Analysis of Level Design 'Push & Pull' within 21 games

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ABSTRACT
This paper investigates the differences between 3D level designs in 21 popular games. We have developed a framework to analyze 3D level designs based on patterns extracted from level designers and game play sessions. We then use these patterns to analyze several game play sessions. Results of this analysis reveal methods by which designers push and pull players through levels. We discuss an analysis of these patterns in terms of three level affordance configurations, combat, environmental resistance, and mixed goals in 21 different games using one walkthrough play session per game. By looking at the variety of games, we can further explore the level similarities and differences between games.

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

General Terms
Design, Measurement

Keywords
Design Pattern, Player Movement, 3D Games

1. INTRODUCTION
Although 68% of American households play video games [1], metacritic.com reviews indicate that less than 10% of games published are rated above 85%. In addition, 10% of games produced generate 90% of the revenue [2]. One way to look at this problem is to focus on the environmental construction and the unfolding mission that the player plays through. One important function of level design is to guide, push, and pull player movement which is a practice that combines art, engineering, and craft [3]. 3D level design is an important yet elusive aspect of 3D game development. This paper analyzes 21 level designs through five patterns validated by game designers in our previous paper [4]. By levels, we aim to distill design lessons that can aid in enhancing future level designs. In addition, our findings benefit those outside the field of level design such as producers, market researchers, or developers in related game communities such as Serious Games.

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2. PREVIOUS WORK
Level design guidebooks, scholars and industry talks discuss some models to analyze game design. Notable guidebooks, e.g., [5-7], explain playful experiences in relationship to spatial configurations in 3D levels. Byrne [5] and Nitsche [8] refer to these configurations as linear/railed, branching/maze, and arena/open. 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 consisting of multiple railed pathways 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 coliseum fight or a performance. This is an excellent start to decompose the topic of level design, however evaluation approaches are missing. In addition these works do not compare different games in terms of their methods to push or pull the player. In our approach, we look at moment to moment motivators that designers use to push and pull movement rather than constraints of the space. In this paper, we attempt to use similar patterns to deconstruct and analyze the differences between level configurations.

Industry talks on level design at conferences, such as the Game Developer Conference, concentrate on lessons learned to build a successful level. For example, Rogers [9] and Upton [10] discussed the similarities between the process of designing a level and that of designing a theme park attraction. They explain various techniques to encourage and anticipate movement in space using visual attractors to elicit effects on the player including tension, rhythm, triumph, and wonder. Although they both demonstrate good level design through several examples, they offer no formal approach to guide or visualize the level construction and they do not compare their methods to others or show some successful vs. a non-successful level design examples.

In addition, Smith [11] presented design principles to keep players on the path to discovery and devised several principles that make players feel smart. He used *Portal* (Valve 2007) to illustrate successful and failed attempts that challenge level advancement. These principles are: visibility, affordance, consistent visual language, feedback, and mapping - physical or conceptual connections and conceptual models. Combined, these principles can assist designers troubleshoot breakdowns in a player's advancement 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. In addition, these principles are explained in relation to environmental puzzle games which exhibit only one play style or genre of many successful titles.

Models to evaluate games have also received attention, including Leblanc et al.'s MDA (Mechanics Dynamics Aesthetics) model [12] and Church's Formal Abstract Design Tools (FADT) [13] which includes design patterns such as intention, consequence and story. Bjork et al.'s work on game design patterns [14] includes several hundred patterns defined through game world & objects, actions & events, and structures of goals and narrative. Although these authors propose insightful views in the level design process, they offer no way to analyze or visualize the patterns in moment to moment gameplay.

3. PROCEDURE

3.1 Patterns and their use

In our previous work, we identified five patterns: path movement, pursue AI, path target, collection, and player vulnerability [4]. We validated these patterns through expert review with 4 game designers as well as inter-rater agreement to verify its reliability in analyzing play sessions. In this section, we will summarize these patterns and discuss results of using them to analyze the 21 game play sessions.

3.1.1 Path Movement and Resistance (PM) Pattern

Path Movement is the general narrative goal or purpose for the player to continue through a mission/quest. A path movement goal (G-PM) usually comes with a challenge to resist movement. For example, path environmental resistance could be a barrier such as a locked door or a forced detour. Path Movement can also be used in parallel with a different pattern, for example in FPS games where the Pursue AI goal also acts as a barrier to the Path Movement goal. In this case, both patterns (G-PM + G-PAI) are tied to a goal. In adventure games, collection of an important artifact, such as a key, acts as a barrier to the Path Movement goal (G-PM + G-Col). Lastly, the purpose or mission of any moment is always present though this can be short or long term in duration. Short term goals can be seen visually in the level like a lighthouse or the goal can be an abstract destination some distance away.

3.1.2 Pursue AI (PAI) Pattern

The pursue AI pattern incentivizes movement 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.

3.1.3 Path Target (PT) Pattern

Path targeting orients and directs player movement or attention towards visible entity 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. Movement can be controlled by where the player can point and aim onto entities.

3.1.4 Collection (Col) Pattern

Definition: incentivizes and rewards movement around the level to collect health, money, ammunition, special items, intelligence, and to regain memory.

3.1.5 Player is Vulnerable (PV) Pattern

Definition: The player is vulnerable if they can "die" which represents a danger to the player's safety. If or when the player is able to die, their sub-goal is to remain alive otherwise they will re-spawn at a previous checkpoint location. Players still must fulfill their mission goal so vulnerability acts as another form of resistance. Players must take cover or seek protection to preserve health by moving to safe areas. Combat encounters only occur if the player is vulnerable. When the player is vulnerable there is additional movement variety and challenge to enhance the combat encounter. It is important to note that the psychological illusion of vulnerability is different from actually being vulnerable as exemplified in many level introductions. For example, the level atmosphere can foreshadow danger ahead, such as the player entering *BioShock's* Rapture, or create the appearance danger in *Tomb Raider Underworld's* inferno disguised as a tutorial.

3.2 Patterns in Games

One important property of each pattern is that each occurrence is tied to a discreet goal seeking behavior except for player vulnerability which is a sub-goal. Game or level designers decide when to make patterns explicitly tied to a goal necessary to advance through the level. In total there are 10 permutations of patterns: (4 goal-tied, 4 non-goal-tied, 1 sub-goal, and 1 cut-scene).

Patterns also operate in parallel with each other. For example, the player may need to collect ammunition and health points placed in the level which helps them accomplish an explicit pursue enemy AI goal. In this instance, collection is not a primary goal, the player can choose to explore around the level to collect, possibly for achievement, although this does not change the active pursue AI goal. For example, in *BioShock* the player can collect audio diaries to learn more about the story although this information is disconnected from the current goal.

In addition, these five patterns can be used to explain level challenges such as environmental resistance (ER) and combat encounters. ER merges path movement with resistance challenge while combat includes four or more additional patterns simultaneously. For example, in a combat encounter the goal is to pursue and kill an enemy AI (G-PAI), collect health and ammunition resources (Col), follow friendly AI (PAI), use a targeting weapon (PT), while the sub-goal is to take cover (PV). If the player does not take cover or seek protection, the player dies and respawns to a safe location where pursue AI is again the primary goal. The non-goal patterns collect, path target, and pursue AI (Col, PT PAI) enhance the combat movement variety and player choice what to interact with and where to explore.

Figure 1 shows a pattern key used to analyze each game as a series of patterns activated by the player. Notating patterns in this way highlights both actions taken by the player walkthrough as well as identifies the critical path as specified by designers. The advantage of a sequence view is to unify variable lengths of patterns into discreet steps along a critical path. The sequence view also allows a comparison of pattern usage between games for example in terms of pacing.

The key shows goal patterns outlined in a solid black line and non-goals outlined in a dotted line. Each block can be filled by the patterns. To explain the key we use *BioShock* as an example which shows a 10-minute gameplay timeline outlining 11 goals tied to patterns to complete the first episode. The figure's horizontal axis is a series of 25 units where patterns become active at a specific place in the level. Numbers 1-11 correspond to the goals which begin with a plane crash cut-scene where the first path movement goal is to 1, 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 refill, and pistol (numbers 2, 3, 5, 6, and 7), while encountering resistance to path movement in the form of locked gates and detours (numbers 4, 8, 9, and 11). Empty blocks indicate areas the player needs to move through in order to accomplish the PM goal. Towards the end of the level one must neutralize a group of enemies in order to advance to the next level (number 12).

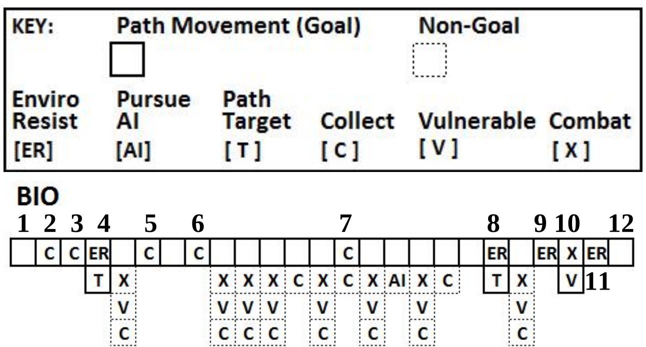

Figure 1: Pattern Key applied to *BioShock* sequential analysis

4. METHODOLOGY

In this paper, we aim to explore level design differences between games. Table 1 shows the games analyzed which has reached a total audience of over 90 million. We use metacritic scores (www.metacritic.com) rather than game reviews discussed by Zagal et al. [15], because the scores are weighted averages from over 50 critics. In addition, we include global sales counts from www.vgchartz.com.

In analyzing the play sessions, we used the first ten minutes of gameplay in each game. These play sessions were typically recorded video obtained through the authors own recorded play sessions and later from YouTube *walkthroughs*. Before annotating, we filtered the gameplay videos by removing cut-scenes, interactive cut-scenes, any mini-games, interactive dialogs, or menu option segments. Depending on the game genre, 10 minutes of actual gameplay may occur over 20 minutes of play. Videos are then imported into Nvivo8 software which has tools for visual content and statistical analysis. Using this tool, we annotated all instances of the 10 pattern permutations as discussed above. Overall this represents over 3.5 hours of game play videos with 1053 unique pattern annotations. This 3.5 hour period includes 211 filtered scene placeholders each lasting a few seconds.

Table 1: 20 games analyzed sorted by sales

Game Title	Short name	Sales (mil)	Console	Meta-critic
Halo 3		10.73	Xbox360	94
Call of Duty: Modern Warfare 2	COD2	9.05	Xbox360	94
Super Mario Galaxy	Mario	8.46	Wii	97
Call of Duty 4	COD4	8.13	Xbox360	94
Grand Theft Auto IV	GTA	7.59	Xbox360	98
Call of Duty	COD	6.15	Xbox360	84
Gears of War	GOW	6.02	Xbox360	94
Gears of War 2	GOW2	5.51	Xbox360	93
The Legend of Zelda: Twilight Princess	Zelda	5.45	Wii	95
Metal Gear Solid 4	MGS4	4.49	PS3	94
Assassins Creed	AC	4.75	Xbox360	81
Half Life 2	HL2	4.13	PC	96
Fable 2		3.38	Xbox360	89
BioShock		2.42	Xbox360	96
Mass Effect	MassE	2.13	Xbox360	91
Metroid Prime 3	MP3	1.55	Wii	90
Prototype	Proto	1.07	Xbox360	78
Tomb Raider Underworld	TOMB	.97	Xbox360	76
Lost: Via Domus	Lost	.51	Xbox360	55
Medal of Honor 2, Heroes	MOH	.33	Xbox360	73
F.E.A.R.: Perseus Mandate	Fear	.06	Xbox360	66

5. RESULTS

Rather than discuss our results in terms of genres such as shooter, action, adventure, platform, and role-playing, we discuss our findings in terms of three, non-mutually exclusive, level affordance configurations. This motivation to push and pull movement extends from Gibson's theory of affordance [16] which defines the environment in terms of its function: what it offers, furnishes, or provides, either for good or evil. Analyzing levels in terms of configurations is beneficial because games often combine genres to appeal to larger audiences. Therefore, we discuss our results in terms of three level affordance configurations derived from patterns: *Combat Core* & *Variety*, *Environmental Resistance*, and *Mixed Goal* without vulnerability. Each configuration varies the duration (% coverage) and pacing of patterns over the entire game play segment. Figure 2 plots the mean duration for each configuration.

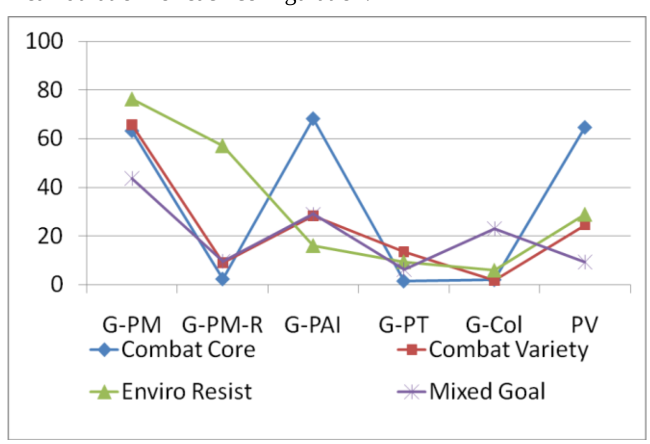

Figure 2: Mean coverage of patterns in each level affordance configuration

Figure 2 shows the combat core configuration relies on the pursuit of enemy AI (G-PAI) pattern while the player is vulnerable (PV). Environmental resistance has the lowest amount of pursue AI and the highest duration of resistance in the form of walls and obstacles separating player's from their destination. And finally, mixed goal configurations create unique combinations of patterns with the highest amount of collection (G-Col) and low amounts of vulnerability, combat and environmental resistance patterns.

5.1 Combat

Combat gameplay relies on the pursuit of enemy AI pattern while the player is vulnerable. Battle encounters catch players' attention and pull them to shoot or attack the enemy AI. In addition, combat resists the forward path movement. Eleven games belong in this category, including seven combat core games; *Halo3, COD, GOW, MassE, Proto*, and *MOH*. These games are unique in that the player is thrown into battle almost instantaneously, and they have the highest duration of combat play while vulnerable. However, four additional combat games introduce pattern variety that defers and foreshadows combat including *COD2 & 4, GOW2*, and *BioShock.* Instead, these games begin with a tutorial or rehearsal exercise to familiarize the player with the mission, back-story tools, and ally NPC's.

In table 2, data from combat have a lower number of cut scenes, lower number of pattern types, and higher percentage of vulnerability compared to combat variety. Conversely, combat variety games activate collection and targeting patterns through tutorial exercises and friendly AI encounters before combat begins. Although *MassE* has a high number of cut-scenes and low duration of vulnerability, the 12 combat encounters are always tied to goals.

As mentioned previously, combat is comprised of several patterns that occur in parallel. Figure 3 shows combat encounters for these seven games where four or more patterns are active simultaneously, including path movement (G-PM), pursue AI (G-PAI and PAI), path target (G-PT), player is vulnerable (PV), and collection (Col). Figure 3 shows the percentage of combat core coverage is approximately half the total game play duration or greater. The challenge for players here is to move through the level from one combat encounter to another without dying.

Table 2: Combat Core and Combat Variety games

Game	#Pattern Types	Total # Pattern	# CUT	#Goal Combat Encounters	% VUL
Combat Core					
Fear	7	44	1	7	44
MOH	7	27	2	4	83
Halo3	7	59	3	9	66
MassE	7	75	16	12	46
COD	7	24	1	4	72
GOW	7	29	4	4	74
Proto	6	36	6	5	67
Combat Variety					
COD4	10	61	13	4	41
BIO	9	60	7	1	27
COD2	9	40	9	3	39
GOW2	9	33	6	1	12

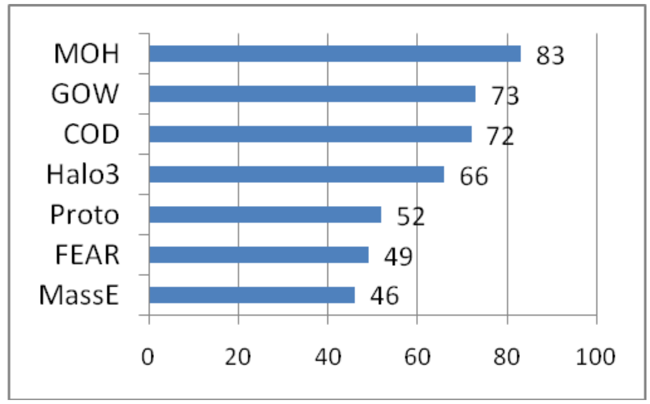

Figure 3: Percentage coverage of the total play duration for four or more patterns active during combat

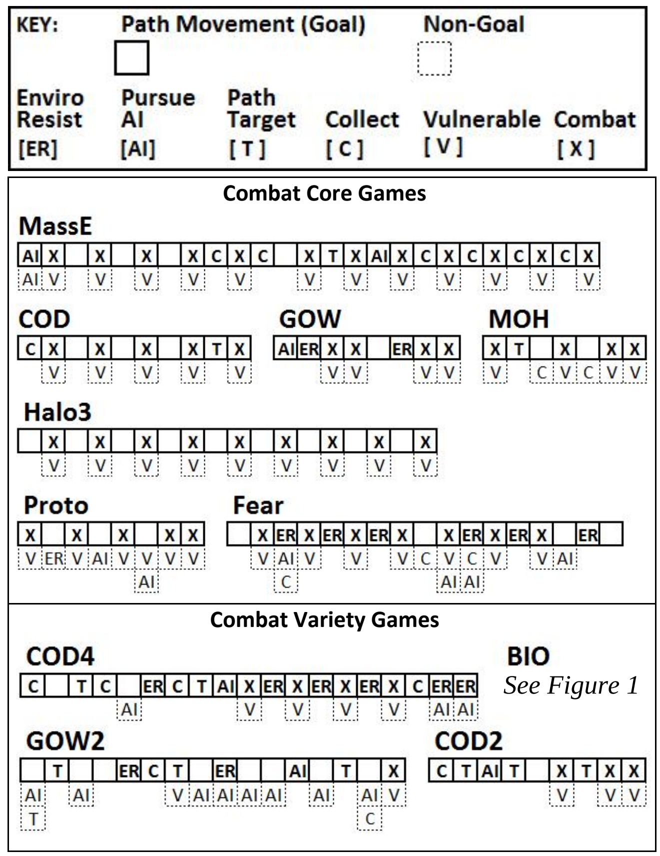

Figure 4: sequential analysis of combat core and variety games

The pacing for combat games is shown in figure 3's pattern sequence. The trend for combat core games is a repetition of G-PM and combat, with intermittent use of pursue-AI (allies), and rare use of additional patterns. In *MassE* this repetition is 25 blocks long while only 7 blocks in *MOH*. *MOH* has four long battle sequences with numerous enemy AI lasting several minutes while *MassE's* are all short, last less than one minute with just one or two enemies, each separated by cut scenes. *MOH, GOW*, and *COD* are virtually identical in their sequence of patterns used. Where battles are fast paced and involve complex movement, the moments between battles are slow in pace. The moments of rest depend on the number of battle encounters and cut scenes. Lastly, there are very few instances where patterns are not tied to combat. Although *GOW*, *Proto* and *Fear* contain environmental resistance (ER) pattern occurrences, the duration is only a few seconds if tied to a goal or are non-goal activities such as climbing a building.

Combat variety games in table 2 and figure 4 shows more patterns, and pattern types, tied to goals and non-goals. This includes collect (G-Col and Col), target (G-PT and PT) and (G-PAI and PAI) outside of battle encounters. Because the player is vulnerable less, goal patterns are less repetitive than combat and occur in series together. For example, collection, target, and pursue friendly AI patterns occur in sequence for *COD4, COD2, GOW2.*

The mean distribution, which is comprised from the percent duration of patterns over the play session, in combat core and combat variety games is shown in table 3. From this we observe less combat variety on pursue AI and player vulnerability patterns (G-PAI 24% vs. 68% and PV 25% vs. 63% respectively).

Table 3: Mean (percentage coverage of patterns over the total play duration) comparison between combat games

	Combat Core			Combat Variety		
	Mean	Lower	Upper	Mean	Lower	Upper
GPM	63.1	37.1	89.2	66.0	57.3	74.7
ER	2.4	0.0	5.5	7.8	0.0	17.3
GPAI	68.1	55.7	80.6	24.0	2.7	45.3
GPT	1.6	0.0	3.6	11.0	2.6	19.4
GCOL	2.1	0.0	6.3	2.2	0.0	5.0
PV	64.6	51.2	78.0	25.0	5.5	44.5
PT	53.7	26.2	81.2	25.4	0.0	57.8
PAI	23.3	0.0	48.0	30.2	0.9	59.5
COL	47.3	14.0	80.6	18.2	0.0	37.0

Comparing the pacing between *BioShock* and *FEAR* exemplifies differences between combat core and combat variety level configurations. From figure 1 pattern sequence, *BioShock's* pace is slow, with only one or two patterns active, while *FEAR* has four or five active during combat. In addition, only one of *BioShock's* battle encounters explicitly prevents movement through the level which allows additional choice for players to control the pace such as collect items, explore with no vulnerability, or increase the pace by engaging in combat. *FEAR*, however, pulls the player from one fast paced battle encounter to the next a total of seven times. During moments of rest, the player replenishes combat resources which can be seen visually in *FEAR*'s symmetrical pattern sequence. In *BioShock*, the sequence is irregular, tailored to the mission design, and level architecture.

5.2 Environment Resistance

Path movement with resistance such as obstacles or vulnerability tied to the environment characterizes this level configuration. Figure 5 shows five games that belong in this category, *MP3*, *HL2*, *TOMB*, *MGS4* and *GTA*, because more than half of the total duration of play challenges the path movement goal. Conversely, the ER pattern is not characteristic of mixed goal or combat (table 3) configurations.

Data from these games are tabulated in table 4. From this we observe that although the number of ER pattern occurrences is a fraction of the total number of patterns, they are active for a majority of the gameplay. For example in figure 6, *MP3* shows a high number of discreet target patterns activated every few seconds of play. Each room can be quickly unlocked by targeting the doorway or scanning objects often followed by a cut scene. Conversely, in *TOMB*, each climbing segment is over a minute in duration.

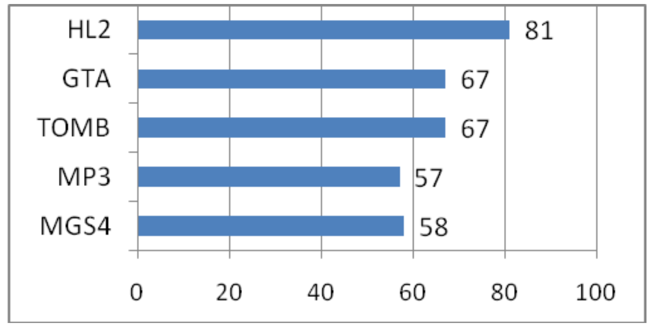

Figure 5: Percentage coverage of the total play duration for the ER pattern

Table 4: Analysis of environment resistance games

Game	Total # Pattern	# ER Occurrence	# CUT
MP3	90	24	19
HL2	39	9	2
MGS4	51	10	9
GTAIV	44	9	9
TOMB	32	7	6

Table 5: Mean (percentage coverage of patterns over the total play duration) comparison between Environment Resistance and Mixed Goal games

	Enviro Resist			Mixed Goal		
	Mean	Lower	Upper	Mean	Lower	Upper
GPM	80.0	65.2	94.8	43.6	3.8	83.4
ER	65.2	57	81	9.6	0.0	21.9
GPAI	16	3.9	25.7	29.0	10.9	47.1
GPT	9.8	0.0	35.0	6.2	1.1	11.3
GCOL	7.0	2.4	11.6	23.0	6.5	39.5
PV	33.4	0.0	79.2	9.2	0.0	26.8
PT	4.0	0.0	10.3	11.0	0.0	39.5
PAI	14.6	0.0	55.1	21.6	0.0	45.7
COL	6.0	0.0	14.2	12.8	0.0	44.3

The mean distribution of patterns, which is comprised from the percent duration of each pattern over the entire play session, in environment resistance games is shown in table 5. From this, several characteristics of the environment resistance configuration can be identified such as the high percentage of path movement (G-PM) and resistance (ER) patterns, and low percentage of pursue AI (G-PAI) patterns, 80%, 65.2%, and 16% respectively. This contrasts to the same patterns in combat games with a combined average of 64.5%, 10.2, and 46% respectively and in mixed goal games 43.6%, 9.6%, and 29% respectively. In other words, there is an inverse relationship for environment resistance and pursue AI patterns between environmental and combat level configurations. One explanation is that environmental challenges replace or substitute the coverage from the G-PAI pattern so as to not overwhelm the player.

Another way to differentiate environmental resistance games is through the sequential analysis in figure 6. From this we observe a high pacing variation in the number of units, general repetition of ER patterns, and that the ER patterns are sometimes tied to additional patterns. The longest sequence is *MP3's* 32 units which require the player to frequently target and scan discreet obstacles, while *HL2's* 8 units are long durations of exploring through the security zone. Like combat core encounters, there is a repetition of ER patterns in relationship to another pattern. For example in *Tomb*, the collection reward and path movement alternate between environmental challenges. In *GTA* resistance and vulnerability occur while driving in order to meet important people in specific places (G-PAI).

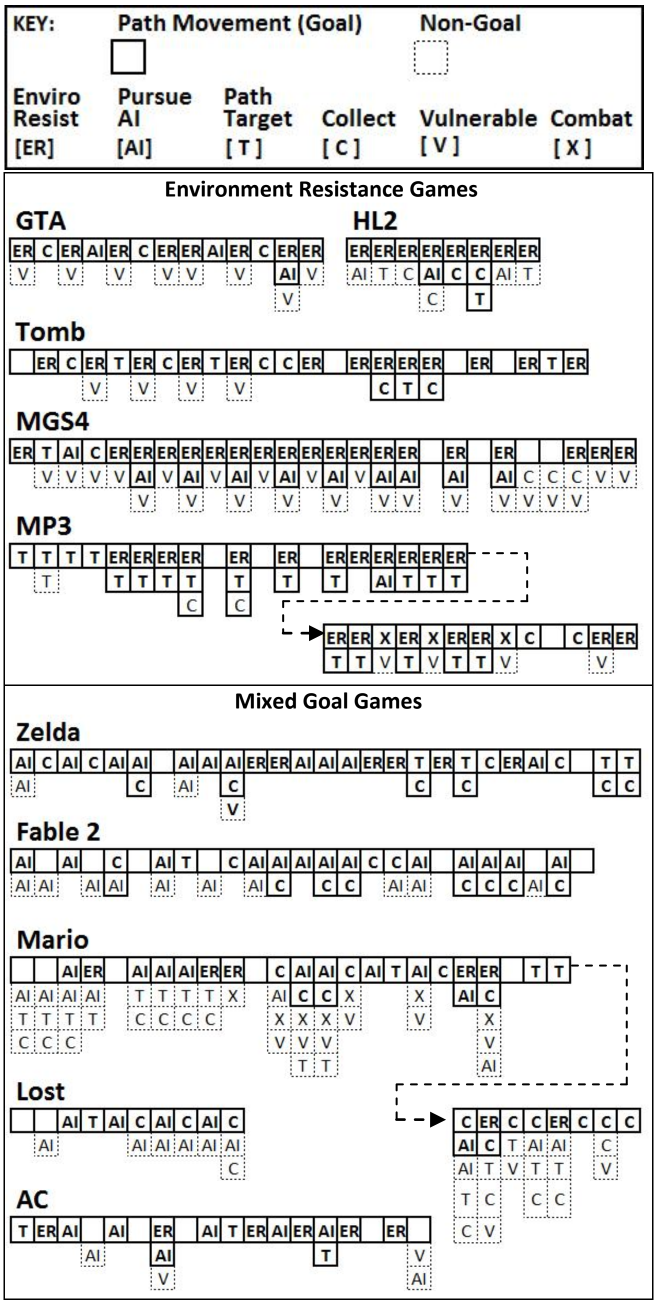

Figure 6: sequential analysis of environmental resistance and mixed goal games

In all five environmental resistance games there are additional instances where the goal overlaps with another pattern such a path targeting (G-PT), pursue AI (G-PAI) or collect (G-Col) goal. For example in *Tomb* the player must collect and carry a stone, then deposit it into the environmental puzzle in order to progress, in *HL2* the guard demands the player collect and deposit trash in order to pass through the gate, in *MGS4* the goal is to sneak around level obstacles while in close proximity to guards.

In addition, we found the challenge in environmental resistance configurations is varied by high vulnerability such as stealth behavior or low vulnerability such as discreet obstacles or barriers blocking movement. In regard to stealth behavior, *MGS4* and *GTA* exemplify continuous resistance where maneuvering through the level is tied to vulnerability. In *MGS4* the player cautiously moves through the hostile environment (G-PM and ER patterns) to avoid detection by enemies primarily by crawling through ducts, crouching around corners, and sneaking around enemies (G-PAI). Similarly, in GTA, the player is deterred from reckless driving or they must change their goal to escape police to avoid being captured. In each mission, the players use their vehicle (G-Col) to reach specific destinations, yet there is more risk when traffic laws are not followed.

MP3, TOMB, and *HL2's* environmental challenges are not tied to vulnerability and instead the level geometry constrains advancement through discreet obstacles. In these cases, resistance functions like a puzzle or maze. In *MP3*, the player must target dozens of doors (G-PT) and scan entities along the path in order to advance while *TOMB* alternates path movement (G-PM) with jumping, targeting, and climbing challenges for collection rewards. In *HL2*, the player is trapped in a high security area and must pass through security check point, locked gates, and back alleys to find a safe passage. During this process friendly and enemy AI are nearby (G-PAI and PAI) that attract or deter movement and provide clues where the player should go next.

5.3 Mixed Goal -Low Vulnerability

The mixed goal play style includes pattern combinations while the player is not vulnerable or has low vulnerability. Mixed goal also has the highest mean average of goal collection as highlighted in table 5. Although mixed goals may utilize both combat and environmental resistance patterns, they rely on additional pattern combinations to pull player movement around the level. Five games belong to this category including *Mario, Zelda, AC, Fable2, and Lost.* Data from these games are also tabulated in table 5 where we observe a high amount of cut scenes and high and low amounts of vulnerability.

Table 6: mixed goal games analyzed and sorted by the number of pattern type

Game	#Pattern Annotations	#CUT	VUL (%)
Mario	83	19	34
AC	52	20	6
Fable 2	60	21	0
Zelda	71	24	6
Lost	32	14	0

In our attempt to graph the significance of percentage coverage of goal tied patterns, we did not find major differences from the other level configurations. Instead we observe a greater frequency of short segments of play due to the large number of cut scenes.

The sequential analysis in figure 6 shows the arrangement of patterns in terms of pacing and repetition. In *Fable2* and *Zelda*, the player is in a village and must talk with many town citizens in order to complete tasks in each place. In *Fable2* the player is always accompanied by the older sister (PAI) and the path movement goal is illuminated as a sting of lights at times. This is represented as a sequence of path movement goals (G-PM) tied to pursue AI (G-PAI). Similar to the previous level configurations, goal patterns overlap at the same time, for instance where the pursuit of friendly AI also leads to an important artifact exchanged. In *Fable2* and *Zelda*, this process is repeated several times where items are collected through discovery or exchanged by friendly AI.

Combat encounters only briefly occur in *AC* and *Mario.* In *AC*, the player goes through a tutorial that introduces targeting (G-PT), fighting (G-PAI), climbing (ER), and stealth (ER and PAI). In *Mario*, combat encounters are short in duration and juxtaposed with different patterns. For example a fight with an enemy followed by collection of multiple coins (G-Col) followed by targeting (G-PT and PT) friendly AI in order to jump to the next level. In addition, *Mario* uses different permutations of the patterns to slowly increase the challenge before combat. First, a path movement goal (G-PM) with non-goal patterns (Col, friendly PAI, and PT) is used as Mario approaches the Princess Castle. Then difficulty increases as Mario needs to chase rabbits (G-PAI) climb (ER), avoid falling into moving traps while collecting (G-Col + ER) in order to collect stars necessary to advance to the next planet. Several times every minute, a different set of patterns are active which leads to different behaviors necessary to advance to the next planet.

By contrast, *Lost* uses the patterns sparingly, only one or two at a time to minimize complexity. In *Lost*, the patterns are tied to numerous cut scenes and interactive dialogs with characters. This organization reinforces the patterns tied to goals to find passengers (G-PM) in the jungle, follow characters to find the plane wreckage (G-PAI), take pictures (G-PT), and collect supplies (G-Col). Although *Lost* relies on few patterns, 32 annotations compared to *Mario's* 83, they are always tied to goals.

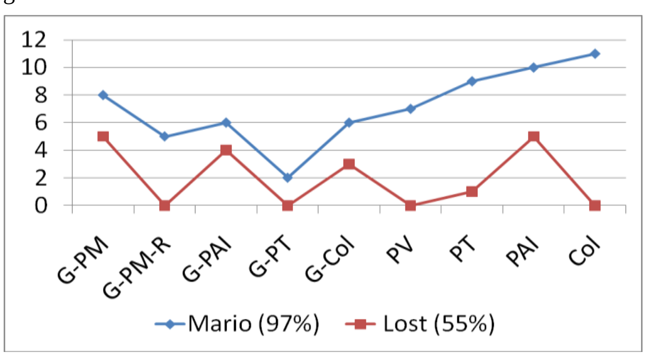

Figure 7: Comparison of pattern occurrence between Mario and Lost

In order to further differentiate between games, we identify the coverage and occurrence of patterns between *Lost* and *Mario* in figure 7. *Mario* has more occurrences of every goal and non-goal pattern which leads to greater game play variety and player choice. *Lost* however has a longer duration of pattern coverage dedicated to path movement (G-PM) to "find other survivors", targeting to "remember" past memories (G-PT), and collection (G-Col) exploration of the wreckage to enable trading which demonstrate a different emphasis to mix goals in support of the *Lost* story.

6. DISCUSSION AND IMPLICATIONS

By distinguishing between affordances in terms of combat, environmental resistance, and mixed goal without vulnerability, we analyze level design push and pull. Our evidence is based upon data collected through annotation, graphs, and sequential diagrams. Excluded from this analysis are cut scenes where we observe mixed goal games have four times the average number of than combat core, 20 compared to 5. The mixed goal play style truncates the play activity with a cut-scene every few seconds to one minute while in combat situations they are primarily used at the beginning and end of the mission. The placement and influence of cut scenes on gameplay should not be overlooked as this is one satisfying element in the overall gameplay experience. Although the cut-scene content is excluded from our analysis, their prevalence is important to motivate and reward movement through the level which should be mirrored by the level affordance configurations.

These results used patterns to discuss level design push and pull by looking at pattern differences in terms of relationships, coverage, occurrence, and repetition. This kind of analysis adds value to game design and the construction of levels and missions. The next step of this study will apply the patterns to evaluate the experience for a large group of participants, all playing the same sandbox level in Assassin's Creed 2 (Ubisoft 2009). By collecting demographic information along with video play sessions we hope to understand how different participants play when multiple goals are available. In addition we hope to collect what they find enjoyable or frustrating in relationship to play styles.

7. CONCLUSION

The contribution of this research presents a visual analysis of level design push and pull for 21 popular games. A framework comprised of patterns is used to annotate these games which identified unique level affordance configurations including combat, environmental resistance, and mixed goal with low vulnerability. The analysis includes several visual examples to compare the use of patterns between games in terms of coverage, occurrence, and repetition. The benefit of this research is for game design and game studies communities.

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