Design Patterns to Guide Player Movement in 3D Games

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ABSTRACT
Video games today increasingly situate play in imaginative 3D worlds. As a result, the industry devotes much time and effort to level design. However, this subject has received very little research. Documentation on the process of level design or how designers push or pull players through a level within a video game is very sparse. In this paper, we propose a set of design patterns for level design. The patterns were developed based on a process involving interviews with game designers as well as gameplay analysis of different games. We established face validity of these patterns through expert review; we also established reliability using inter-rater agreement. In addition, we also developed a timeline video annotation method based on these patterns. This visualization method provides a very effective approach to view players' play style and preference as well as level design problems. The patterns as well as the visualization method will be discussed in the paper.

Categories and Subject Descriptors
D.3.3 Game Design, Level Design

General Terms
Design, Measurement

Keywords
Design Pattern, Player Movement, 3D Games

1. INTRODUCTION
3D immersive video games are becoming increasingly popular. 68% of American households play video games; many of these games are 3D games [E.S.A. 2009]. 3D level design is an important yet elusive aspect of 3D game development. The process of creating a 3D level involves art, engineering, and craft [Adams 2009]. Level design involves crafting an environment where players can experience interesting encounters, revelations, and rewards. Level designers act as the "invisible hand that guides the player through each environment in a game for instance pushing to go through a certain doorway, defeat a certain challenge, or subtly pulling using lighting, sound effects, item placement, and other breadcrumbs [Byrne 2005]."

While the industry is in dire need to develop good methods for level design, the actual process is still mostly an art that very few experienced designers excel at. While there are some papers published by level designers describing the process of level design, none provide details to guide young designers or to allow curious readers to understand what makes a good level. We also found no previous research work on level design beyond some notable seminal work [Byrne 2005; Fiel et al. 2005].

In this paper, we address the development of a model for evaluating and understanding good level design and player movement within 3D environments. We, thus, construct a set of level design patterns developed based on interviews of four game designers and analysis of six play sessions. We further visualize these patterns within a timeline associated with a play session. This visualization enables play styles understanding as well as visualization of level design problems. In this paper, we will discuss (a) the patterns, (b) validation and reliability process used to validate the patterns and their use, and (c) the visualization method proposed.

2. PREVIOUS WORK
Research analyzing the process of level design has received very little attention. Previous works in this area are informal qualitative descriptions from designers. At the 2009 Game Developer's Conference, Rogers [2009] discussed the similarities between the process of designing a level and that of designing a theme park attraction. He discussed various techniques used by both industries to encourage movement in space, such as anticipating movement and using visual attractors. For example, using a central theme and lighting cues can grab attention and heighten players' emotions. Reinforcements or deterrents along paths also create unique encounters to attract or repel movement such as rewarding exploration with hidden treasures

Smith [2009] presented design principles to keep players on the path to discovery. He devised several principles to constructing a good level that make players feel smart, based on several case studies, including Valve's Portal. These principles are: visibility, affordance, consistent visual language, feedback, and mapping physical or conceptual connections and conceptual models. Combined, these principles can help designers troubleshoot breakdowns in players' advancements through a level. Although this approach is more formalized than Rogers' and is especially useful to troubleshoot communication breakdowns, each principle can be interpreted in different ways which makes solutions dissimilar between games.

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Byrne, Nitsche [2009] and McGregor [2007] explain playful experiences in relationship to spatial configurations in 3D levels. Byrne and Nitsche refer to these configurations as linear/railed, branching/maze, and arena/open; McGregor considers how these allow playful situations. Railed is a linear path along a single axis or track through a level that challenges movement. Goals or contests are always placed along this pathway. Along the same logic, mazes consist of multiple railed pathways which allow choice, when paths branch, and create tension, when bottlenecking paths converge. An arena is an open space, which emphasizes entities contained by the space, such as a coliseum fight or a performance. Instead of concentrating on space and goals, we look at moment to moment motivators that designers place. We also look at methods for visualization and analysis allowing reflection on players' satisfaction and play styles.

3. THE METHOD

In order to examine how designers lead players forward, we decided to use a combination of expert interviews and game analysis. We emailed several game designers who developed AAA 3D game titles. We received four responses from designers ready to commit time for this research. Table 1 shows the designers names and games they worked one that we selected for our research Online rankings through www.gamerankings.com provide aggregate averages across platforms and units sold, and www.vgcharts.com show total sales across all platforms.

Table 1: Games analyzed to determine patterns. *excludes PC

Game Title	Game/Level Designer	Ranking	Units Sold
BioShock	Jean-Paul Lebreton	94.4%	2.9m*
F.E.A.R.: Perseus Mandate (FEAR)	Steve Gaynor	63.3%	n/a
LOST:Via Domus (Lost)	Alexandre Elsayad	58.7%	0.7m*
Medal of Honor 2: Heroes (MOH)	Dan Taylor	71.1%	1.56m

The data collection process consisted of preparation, open ended interview, analysis, and verification. Before the interview session, the researcher obtained and played the first few hours of each game. During play, the researcher took notes, which included actions taken, goals listed sequentially, and screenshots of important moments. These notes were sent to designers and served as a reference during a 1-hour interview focused on: 1) What elements are used to guide/push/pull the player's movement through the level? 2) What are the intended player experiences, reactions, or effects from these elements?

We found that each designer discussed this problem differently. All designers discussed story moments and sticking to the critical path, yet from here, their discussions focused on the art direction and visual design, mechanics, environmental affordance, and battle moments. Relevant views are included below.

Following the interview, the researcher devised specific level design patterns based on analysis of designers' interview data. Specifically, the researcher extracted examples addressed in the interviews and searched the other games to find similar segments under the same constraints. These segments were then assembled and abstracted to formulate a pattern. The researcher then video coded continuous play sessions for each game, where codes represented an activation of a certain pattern. Designers were then given links to these video coded segments. They were asked two questions in order to face validate the patterns: 1) whether the patterns are an accurate depiction of how they designed the level and 2) whether these patterns represented moment-to-moment and goal-oriented movement for each game.

4. PROPOSED PATTERNS

The five patterns derived are: Collect, Path Target, Pursue AI, Path Movement, and Player Vulnerability. In our analysis, the first four patterns are associated with a primary goal and the last, player vulnerability, is a sub-goal. For example, in a combat encounter the goal is to pursue an enemy AI and the sub-goal is to take cover. If the player does not take cover or seek protection, the player dies and respawns to a safe location where Pursue AI is the primary goal again. Most of these design patterns can occur in conjunction with a goal or with no goal.

4.1 Collection Pattern

Definition: incentivizes and rewards items placed around the level, e.g., health, money, ammunition, and special items.

Design Goal Example: In *Lost* (Ubisoft 2008), the player must collect food and water to trade for important items.

Non-Goal Example: In *BioShock* (2kMarin 2007), the player can collect audio diaries left behind by residents to understand the story behind the game.

4.2 Path Target (PT) Pattern

Definition: orients and directs player movement or attention towards visible targets in the level. This behavior reinforces vertical or horizontal scanning of an area to apprehend a target. This could be a visible landmark to attract movement or a means to orient in the direction of important entities using a targeting device, for instance a camera or weapon.

Design Goal Example: *MOH* (Electronic Arts 2007) used a weapon targeting device in a combat situation to lead the player forward.

Non-Goal Example: In *BioShock* and *MOH*, the player moves around landmarks or built structures in the environment to signify, cue, and otherwise attract movement. Visible points along a path are used in a similar way as wayfinding signage.

4.3 Pursue AI (PAI) Pattern

Definition: incentive to move around the level in response to friendly or hostile characters. In a combat situation, movement tactics are used to neutralize enemy AI threats to safety/health. In a friendly situation, the player may need to follow or talk to specific characters.

Design Goal Example: Combat situation in *FEAR* (Sierra 2007) requires players to kill the boss who is obstructing the Path Movement. In *BioShock*, some enemies provoke the player into a chasing behavior. Players can also follow friendly characters to a new location, or stay next to strong characters for protection such as in LOST or Medal of Honor.

Non-Goal Example: Games frequently have friendly or hostile non-player characters placed throughout the level. In *Lost p*layers may enjoy seeking other characters to socialize with, while in *BioShock*, players may be challenged to neutralize more enemies than necessary to advance through the game.

4.4 Path Movement and Resistance Pattern (PM or PM-R)

Definition: A Path Movement goal is usually present in action-adventure games but they are not a challenge without resistance. Path Movement is the general narrative goal for the player to continue through a linear mission/quest. Path Movement can be with or without resistance or explicit environmental barriers. For example, path resistance could be a barrier such as a locked door or a forced detour, and can be used in conjunction with a different pattern. A Path Movement goal typically has a layered goal contingency with another pattern. For example, in adventure games, collection of an important artifact, such as a key, acts as a barrier to the Path Movement goal. Lastly, the mission at any moment is always present though this can be short or long in duration which can also be visual, e.g., a lighthouse or a specific destination seen from a distance.

Design Goal Example: In *MOH* "Breach the Bunker" is a short term goal where the bunker is immediately visible in the distance at the moment the goal is presented to players. Conversely in *FEAR*, "Go to the Data Center" is abstract because the center is not actually reached until the second or third level. Instead, the player must progress through a series of corridors, underground sewers, and streets while encountering enemies (Pursue AI) as resistance to movement along this path.

Non-Goal Example: Exploration for secondary artifacts in secondary areas may increase the replayability for a game through achievements, rare artifacts to collect or other rewards but does not contribute to advancement through the game.

4.5 Player is Vulnerable (PV) Pattern

Definition: The player is vulnerable if they can "die" which represents a danger to the player's safety. If players are able to die, their sub-goal is to remain alive. Players still must fulfill their mission goal, thus vulnerability acts as another form of resistance. It is important to note that the psychological illusion of vulnerability is different from actually being vulnerable as exemplified in *BioShock's* introduction chapter. When the player is vulnerable there is additional movement variety and challenge to enhance the combat encounter.

Design Goal Example: When the player dies, he/she can still replay an infinite amount of times after respawning. In games with combat encounters like *MOH* and *FEAR*, the player must actively use Cover and Target when pursuing AI in order to maintain health.

Non-Goal Example: Cover is a sub goal tied to combat encounters and the Pursue AI Pattern.

5. USE OF THE PATTERNS

Upon examination of the patterns applied to the games reviewed, we found many instances where two patterns are active simultaneously; for example Path Movement along with another pattern. In addition, these patterns also affect non-goal movement such as collection of special items for points.

To this end, visual analysis shows patterns tied and untied to a goals necessary to complete the level showing their occurrence, context and frequency. In addition, the number of cut scenes, moments of rest, or slow pace can also be compared between cases.

Figures 1-5 show the visual model applied in detail. Figure 1 shows a 10-minute gameplay timeline of *BioShock's* explicit goals in the first episode tied to patterns. The figure's horizontal axis is time. Numbers 1-11 correspond to the patterns tied to goals. *BioShock* begins with a plane crash cut-scene where the first Path Movement goal is to navigate to the tower structure in order to descend further into the underwater world. Once there, one must Collect the radio, wrench, genetic tonic, and pistol (numbers 2, 3,5, and 6), while encountering resistance to Path Movement in the form of locked gates and detours (numbers 4,7,8, and 10). Towards the end of the level one must neutralize a group of enemies in order to advance to the next level (number 9). *BioShock* also presents an illusion of non-linear gameplay by changing the Path Movement destination on numerous occasions. Figure 1 shows seven segments of the Path Movement pattern interrupted by seven cut scenes. The player first descends into Rapture (number 1), and as time progresses is instructed to "get to higher ground", then "go to Neptune's Bounty", and at the last moment, is rushed to the Medical Pavilion instead. Figure 2 shows the gameplay for *BioShock* for non-goal patterns such as Collection of extra loot and Pursue AI enemies while the player is Vulnerable.

This kind of visualization tool shows differences in pattern occurrence and frequency. Due to space limitations, we only present and compare goal-based patterns shown in figures 3-5. Figure 5 shows a play session of *MOH*, where the player has three Path Movement goal segments to *Breach the Sea Wall* by first going to a Bunker, then *clearing it out* with a grenade, followed by *destroying a German U-Boat*, all while encountering three enemy AI resistance segments. Figure 3 shows a play session of *FEAR*, where the player has an abstract Path Movement goal to go to a *Data Center* while encountering seven shorter enemy AI segments that act as the primary barrier along this path. *MOH* and *FEAR* both rely on the Pursue Enemy AI pattern and player vulnerability to allow combat variety. Conversely, *BioShock* and *Lost*, figures 1 and 4, apply three and four patterns tied to goals respectively, while first person shooter games *MOH* and *FEAR*, predominantly rely on two (Path Movement and Pursue Enemy AI). In *BioShock* and *Lost*, the player is not Vulnerable upon arrival and instead Collects or uses a camera to *Target* important artifacts tied to goals. In *BioShock* Collection is further emphasized by narrative logs placed throughout the level which adds depth. In addition, the six cut scenes in *BioShock* and fourteen in *Lost* allow for story foreshadowing as well as memory recalls that are important in subsequent levels.

6. VALIDATION AND REALIABILITY

All designers were asked to give researchers their feedback on the patterns. They all agreed these patterns are "certainly valid and can be seen in most games", "seem quite reasonable", "graspable", "especially to see the variance between titles." One designer reiterated that the patterns can be used explicitly when tied to objectives and implicitly in order to subtlety nudge the player towards points of interest.

While this establishes face validity for the model, it does not give us a measure of reliability in its use as a video coding device. In order to accomplish this we first transcribed the YouTube annotations into Nvivo8 software which has tools for visual content and statistical analysis. We asked two researchers to code approximately 20 minutes of continuous gameplay in *Assassin's*

Creed (Ubisoft 2007) which contained the tutorial session and the first story episode. This game was selected because all raters had played this game previously. The raters were verbally introduced to the study and then shown the same YouTube videos presented to designers. They were also briefly shown one coded video as a training example. They were then asked to code the *Assassins Creed* game. Both instruction and coding process took approximately one hour to complete. Results were imported into Nvivo8. We used the kappa coefficient as a statistical measure of inter rater reliability.

Our analysis shows fair, moderate and substantial agreement in 9 out of 12 occurrences of 4 out of 5 patterns. Only four out of five patterns were coded since the Collection pattern did not occur within this video segment. Fair agreement occurred for PT-Goal (kappa .363). Moderate agreement occurred for PM-Goal (kappa .4895), PM-R Goal (kappa .5365), PV (kappa .525), and PAI (kappa .514). Substantial agreement occurred for, PAI Goal (kappa .699) and PV Goal (kappa .664). This establishes reliability for the use of this method. For future research, we intend to follow up this study to validate this model with several other games and input from other designers.

7. CONCLUSION

In this paper, we discussed two contributions: the level design patterns and a method to visualize them. One important property of each pattern is that it is tied to a discreet goal seeking behavior. Whether or not this behavior is tied to a design or mission objective necessary to advance through the level is a design decision. Game designers determine when a pattern is contingent upon a goal in certain moments, places, or under specific conditions. In addition, mission objectives often require multiple patterns to be activated simultaneously in order to advance which creates layered goal contingencies. We face validated these patterns and also confirmed their reliability for use as a video coding method through performing an inter-rater agreement. The authors believe the patterns can assist in the creation and evaluation process of level design.

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10. REFERENCES

ADAMS, E. 2009. *Fundamentals of Game Design*. Second Edition. Berkeley, CA: New Riders.

E.S.A. 2009. *Essential Facts about the Computer and Video Game Industry*. Entertainment Software Association. http://www.theesa.com/facts/index.asp.

BYRNE, E. 2005. *Game Level Design*. 1st ed. Hingham, MA: Charles River Media.

FIEL J, and SCATTERGOOD, M. 2005. *Beginning Game Level Design*. Boston: Thomson Course Technology.

MCGREGOR, G. 2007. Situations of Play: Patterns of Spatial Use in Videogames. In . Tokyo.

NITSCHE, M. 2009. *Video Game Spaces: Image, Play, and Structure in 3D Worlds*. Cambridge: MIT Press.

ROGERS, S. 2009. Everything I Learned About Level Design I Learned from Disneyland presented at the Game Developers Conference - Game Design Track, San Francisco, CA.

SMITH, R. 2009. Helping Your Players Feel Smart: Puzzles as User Interface presented at the Game Developers Conference - Game Design Track, San Francisco, CA.

Figure 1: *BioShock* patterns tied to goals. Numbers 1-11 correspond to patterns tied to goals necessary to advance: 1. Path Movement: Enter Rapture through tower, 2. Collect Radio, 3. Collect Wrench, 4, 7, 8, 10. Path Movement Barriers, 5. Collect Genetic Tonic and collect refill, 6. Collect Revolver, 9. Pursue AI (Enemy), 11. Path Movement to next level

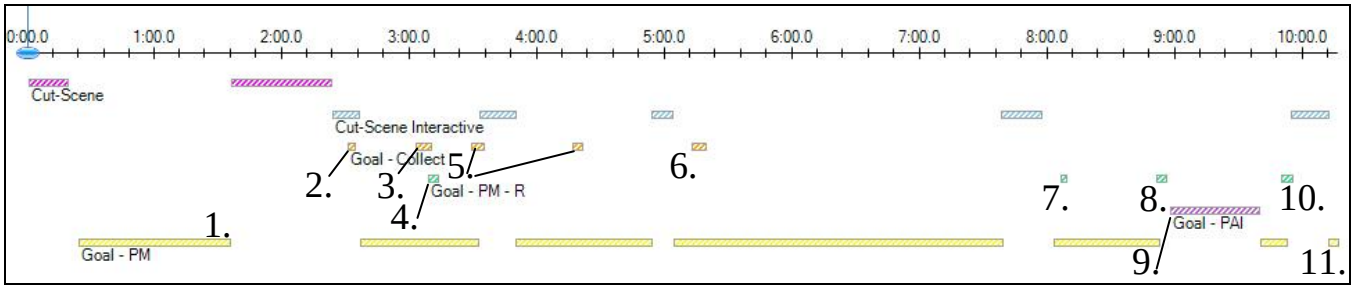

Figure 2: *BioShock* patterns not tied to goals necessary to advance through the level (same 10 minutes of gameplay).

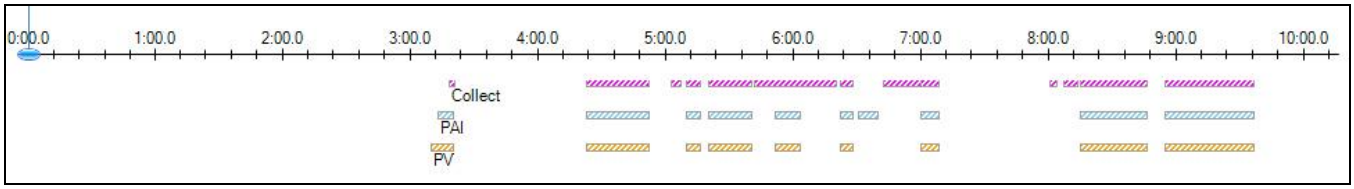

Figure 3: F.E.A.R: Perseus Mandate patterns

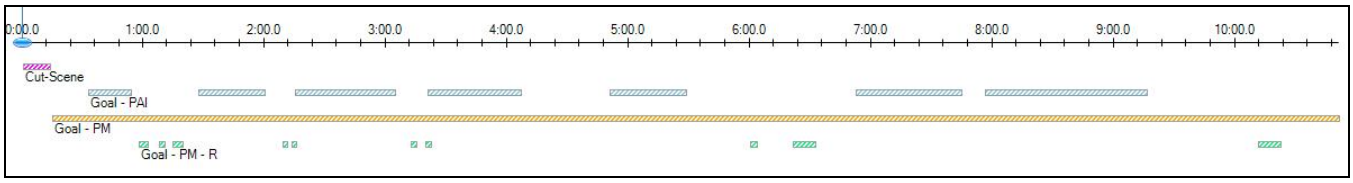

Figure 4: Lost: Via Domus patterns

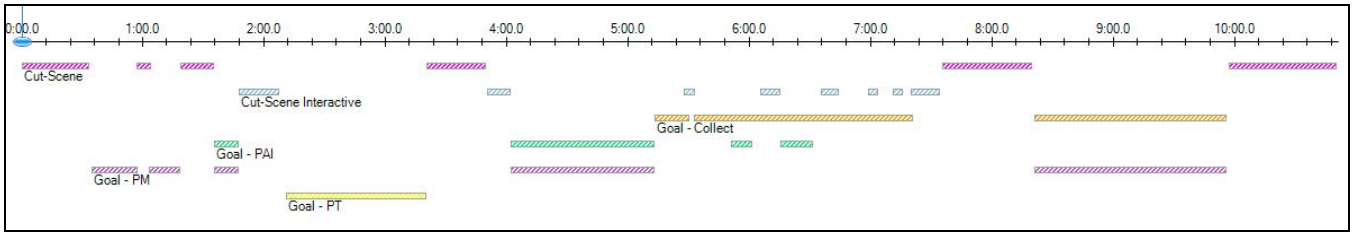

Figure 5: Medal of Honor 2: Heroes patters