (elements that highlight an object), and compasses. Immersed tools, on the other hand, are categorized according to their functions, which include attract, identify, and guide. In this regard, the author states that contrast, composition, weenies (a concept that comes from Disney's theme parks, also cited by Rogers [2009]), motion, cut scenes, game characters, and pick-ups are elements that attract the player. On the other hand, landmarks and style (e.g., architectural style, indoor versus outdoor spaces, etc.) are used to identify areas within the game. The author also explains that signs and lines guide the player through the level. While Nerurkar specifies many elements that support navigation in games, some of these elements are vague and need detailed analysis.

Table I. Games Analyzed, Sorted by Release Date

Game Title	Short Name	Publisher[1]	Year
Ico	Ico	SCE	2001
Maximo: Ghosts to Glory	MaxGG	Capcom	2001
Rygar: the legendary Adventure	Rygar	Tecmo	2002
Sly Cooper and the Thievius Raccoonus	Sly	SCE	2002
Beyond Good and Evil	BGE	Ubisoft	2003
Castlevania: Lament of Innocence	CasLI	Konami	2003
Kya	Kya	Eden Games	2003
Maximo vs. Army of Zin	MaxAZ	Capcom	2003
Tomb Raider: Angel of Darkness	TR	Eidos Interactive	2003
Prince of Persia: Warrior Within	PPWW	Ubisoft	2004
Castlevania: Curse of Darkness	CasCD	Konami	2005
God of War	GoW	SCE	2005
Prince of Persia: the Two Thrones	PPTT	Ubisoft	2005
Red Ninja	RedN	Vivendi	2005
Shadow of the Colossus	ShadCol	SCE	2005
Grand Theft Auto: Liberty City Stories	GTA	Rockstar Games	2006
Ice Age 2	IceA	Vivendi Games	2006
Heavenly Sword	HS	SCE	2007
Grand Theft Auto IV	GTAIV	Rockstar Games	2008
Brutal Legend	BL	EA	2009
Uncharted 2: Among Thieves	Uncharted	SCE	2009

As discussed above, there are many elements influencing navigation in games. Those elements can also be categorized in different ways. Even though we mentioned several studies that proposed contributions toward developing a model for navigational systems and their use in games, a detailed analysis of video game navigational systems is still missing. This is the subject of this paper. Particularly, we extend previous studies by providing a comprehensive study of navigational patterns used in 21 3-D action-adventure games. We then abstracted such elements, creating a set of design techniques and proposing a terminology for each one of them based upon our study. Table I presents the games played for the development of this work.

3. METHODOLOGY

These parameters measure the level of visual As stated above, the main questions guiding this study are: What design patterns have game and level designers included in action-adventure game worlds to influence the player's navigation process, and how can we abstract those patterns from a specific game or context? As mentioned previously, we will not concentrate on architectural design, but rather on grouping and introducing design techniques for aiding navigation based on an analysis of how successful games use visual elements to guide the player through 3-D spaces. We also suggest a terminology for each one of the navigational tools to start a unique vocabulary in the field.

Twenty-one 3-D action-adventure games were chosen for this analysis. All of them use third-person perspective. We established only the following criterion for game selection: AAA titles that have been published by reputable commercial studios. This excludes student games or games published by inexperienced designers or independent studios. We also set the count of games chosen to more than 10 games to ensure the generality of the patterns (or design techniques) created from this research. Games

[1]SCE is Sony Computer Entertainment.

chosen were released over a nine-year span, enabling us to analyze navigational systems from different qualities of games (see Table I).

We focused on action-adventure games because most of them use navigation as one of the major challenges or primary task. That is, while such games present rich scenarios and mechanics related to navigation, other game genres may use navigation as a secondary task (e.g., first-person shooter). Besides, we decided to start from a specific set of games instead of extending our sample. That being said, we believe that many of the navigational patterns introduced in this paper can be applied to other game genres.

We used a qualitative analytical method, rather than empirical or user study approaches, to identify elements related to navigation within game worlds. In this sense, our analysis method is descriptive and qualitative where one researcher (the first author of this paper) played the games herself as suggested by [Aarseth 2007]. This is a necessary step in theory formation, especially since this topic received very little research in the past. We want to elucidate that a theory of navigation in games has yet to be built, so we could not borrow from such theory to conduct our study. We did borrow from previous research on navigation in real environments that defines the wayfinding process and also the role of signage in navigation [Passini 1996].

Therefore, we used a theoretical thematic analysis approach [Braun and Clarke 2006] to fit part of our data into the categories defined by previous research on navigation in real world, as well as a thematic approach (i.e., themes emerging from the data), which is similar to grounded theory, as recommended by researchers such as [E. Brown and Cairns 2004; Fabricatore et al. 2002]. In the thematic approach, the researcher does not have any stated hypothesis to test, or theory to guide the process of analysis. Instead, s/he analyzes and categorizes the data through an iterative process [Fabricatore et al. 2002]. The discussion regarding the characteristics of the game world and the game mechanics related to navigation came from this perspective. Theories and conclusions emerged from the data itself.

The researcher played each game from beginning to end at least once. During all play sessions, Moura paused the game and took notes on all the elements guiding her through the game environment. The researcher had in mind the following specific questions while playing the games: Where am I? Where should I go and why? What is pulling me to follow this path? What is helping me to follow this path? Do I know where I am going? How?

Game walkthroughs were avoided since the goal of this analysis was to identify the elements guiding navigation within the game; that is, the researcher tried to recognize all information helping her to progress through the game environment. The information had to be in the game world, not in external sources.

After listing and categorizing all the elements, the researcher analyzed her findings further to identify reoccurring themes and patterns. By doing that, the researcher abstracted some elements from their context, giving them specific names and creating a set of design techniques that can be used by designers and researchers in different contexts. For example, in Shadow of the Colossus the researcher described a "sword that indicates the direction a player should take." From this description, she suggested a Specific tool indicating direction. This tool is also found in Dead Space (Electronic Arts, 2008), a game that is not part of our sample because it is not an action-adventure game. Thus, the patterns identified in this paper are abstract and can be found in many games within and across different genres. Subsequently, designers can also apply them within their games. These patterns are presented in the following section.

4. RESULTS

Following the process outlined in the methodology section, we developed our set of navigational tools, composed of three different types of patterns that influence navigation:

- *Navigational aids.* These are categorized as elements that fit into one or more of the following functions: directional sign, if the element points players toward a direction, action or object; identification sign, if the element identifies a place or object in the game environment; and orientation sign, if the element orients or locates players in relation to game world.
- *Level design choices affecting navigation.* These are related to decisions that level designers should make when designing a game. Depending on those decisions, the navigational system may be more or less complex and players will have an easier/harder journey. Designers should decide [a] how much exploration the game environment will incite, [b] how much access to the game world players will have (or how large each level will be), and [c] how much control over the camera settings players will have.
- *Game mechanics related to navigation.* These mechanics are deeply related to navigation because they enable the players to move forward through the game world. Sometimes, they also signalize and conduct the player through the game environment.

We discuss these elements in detail below.

4.1. Navigational Aids

As explained previously, navigational aids are included in game environments when a game is too complex to enable navigation and interaction without extra information. In short, players need guidance to know where to go and what to do. Navigational aids can be categorized as *directional signs*, *identification signs,* and *orientation signs* according to their function. Table II summarizes our findings. It shows the 21 navigational aids we identified within the 21 games we analyzed; it also shows the number of navigational aids per games, and how navigational aids are categorized in each game. Note that some navigational aids fit in more than one category. Games are sorted by the total number of navigational aids they present.

For example, Grand Theft Auto IV presents the highest number of navigational aids, 16 in total. In this title, we found eight elements Directing the player through the game, five elements identifying locations and other characters, and three elements used to orient the player within the game world. In addition, the last column indicates how many games applied a specific navigational aid. For example, 16 games applied *guided tours* to their navigational systems, 13 games used map [in the game menu], and so on.

In the game, characters, including players, are divided in two factions: the Cubers Liberations Army (CLA) and the Rabid Viper Special Forces (RVSF). A player chooses which of the factions they want to join before starting the game. The game can be played online with and against human players or with virtual enemies (bots). There are 12 different game modes: Capture the Flag, Keep the Flag, Team Keep the Flag, Deathmatch, Team Deathmatch, One Shot One Kill, Team One Shot One Kill, Last Swiss Standing, Survivor, Team Survivor, Pistol Frenzy, and Hunt the Flag. Among them, only the modes Deathmatch, Team Deathmatch, and One Shot One Kill are available to play against bots.

In the following sections we define all the 21 navigational aids, explaining how they work and how they are presented in games. We also critique those navigational patterns suggesting possible situations for their use and commenting on their benefits and drawbacks.

We want to clarify that our goal is to create a set of design techniques with unique names and introduce such patterns related to navigation in this paper. Critics are not making any final claims here regarding the finality of the benefits and drawbacks of said patterns. Game design is a creative discipline and we believe that, while game

Table II. Number and Types of Navigational Aids per Game

Navigational aids	GTAIV	BL	GTA	GoW	MaxAZ	Rygar	Uncharted	HS	CasCD	TR	Sly	Kya	IceA	PPTT	ShadCol	BGE	MaxGG	CasLI	Ico	PPWW	RedN	TOTAL
TOTAL	**16**	**12**	**11**	**11**	**10**	**9**	**9**	**9**	**9**	**9**	**8**	**8**	**8**	**7**	**7**	**7**	**6**	**6**	**5**	**5**	**4**	
DIRECTIONAL SIGNS	**8**	**8**	**6**	**7**	**6**	**5**	**7**	**7**	**6**	**6**	**5**	**7**	**5**	**5**	**4**	**5**	**4**	**4**	**4**	**4**	**2**	
Guided tour		x		x	x	x	x	x	x	x		x	x	x		x		x	x	x	x	16
Map [in the game menu]	x	x	x		x	x			x		x	x		x	x	x		x		x		13
Mission or goal	x	x	x	x			x	x		x	x	x			x	x					x	12
Instructional aid	x	x		x		x	x	x		x			x	x		x						10
Environmental object representing paths				x			x	x		x	x		x	x					x	x		9
Marker	x	x	x	x	x	x	x	x									x		x			10
Lever, gear and button					x			x	x					x			x	x	x	x		8
Direction from characters		x		x	x		x		x	x	x		x		x							9
Subtitle stating directions	x	x		x				x		x												5
Collectible item indicating paths					x						x	x	x				x					5
Teleport [in game]	x								x			x					x	x				5
NPC that should be followed	x	x	x				x					x										5
Arrow			x						x			x										3
GPS	x		x																			2
Compass																x					x	2
Specific tool indicating direction															x							1
Teleport [through the map in the menu]											x											1
IDENTIFICATION SIGNS	**5**	**3**	**2**	**4**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**0**	**3**	**1**	**2**	**1**	**2**	**1**	**1**	**0**	**1**	
Instructional aid	x	x		x		x	x	x		x			x	x		x						10
Subtitle identifying level/area	x		x	x	x	x			x								x	x				8
Marker	x	x	x	x	x	x		x							x		x		x			10
Direction from characters		x		x	x		x		x	x	x		x		x							9
Signboard	x										x		x								x	4
GPS	x																					1
ORIENTATION SIGNS	**3**	**1**	**3**	**0**	**1**	**2**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	
Map [in the game menu]	x	x	x		x	x			x		x	x		x	x	x		x		x		13
Map [on screen-HUD]	x		x			x																3
GPS	x		x																			2
Directory										x												1

designers may learn from our work, they will add to it and develop innovative and interesting games. Besides, our suggestions are based on our own experience. Empirical research is necessary to verify.

4.1.1. Directional Signs. Directional signs are used to inform players where to go and what to do. That is, directional signs point players toward locations and/or interactions with objects or NPCs. Through our investigation 17 different directional signs were identified. The directional signs are as follows:

Guided Tour

Definition: It is a cut scene that walks the player through a path in the game environment or shows the aftereffects of a player-game interaction.

Usage: In general, Guided tours are presented when a player first reaches a new and complex room in the game and has to follow a specific path to get out of that room. They are also used when the player interacts with an object, changing something in another

room (e.g., unlocking door, changing platforms, etc.). In some games, the cut scene starts from the character position to the last step the player should take (e.g., Prince of Persia: the Two Thrones and some scenes of God of War 3—http://www.youtube.com/watch?v=bUKNC9hNKe8&feature=related [0:57 - 1:07]). But in other games, the cut scene starts from the exit backward to where the character is (e.g., Pryzm, the Dark Unicorn and some scenes of God of War 3).

Benefits and drawbacks: This pattern is useful for teaching the player the sequence of actions that should be taken in order to advance in the level. It can be really helpful especially if the player is a novice. It is also helpful for informing changes that are not visible from the player's location (for example, when the player presses a button in one room, opening a door in a different room). A disadvantage of this design technique is that the player loses control of the game, so it may break the continuity of the experience. In addition, it is hard to remember all the steps when the Guided Tour is backward. Finally, more experienced players may not like such navigational pattern because they would rather explore the game on their own.

Map [in the menu]

Definition: This tool is a 2-D representation that shows the 3-D world from a top-down view. Such representation can be accessed through the game menu.

Usage: Maps present a total or partial visualization of the game environment. Maps [in the menu] work as directional signs when they indicate the player's position, goals or interesting locations, and the path the player should take to reach those goals or locations. In general, we identified seven different kinds of maps placed within the menu. They are distinct from one another in the amount of information they provide and in their operation. For example, some maps display locations alone, others give the character's position, others allow the player to quickly travel from one place to another, others allow the player to set a location and a path will be drawn connecting the character's position and the said location, and so on. In Brutal Legend, for example, players can move their target location through the map and a path will be drawn linking the player to the target location (http://www.youtube.com/watch?v=g_xjZUilF1U&feature=channel [0:04 - 0:12]).

Benefits and drawbacks: This pattern is useful if the game has large environments or if it is an open world. It helps the player to make sense of the environmental layout and memorize locations, especially because players can take time to study the map without being at risk in the game. We want to clarify that designers should take into account the level of abstraction they want for the maps. Note that the higher the level of abstraction, the harder it is for users to make sense of the game environment. A disadvantage of this tool is that players have to interrupt the game to check the map, and that can harm the overall experience of the game.

Mission or Goal

Definition: Missions direct players by explicitly informing them of where to go and/or what to do.

Usage: Stating a mission is important, because players become aware of both what they should be looking for and what they should do in a specific location. Designers can direct players' attention to a specific task related to the goal or mission. For example, if the immediate mission is to find a key, players' attention will focus on objects that look like a key. In short, it is easier for the player to find a location or object if he knows what he is looking for. This is called a top-down process in visual attention theory as explained by Colin Ware [Ware 2008]. Note that missions are usually informed through game narratives, legends/subtitles on screen or in the menu, or by an in-game Non-Player Characters (NPCs).

Fig. 1. Examples of Instructional aids in God of War (left) and Heavenly Sword (right).

Benefits and drawbacks: Based on both our analysis and literature review, it is always important to mention to the player what to do and where to go. The benefit is that the player will be able to engage in something and s/he will not wander around lost in the game. Thus, there is no drawback for this tool. However, this pattern can be misapplied when the goal is confusing and, as a consequence, the player cannot make a connection between what s/he sees in the scene and what s/he is asked for. Clear goals are crucial for a good game experience.

Instructional Aid

Definition: Instructional aids are a class of tools illustrating the controls that should be used in particular situations. They take on different forms.

Usage: Such aids can be a graphical representation of buttons of the controller as seen in Figure 12 or they can be a textual explanation of how the user should control the character in a specific situation. Figure 1[2] shows two examples of Instructional aids: In God of War (left) the player is instructed to press R2 to perform an action and, in Heavenly Sword (right), players are instructed to press X in a navigation scene. In Assassin's Creed II (Ubisoft, 2009), instructions remain on screen (heads-up display or HUD) to remind players of which buttons should be pressed depending on the action they want to perform (e.g., "fast walk").

Benefits and drawbacks: Designers use these elements to direct players' attention toward an object or action. For example, specific buttons are represented on the screen when players get close to interactibles such as a doorknob that can be used to open a door, an NPC that players can talk to, or an object that can be picked up. This is helpful because players would take a long time to distinguish the object that they should use from those that are only part of the background story. Also, instructional aids can be used in battles, as in Heavenly Sword, to inform players of actions they should perform. Without following that information (i.e., pressing the correct buttons), players will not be able to progress in the game. In addition, Heavenly Sword presents an example of instructional aids in a navigation scene where players should coordinate their actions with instructions on the screen as seen in http://www.youtube.com/watch?v=SQw2BfnHKiE&feature=related [0:13 - 1:44]). These examples make clear that instructional aids can be part of the game mechanics. The major issue of this pattern is that it is capable of breaking the suspension of disbelief because the player will see a message popping up throughout the gameplay. Designers should make sure that instructional aids are visible enough to be seen and followed, but will not impair gameplay by hiding important in-game information.

[2]All images in this paper are reprinted with permission from IGN Entertainment.

Fig. 2. Examples of "environmental objects representing paths" in Prince of Persia: Warrior Within (left), God of War (center) and Ico (right). It is easy know where to go after noticing such elements.

Fig. 3. Examples of "Narkers" in Castlevania: Curse of Darkness (left), Brutal Legend (center) and Uncharted 2: Among Thieves (right). Through brightness and color contrast, designers grab players' attention and indicate where they should go.

Environmental Object Representing Paths

Definition: This pattern refers to objects that allude to transportation or connection between two locations. They are unique and, most of the time, easily recognizable in the game environment such as ladders, ropes, chains hanging from the ceiling, distinct textures on the wall, and so on.

Usage: Such embedded objects operate as directional signs combined with the architectural design. Usually, such objects stand out visually and they repeatedly appear in the game. For this reason, they rapidly communicate the path players should navigate through. For example, in platform games such as Prince of Persia: Warrior Within, Prince of Persia: the Two Thrones and Tomb Raider: Angel of Darkness, players can recognize their paths through the contrast added to specific platforms the player should climb on. Uncharted 2: Among Thieves (see Figure 3, right, in the next section) is an example of such platforms that work as an Environmental object representing paths, combined with another pattern (i.e., Marker). Figure 2 presents some examples: in Prince of Persia: Warrior Within (left), a tapestry on the wall indicates the path players must take to advance in the game; in God of War (center), textures contrast with the wall and point the path to the player; and in Ico (right), chains indicate how to get in different areas in the game environment.

Benefits and drawbacks: This design technique usually does not break the suspension of disbelief because the objects compose the scenario. They are a clever way of guiding the player in the game world through interaction. Issues with this pattern occur when the objects are too repetitive, which may make navigation too easy and the scenario visually boring, or when there is a mismatch between the visual characteristics of the object and the scenario.

Marker

Definition: Markers are high-contrast elements within the game used to bring objects and locations to players' attention.

Usage: These visual compositional elements work as directional signs when the high-contrast object or spot indicates a path to the player. For example, some games present glowing arrows that can easily be seen in the environment (See Figure 3, left). Uncharted 2: Among Thieves (Figure 3, right) has drastically changed the way contrast is applied to platforms in the game environment. Instead of using brightness to enhance contrast, only colors are added those elements. The result is a realistic environment where objects are blended within the game architecture, requiring more attention from the players. As explained in the previous section, in this example, Uncharted 2 presents a combination of marker and environmental object representing paths. It is an example of the former because there is contrast between the blue platform and the game world, and it is an example of the latter because the platform is an object embedded in the environment that should be used as a connection between locations. In Grand Theft Auto: Liberty City Stories and Brutal Legend, glowing elements are added to mini racing games to make the path evident to the player (http://www.youtube.com/watch?v=tBCTZ9qwy5c [0:48 - 1:08]). Figure 3 shows glowing arrows indicating paths in Castlevania: Curse of Darkness (left), a shining element indicating the direction players should take to reach the next mission in Brutal Legend (center) and a blue pipe indicating the path in Uncharted 2 (right). Note that, different from the object in Uncharted 2, players cannot interact with the elements presented in the first two examples.

Benefits and drawbacks: Since markers clearly highlight important locations and objects, they can easily guide the player. They are part of what can be called a "game language" since expert players have no problem in interpreting what this design technique means. Besides, markers attract players' attention to part of the scene, helping them with their goals. A drawback of using this feature is that, if not well applied, the player can feel it gives too much guidance.

Lever, Gear, and Button

Definition: The name of this pattern is self-explanatory. They are levers, gears, and buttons that work as directional signs because they notify the player that a new path will be opened as soon as s/he interacts with them.

Usage: This pattern makes clear to the player that there is a sequence of actions that should be performed if s/he wants to advance in the game. Levers, gears, and buttons are used to open doors or activate elevators and platforms. Some games, like Heavenly Sword, add brightness to gears and ladders, which makes them easily noticed (this means that this pattern and markers can be used together). Also, if the door or platform to be opened is not close to the lever, a guided tour (see above) is usually presented showing the door being opened.

Benefits and drawbacks: This pattern is useful if the designer wants to use an element that can be easily recognized by the player. Levers and buttons exist in the real world, so the player can make a direct connection between the actions that should be performed. Some issues with this pattern can be both lack of visibility of the object itself or lack of visibility of the consequences of using the object (i.e., lack of feedback).

Direction from Characters

Definition: This means directions or instructions that come from an NPC, who tells the player where to go or what to do.

Usage: This is the only navigational aid presented in this paper that can be verbally communicated. That is, although we are concentrating on visual elements that compose navigational systems, directions from characters can be applied in the game as a dialogue or monologue. Bear in mind that sometimes those directions are added to the game in the form of subtitles as well. As explained before, an NPC can give the players several missions or can inform locations that players should navigate to. Also,

Fig. 4. Examples of "lever, gear, and button" in Prince of Persia: Warrior Within. Players should rotate the lever in order to open new paths and progress in the game.

an NPC can give hints of how to defeat an opponent or inform the player of what to do to advance in the game. In addition, sometimes directions are given to the player through his own character's thought. Heavenly Sword and Brutal Legend, for example, make use of this aid in battles and puzzles. In Uncharted 2, there is always an NPC walking with the player, giving him some hints.

Benefits and drawbacks: This design technique has the benefit of being embedded in the game story; therefore, it does not break immersion or the continuity of the game. A disadvantageous aspect of this pattern is that designers should carefully think of dialogues that will make sense in the context of the game, especially if the player does not understand the first clue that is given to him/her and the player waits for more information. Repetitive sentences will break the suspension of disbelief.

Subtitle Stating Directions

Definition: These are sentences that appear on screen to inform players of goals and directions they should take.

Usage: Sometimes the subtitle pops up and disappears from the screen; other times the subtitle stays on the screen until the player accomplishes the task. Also, sometimes the subtitles appear on the screen, and after they disappear, the player can still check the information in the game menu. In Uncharted 2, players can decide whether they want a hint or not by pressing a button. The hint is available if the player spends too much time walking around the environment without following the path intended by the designers.

Benefits and drawbacks: An advantage of this technique is that it is usually quite visible to the player. Game designers should judge whether subtitles break the suspension of disbelief or not. Also, they should make sure that the subtitles will not impair the visibility of the game world.

Collectible Item Indicating Paths

Definition: This is a collection of items spread through the game environment that can be picked up by the player.

Usage: In general, pickups will inform players of areas that can be reached. That is, if there is an object that can be collected, the player will automatically know that s/he can navigate through that area. Sometimes collectible items indicate a path even more explicitly. For example, games such as Maximo: Ghosts to Glory (Figure 5, left), and Ice Age 2 (Figure 5, right) indicate the whole path to the player by presenting series of collectible items (coins and nuts, respectively).

Fig. 5. Examples of "collectible items indicating paths in Maximo: Ghosts to Glory (left) and Ice Age 2 (right).

Benefits and drawbacks: A benefit of this patter is that collectible items are usually pretty visible in the level; therefore, players do not have to think too much to decide which path they should take. A drawback is that not all games can accommodate such feature in their mechanics, which limits this feature to the game genre, the game goals, or the game audience.

Teleport [in game]

Definition: This is an element used by the player to travel from one place to another without experiencing the entire game environment. That is, this tool offers a lower-cost transportation.

Usage: Teleports [in game] are used as directional signs when they indicate the final destination to the player. The user gets a sense of locations s/he has visited and those that s/he has not. Kya uses this tool in its navigational system (http://www.youtube.com/watch?v=IdkAXAWcF6s&feature=related [1:05 - 1:20]). In Grand Theft Auto IV (Rockstar, 2008) it is possible to teleport from one place to another through the taxi that belongs to the main character's cousin.

Benefits and drawbacks: Although teleports [in games] enable a way of navigating that is not comparable to a "natural" navigation as it occurs in real environments, they may not break the suspension of disbelief. Even though the player does not experience the environment, the fact that there is an object embedded in the game world makes it acceptable. Besides, this tool is very helpful when the player needs to navigate a long way but does not have any goal to accomplish in those areas that s/he should navigate through. Teleports can save a lot of time. A drawback is that players may not learn the environment as much as s/he would if s/he navigated the game world over and over again. Designers should accommodate this technique to the goals of the game.

NPC that should be followed

Definition: This technique is self-explanatory; it is a design technique that uses NPCs to guide players to different locations.

Usage: In Kya and Assassin's Creed II, for example, this directional sign is used in the tutorial phase. That is, an NPC directly asks the player to follow him so the player will learn how to navigate through the game by pursuing that NPC. In Brutal Legend, this pattern is used as part of the gameplay. Navigation and shooting are combined as players chase friendly NPCs to protect them from enemies on a road (http://www.youtube.com/watch?v=yj4PE52Mjbk&feature=related [3:25 - 6:15]). Some games use a single NPC to guide the player through the levels. Other games, like Uncharted 2, have different characters teaming up with the player.

Benefits and drawbacks: This technique is a clever method for guiding players without breaking the suspension of disbelief because the characters are already embedded

in the story and game world. However, this pattern should be well designed or it will not fit in the game. Also, too much guidance might negatively affect the gaming experience.

Arrow

Definition: It is an artifact that points toward a specific direction. This type of aid notifies players of paths in a pretty straightforward way.

Usage: Arrows may be applied in games in the same way they are applied in real environments, as signage. However, sometimes games add floating and glowing arrows (see Markers) that are easily perceived and hard to ignore. As we mentioned, glowing arrows are applied in Grand Theft Auto: Liberty City Stories to allow players to navigate while focusing on the task at hand (e.g., racing). The quality of the arrow (i.e., if it is big, small, high contrast, floating, location, etc.) should be decided based on how easily a player should perceive or notice a path.

Benefits and drawbacks: The benefit of using an arrow is that it is part of a convention-based symbolic system; therefore, the player can easily and quickly interpret it. A drawback is that expert players may find that arrows provide too much guidance. Besides, designers should decide how to best integrate arrows in the game world in a way that it will fit the story and the art of the game.

GPS

Definition: It is a personal navigation device simulating what we call GPS in the real world. In games, a GPS is not only a simple map on the screen, but it also shows the main character represented by an arrow (instead of a dot) that indicates the direction the player is moving toward. Also, a GPS shows important landmarks and highlights the location the player should reach.

Usage: This directional sign is used in games that have open worlds such as Grand Theft Auto and Assassin's Creed series. The GPS in Grand Theft Auto IV goes even further by drawing the path the player should follow to reach his destination while a voice message informs where the player should turn right or left. If the player misses a turn, the path is updated.

Benefits and drawbacks: As previously stated, this tool is absolutely useful in open world games because it is very hard to memorize the entire game. This technique gives the player the opportunity to focus on other tasks, without concentrating that much in navigating the game environment. This tool is not ideal if the player has to learn the environment (or even part of it) as explained before. Also, depending on the context of the game (e.g., if a scene requires fast navigation), it can be difficult to navigate and check the GPS at the same time.

Compass

Definition: A compass is a device that that points the player toward a direction without giving him/her details about the path that should be followed.

Usage: This directional sign is normally used in FPS games but action-adventure games make use of this design technique as well. Usually the compass is placed on the HUD. Beyond Good and Evil and Red Ninja use this tool. In Beyond Good and Evil (Figure 6, left) the compass should be activated to be used (top right of the screen). In Red Ninja (Figure 6, right), the location to be reached is represented by an X on the compass (bottom right of the screen).

Benefits and drawbacks: It is appropriate to use a compass if the designer wants to guide the player but not give him all the information necessary to reach each mission. If the game environment is large enough to need a navigational aid, but not large enough for a GPS or something more straightforward, a compass might be a good option. As a drawback, a compass is usually permanently on the HUD, which may impair visibility

Fig. 6. Example of Compass in Beyond Good and Evil (left) and Red Ninja (right).

Fig. 7. Example of "specific tool indicating direction" in Shadow of the Colossus. When rays are dispersed (left), the player is facing the wrong direction.

and break the suspension of disbelief. Also, the game world should be well planned; otherwise, the compass will not satisfy the needs of the player.

Specific Tool Indicating Direction

Definition: Similar to Compass, this navigational aid refers to tools that indicate the direction players should follow. The difference is that a specific tool indicating direction should be activated by the player.

Usage: We identified this aid in Shadow of the Colossus. In that game, the character's sword is the tool that allows players to see the direction to follow. While Nerurkar [2009] defines that sword as a compass, we want to differentiate both. A compass is usually part of the HUD and the player does not interact with it. In Shadow of the Colossus, however, the tool is a game mechanic. Other examples of specific tools indicating direction can be found in Dead Space (Electronic Arts, 2008) and in Stacking (THQ, 2011). In those games, the tools are activated by the player. Figure 7 presents the feedback players get when they raise the character's sword. When the rays are dispersed (left), players are facing the wrong direction; otherwise (right), players are facing the direction they should follow to reach their next mission.

Benefits and drawbacks: Because this aid is part of the game mechanics, it can be fun if well implemented. Also because it is part of the game mechanics and because players have to interact with the tool, it does not break engagement and immersion. As suggested for compass, the game world should be well designed to accommodate a tool that does not give specific information about the path that should be followed.

Teleports [through the map in the menu]

Definition: This teleport is different from the other presented in this paper (i.e., teleport [in game]) only because the player needs to go to the game menu before using

it. Other than that, teleports have the same function: transport the player from one location to another without forcing the player to navigate the game world.

Usage: This navigational tool was found in Sly Cooper and the Thievius Raccoonus. In that game, the player can go from one place to another through the map in the menu. Note that only rooms previously visited can be reached through this tool. The same type of teleport is found in Fable 3 (Microsoft Game Studios, 2010).

Benefits and drawbacks: This is a way of making navigation faster rather than forcing the players to experience the entire environment a second time, as previously explained in teleport [in game]. A disadvantage of teleports in the game menu is that players have to leave the game environment to teleport to a different place. The benefit is that labels can be added to the map, making players aware of where they are going.

4.1.2. Identification Signs. Besides finding their paths, players need to know when they have reached their destinations. In addition, they need to be informed of elements they can interact with. This is why game designers need to add identification signs, to signalize locations and interactive objects to the player.

Instructional Aid

Definition: As identification signs, instructional aids indicate elements that players can interact with (e.g., doors, levers, gears, NPCs, etc.).

Usage: In Tomb Raider: Angel of Darkness, for example, buttons the player should press appears on the screen when s/he gets closer to specific objects, such as doors that can be opened or objects players can interact with (http://www.youtube.com/watch?v=cwJTNKO68y4 [1:25 - 1:57]).

Benefits and drawbacks: While instructional aids direct the player to an action, they also identify specific doors and objects. This is the reason why instructional aids work as both directional and identification signs and the reason why they are constantly applied to games. A drawback of this technique is that messages will pop up on screen even before the player has a chance of exploring the level.

Subtitle Identifying Level/Area

Definition: This technique refers to subtitles that appear on the screen, naming a level or area when players reach those locations in the game.

Usage: In Grand Theft Auto: Liberty City Stories, for example, subtitles signal transitions among different neighborhoods, while in Maximo: Ghosts to Glory, subtitles pop up on the screen when the player changes levels.

Benefits and drawbacks: Subtitles are important to contextualize the player within the game environment. They are useful, for example, when the player is sent to a specific location and sees the name of that location upon arriving. The drawback is that subtitles have the potential to break the suspension of disbelief if they do not match the atmosphere of the game.

Marker

Definition: Brightness and color contrast work as identification signs when they specify interactive objects or locations to the player.

Usage: When a Marker is used in a specific spot, it indicates the location the player should visit or stand at. In Shadow of the Colossus, for example, a glowing area identifies the spot where the character should stick his sword to defeat foes. Figure 8 presents two examples of Markers: In Grand Theft Auto IV (left), red arrows point to characters the player should defeat; in Brutal Legend (right), a bright spot identifies the location the player should stand at to start his next mission.

Benefits and drawbacks: Brightness and color contrast make the interaction with objects faster because they are powerful in attracting players' attention. As mentioned

Fig. 8. Example of "Markers" in Grand Theft Auto IV (left) and Brutal Legend (right).

before, the main potential drawback of Markers is that they should be well designed and integrated into the game world. Otherwise, players will feel that too much information is being given, which reduces the challenge of the game.

Direction from Characters

Definition: It works as identification signs when the NPC identifies himself or when the NPC says where the player has arrived.

Usage: This technique is pretty straightforward; some games use an NPC to contextualize the player so s/he can understand whether or not s/he has reached his destination.

Benefits and drawbacks: This technique is good for contextualizing the layer through an in-game entity. There is no drawback of using such tool if it fits the story and the game world.

Sign Board

Definition: As in the real world, sign boards are visual elements used to identify locations in the game.

Usage: Grand Theft Auto IV, for example, makes use of this kind of navigational aid. In that game, players have to find different places in a huge city and Sign boards are somehow useful. Note that the GPS also helps the player in the process of identifying those places because sometimes the Sign boards do not present a high contrast against the environment in Grand Theft Auto IV.

Benefits and drawbacks: When visible (i.e., placed in a good spot), and when the player has the chance and the time to read them, sign boards are very useful for identifying locations. An issue with this navigational tool, as seen in Grand Theft Auto IV, is that players are usually driving (and driving fast) in that game. As a consequence, it can be difficult to read sign boards. As any other navigational aid, designers should guarantee that each sign board is visible and matches the atmosphere and art of the environment.

GPS

Definition: As previously defined in the directional signs section, this navigational tool is a personal navigator device. It works as identification sign only when it "identifies" a specific location.

Usage: in Grand Theft Auto IV the GPS works as an identification sign because it directly declares, "you have reached your destination" when players are in front of the place they should visit.

Benefits and drawbacks: This navigational aid is very useful in Grand Theft Auto IV because players have to focus on driving, so the notification helps sometimes. Besides, it matches the style of the game, which makes the game more immersive and more fun. This pattern does not fit all kinds of games, so designers should be careful when applying this navigational tool to a game.

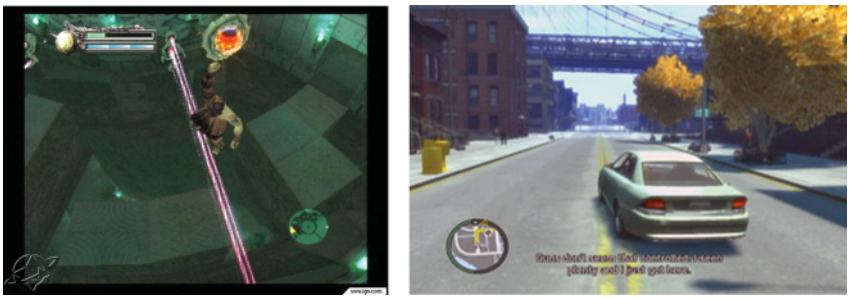

Fig. 9. Example of "map [on screen-HUD]" in Rygar (left) and in Grand Theft Auto IV (right). Note that in Grand Theft Auto IV the map indicates landmarks and the path of the current mission.

4.1.3. Orientation Signs. Finally, in addition to directional and identification signs, games include orientation signs. They are necessary to inform players of their relative position within the game. Orienting players is especially important when they have to navigate back and forth through the game world. Games like Grand Theft Auto series, Assassin's Creed series, and Brutal Legend make orientation signs crucial. We identified four elements working as orientation signs.

• ***Map [in the menu]***
Definition: As previously defined, maps are 2-D representations of the 3-D environment (see Map [in the menu] in the directional signs section).

Usage: Besides giving directions to indicate paths, a map [in the menu] can be used to situate the player in relation to landmarks in the game. Games like Grand Theft Auto series and Brutal Legend present detailed maps that help players locate themselves and the areas they want to visit. Other games, like Shadow of the Colossus and Rygar, present more abstract maps. In such cases, the maps do not provide as much orientation as the maps in Grand Theft Auto and Brutal Legend. Designers should judge how much information should be provided to the player according to the goals of the game.

Benefits and drawbacks: Maps are great tools for orienting the player. When implemented in the game menu, maps can be very versatile. The designer has the opportunity of deciding how much information will be available (e.g., landmarks, labels, player position, total or partial visualization of the level, and so on). A possible disadvantage of this aid is that players need to stop their navigation (or any other action in the game) to be able to open the map.

Map [on screen-HUD]
Definition: This kind of map provides a partial view of the game environment so a player can situate himself according to what is shown.

Usage: As we see in Rygar (Figure 9, left), the player is able to identify his position based on the geometry of the building; that is, no other landmark is provided in this case. On the other hand, in Grand Theft Auto IV (Figure 9, right), the map is more detailed, highlighting important landmarks as well as player position.

Benefits and drawbacks: Maps on the HUD are beneficial when the player needs to navigate the environment and keep his/her orientation at the same time. That is, this navigational pattern allows the player to continue his/her activities in the game and consult the map at the same time. This tool has some disadvantages, thought. It can provide only a partial visualization of the level, it can be distracting, and it should be carefully designed to accommodate as much information as needed without cluttering the screen.

GPS

Definition: As an orientation sign, a GPS is responsible for providing important landmarks in the environment and the player's position and orientation (i.e. the direction the character is facing). See also 'GPS' in the directional signs section.

Usage: Especially in Grand Theft Auto IV, the GPS advises the player to turn left or right through verbal instructions. Note that games that have a GPS also have a map [on screen-HUD], but not all the games that have a map [on screen-HUD] have a GPS. Figure 9 (right) shows the GPS in Grand Theft Auto IV: A player's position, his orientation, and landmarks can be seen through this navigational aid. The player is also guided through verbal instructions.

Benefits and drawbacks: As explained, a GPS is a powerful tool to orient the players since it shows the players' position in relation to the environment, the direction the player is facing, and landmarks around him/her. The path the player should follow is also visible, and verbal instruction helps the player navigate without having to look at the GPS. The limitation of this aid is that it can mostly be applied to driving games.

Directory

Definition: Similarly to directories in the real world, this tool is a map fixed in a specific location of the game environment. The environmental layout, and sometimes the character position, is displayed in this tool.

Usage: A directory was found in Tomb Raider: Angel of Darkness. The player should stand in front of a map in the game environment, locate his/her relative position, and then move to the location s/he wants. If the player gets lost before reaching his/her destination, s/he should go back to the map and try to make sense of the environmental geometry again.

Benefits and drawbacks: This navigational tool makes the game environment very realistic. Also, because directories are available in real environments, the player can easily recognize this aid in the game. An issue with this design technique is that players cannot carry the map with them. Thus, if the environmental layout is too complex, the player might need to be back and forth to look at the directory over and over.

So far, we have presented 21 design techniques used to aid navigation in games. The following section explains the three level design choices that influence not only the navigation process itself but also the selection of the design techniques previously introduced.

4.2. Level Design Choices Affecting Navigation

We identified three design choices that one should make when analyzing or designing navigational systems for games. The first two design choices are genuinely related to architectural design. The last one is related to the player's point of view. Although none of these design choices are navigational aids per se, they deeply affect both navigation and game experience depending on how they are designed. Thus, it is worth discussing these design choices in this paper.

4.2.1. How Much Environmental Exploration will the Game Incite? Some games provoke curiosity and pull the player to search for objects, NPCs, or places that are hidden in the game. This is important because it will make the player navigate, investigate, and experiment with the game world. All the games we analyzed strongly incite exploration even though they take different approaches to do so. For example, some games promote exploration through their visual appeal (e.g., the Prince of Persia series and Grand Theft Auto series). It is pleasant to navigate through those games even if you are not trying to accomplish a goal, but just exploring and staring at the game scenario.

Other games, such as Ico and Shadow of the Colossus, tie exploration to gameplay. That is, only through deep exploration, players are able to solve architectural puzzles

in Ico and find foes in Shadow of the Colossus. In Uncharted 2, players need to explore the environment in order to progress. For example, by stepping on specific spots, the floor breaks, opening a new path. Some pipes and sign boards move around or fall down when the player holds them. Such events also open new paths.

Finally, the most common way of inciting exploration is by giving rewards to the players. In God of War, for example, players who explore the environment find antique boxes to fill up their health. In Grand Theft Auto: Liberty City Stories, players will find not only collectible items (e.g., new weapons and ammo) but also mini-games. In Brutal Legend, players can find binoculars (called landmark viewers) spread over the game environment. Besides earning game currency, players can experience the environment from a new and appealing perspective. The lesson for designers is that they should define how exploration relates to their game. Then they can design the means to provoke curiosity and incite exploration, and that will affect how the player experiences the game.

4.2.2. How Large is the Game World? This design choice influences both navigation and the design of navigational systems for games. Regarding navigation, limited spaces tend to decrease exploration for obvious reasons: The area is reduced, the amount of information is reduced, and most of the time all information is available at once on the screen. In addition, limited spaces tend to keep players oriented, which might make the navigation process less challenging. It means that, for such small areas, navigation may not be the *main* gameplay; on the contrary, designers should also include puzzles, items to be collected or battles. On the other hand, when the player has access to a larger portion of the game, navigation may be more demanding. In our analysis, we identified four games that present extremely limited spaces, 12 games that somewhat limit access to the game environment, and five games that present free access to the game world (see summary below).

Regarding the design of the game world, game and level designers can considerably limit the game space by designing levels comprising small areas. However, even if the game environment is small, designers should inform where the player can go before informing him/her of where s/he should go. Art and architectural design work together, differentiating navigable areas and boundaries, giving the player all necessary information. Besides the extension of the level, designers can limit access to further areas of the game until the player solves all the missions in his/her current location. For example, when a player finds a locked door, s/he intuitively understands that s/he needs to find the key that opens that door. This technique affects navigation because the player is not allowed to move further until a key is found.

It is important to notice that designers should take into account how much access to the game world players will have at any one time because this will have an impact on the selection of tools that compose the navigational system. For example, in the Grand Theft Auto series, players experience a massive game world, so a map and a GPS are essential to orient and guide the players. On the other hand, games like Maximo: Ghosts to Glory and Heavenly Sword present a very small portion of the game world per level, which makes maps unnecessary.

Based on our analysis, we summarize by presenting the following categories:

- *Extremely limited access to the game world*: These games introduce a small area at a time. Usually, navigation is linear and the player cannot go back to areas already visited. It is unlikely that a player will get lost in this kind of games. Examples include: Ice Age 2, Maximo: Ghosts to Glory, Maximo vs. Army of Zin, and Heavenly Sword;
- *Limited access to the game world*: The area presented to the player is bigger than in the previous games but still limited. In such games, the player can go back and

forth from one room to another until he finishes the entire level. After changing levels, players cannot go back. Examples include: God of War, Beyond Good and Evil, Castlevania: Lament of Innocence, Castlevania: Curse of Darkness, Ico, Rygar: the legendary Adventure, Prince of Persia: Warrior Within, Prince of Persia: the Two Thrones, Red Ninja, Sly Cooper and the Thievius Raccoonus, Tomb Raider: Angel of Darkness, and Uncharted 2: Among Thieves.
- *Free access to the game world*: These games present a large game environment to the player that s/he can freely navigate. Sometimes the entire environment is presented from the start. Sometimes the player has access to new areas gradually. In any case, the player has access to a large navigable area at some point in the game. Examples include: Grand Theft Auto: Liberty City Stories, Grand Theft Auto IV, Shadow of the Colossus, Kya, and Brutal Legend.

4.2.3. How does the Camera System Work? Providing a user-controllable camera is especially important when players have to solve environmental puzzles (like in the Prince of Persia series, for example) or need to orient themselves in the environment (Grand Theft Auto series). Providing a user-controllable camera is also very important for games that add vertical gameplay, such as Assassin's Creed II. In the Tomb Raider series, it is possible to solve some puzzles only if the player moves the camera around.

On the other hand, some games, such as God of War, present a fixed camera without compromising the player's experience. But in other cases, fixed cameras may make it harder for the player to get a sense of the environment (e.g., Rygar). Based on the proposed gameplay and architectural design, designers should determine whether players will interact with the camera or not.

It is also important to note that some games also offer the option of switching from third to first-person view. In some scenes in Prince of Persia: the Two Thrones and Tomb Raider: Angel of Darkness, players can see the same rooms from different angles by pressing a specific button. From our analysis, only six of the 21 games did not use a user-controllable camera: Maximo: Ghosts to Glory, Heavenly Sword, God of War, Castlevania: Lament of Innocence, Castlevania: Curse of Darkness, and Rygar: the legendary Adventure.

In summary, the three design choices presented here somehow affect navigation. Such design choices should be planned together, so designers will be able to select the appropriate navigational aids to support player progression.

4.3. Game Mechanics Related to Navigation

As our goal is to point to elements that relate to navigation, we have included eight game mechanics that genuinely interfere with the navigation process. That is, it is hard, or sometimes impossible, to navigate through the game without mastering such game mechanics. The lesson for game designers is to understand how the game mechanics affect navigation and judge how to balance the game based on that:

- *Master character's movements and skills:* These mechanics involve walk, run, climb, drive, swim, jump, duck, and so on. The player needs to know their possibilities and understand the controls to be able to keep moving in the game. In Prince of Persia: the Two Thrones, for example, the character must perform tasks such as run upon a vertical wall and support himself between two walls. The player cannot navigate if s/he does not master all those movements.
- *Level up the character:* The player should learn new combos or movements to be able to progress. In Kya, for example, the player should keep buying new bracelets because they make the character stronger and capable of defeating some enemies. If the character does not level up, the player will not progress in the game.

- *Level up tools or vehicles:* Similarly to the previous mechanic, players should improve their tools, weapons and vehicles. In Beyond Good and Evil, for example, players should go back to a specific location to upgrade their vehicle after accomplishing a task. If players do not do that, the vehicle will not be powerful enough to reach the next mission. In Brutal Legend, players should also visit specific places to upgrade their car and weapon. It interferes with navigation and overall game pacing because it will make the player defeat his enemies faster or slower.
- *Use of NPC to open doors or solve puzzles:* In this case, players need an NPC to advance in the game. In Ico, for example, this game mechanic slows down the game pacing since the player should always wait for the NPC. Also, the player needs to solve many architectural puzzles in order to open a path for the NPC. In this game, some doors are opened only by the NPC, and that is the reason why the player cannot leave the NPC behind. In Beyond Good and Evil, players should switch the control between the main character and a secondary character to solve puzzles and open doors.
- *Puzzle solving:* This mechanic relates to navigation when the puzzle opens a new path to the player. Games like God of War and Prince of Persia: Warrior Within make use of puzzles in a way that players have to solve them in order to advance. In general, puzzles slow down the game pacing.
- *Defeat enemies:* In general, this mechanic is indirectly related to navigation, but worth mentioning. Many games block paths until the player defeats some enemies thus restraining the player from going further. In Kya, new tools (e.g., bracelets, snowboards) become available only if the player defeats opponents. It is a whole cycle where all elements are connected; that is, players defeat enemies, get new tools, and reach new areas in the game so they can defeat more enemies.
- *Race:* Races are used in Grand Theft Auto and Brutal Legend. In Grand Theft Auto, some races are missions that force the player to navigate through the game world so that he can become aware of the game environment. In Brutal Legend, the character should race against opponents and win the races (those are mini-games). Also in Brutal Legend, the character should follow his friends' car, shooting several opponents in the road (otherwise his friends' car will be damaged and the player will have to start the mission again).
- *Stealth:* This mechanic affects navigation because it forces the player to move quietly. Obviously, it also slows down the game pacing. In Sly Cooper and the Thievius Raccoonus, for example, some levels include lasers that move around the space. Players should move carefully so as not to be detected. Besides the game pacing, it affects navigation because stealth can be combined with other tasks such as collection, for example. If the player has to deeply concentrate on stealth, the designer should make the collectible items easy to be seen to help in the process. Note that game and level designers should always judge how to balance the game.

5. CONCLUSION AND FUTURE WORK

In this paper, we discussed how game and level designers use visual navigational aids, game mechanics and other design choices to support and influence the navigation process within game worlds when the architectural design alone does not provide all the necessary information to guide the players through the game environment. Navigation is an extensive, elusive topic that cannot be concluded in only one study. In the work presented here, we named and grouped design techniques that are part of navigational systems in games, in order to help in the analysis, design, and discussion of navigation in digital games. The design techniques introduced in this paper include elements that direct, identify, and orient players within game world, as well as design choices and

game mechanics that affect navigation by limiting or extending players' possibilities of interaction.

Through our study we recognize that navigation in games is a complex process that is related to different aspects of the game. Our first step was to list elements that relate to navigation in games; however, we believe the navigational tools discussed here are not comprehensive and can be extended. Our analysis presents some limitations due to the complexity of the theme and the lack of a formal methodology to analyze this rich medium called video games. It was an exhaustive, iterative process that took months of work.

In spite of that complexity, we managed to define each design technique, providing examples to help the reader understand how such techniques were applied. We also listed benefits and drawbacks for each of the navigational tools introduced here. In addition, we discussed how design choices such as exploration, the size of the game world, and the use of the camera system may influence both navigation and the selection of navigational aids. For example, we discussed that games with large environments might need navigational aids qualitatively different from those with small spaces. Also, if exploration plays a role within a game, we suggest that more subtle navigational cues should be applied. The whole navigational system should work well with the architectural layout and the art of the game.

Navigation in games is a large field and we do not expect to exhaust it here. Much work in this area is needed; we believe this paper achieves another step. Our future research will test for the effectiveness of specific navigational aids listed in this paper. We are interested in examining several research questions, including: Do some navigational aids work better for particular situations than others? Do players notice some navigational aids faster than others? How many navigational aids should be included in any specific game, and how do such navigational aids affect player experience? Do novice players need more aids than more experienced players? In addition, we are currently investigating how moving objects (e.g., visual effects that influence the atmosphere of a game) influence or relate to the navigation process and game pacing.

Finally, we want to mention that we hope that this work will help game and level designers to understand how design techniques for aiding navigation are applied in games today, while we believe that designers are creative enough to propose new techniques and solutions. Also, we hope that this study will contribute to the development of a theory of navigation in games.

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