Spring 2024

Using Multi-staged Puzzles to Improve Backtracking in Level Design

Yufei Tian
Southern Methodist University, fayettian@gmail.com

Using Multi-staged Puzzles to Improve Backtracking in Level Design

Yufei Tian
SMU Guildhall, yufeit@smu.edu

Abstract
This study explores the potential best practices in using multi-staged puzzles, which involve backtracking, in video games. The researcher focused on enhancing the players' experiences by applying elements of the Flow Theory to an artifact level in *Dying Light 2*. Playtesters' feedback suggested that the best practices in multi-staged backtracking puzzles improve flow state entry and increase enjoyment.

Keywords
Level Design, Backtracking, Multi-staged Puzzle, Environmental Puzzle, Conveyance, Flow Theory, *Dying Light 2*.

1 INTRODUCTION

Backtracking is a commonly used tool in level design to maximize the use of available space and minimize development costs. However, it can also lead to repetitive gameplay that ultimately bores the player [1]. To solve this issue, the researcher explored the use of multi-staged backtracking puzzles and formed several best implementation and design practices. The researcher then tested those best practices in a customized *Dying Light 2* level called "Activate Metro Station." The researcher conducted playtests and gathered player feedback. The responses alluded to the effectiveness or ineffectiveness of the multi-staged puzzle and backtracking practices.

2 RESEARCH

2.1 Multi-staged Puzzle [2]

Puzzles are challenges that require the solver to assemble or take apart pieces logically to reach the correct solution. There are several types of puzzles, such as logical puzzles, physical puzzles, and environmental puzzles. For this thesis, the researcher primarily focused on environmental puzzles. These puzzles require players to interact with and use elements of their surroundings to reach or achieve their goals. For instance, if the player cannot proceed to the next location due to a rock blocking their path, they can use an exploding barrel in the environment to destroy the rock and clear the way. Such puzzles require players to use the items in the environment to overcome obstacles.

A "multi-staged puzzle" is a single puzzle that is comprised of multiple smaller puzzles or stages. These smaller puzzles may not directly relate to one another, but they all contribute to solving the larger puzzle.

Figure 1: *The Legend of Zelda: Ocarina of Time 3D* [3]

In *The Legend of Zelda: Ocarina of Time 3D,* the Water Temple is a well-known, multi-staged puzzle. As the player progresses through the temple, they must raise and lower the temple's water level to access different rooms and, relatedly, unlock those rooms to proceed. Each of these challenges is a type of environmental navigation puzzle. These smaller progression puzzles contribute to the larger puzzle of accessing and entering the final boss room. The puzzles collectively form a single multi-staged puzzle; the player solves the larger puzzle by solving the smaller individual puzzles.

2.2 Backtracking

Backtracking occurs when an individual re-traverses a path they previously traversed [4]. In video games, players backtrack through a level when navigating previously explored areas/space [1]. Backtracking is a common feature in *Castlevania* games. For example, when a player comes across an obstacle that cannot be passed without a special item, they must return to another location to obtain that item before clearing the obstacle.

Similarly, in the first *Resident Evil* game, players must locate different keys to unlock doors in a big mansion. The

player is relatedly backtracking through the mansion. However, this type of forced backtracking can become tedious and frustrating if it is not fresh or fun for the player [5]. To prevent this negative experience, the designer needs to add a stronger sense of meaning or differentiation to the backtracked spaces. Changing the environment or introducing new enemies can give a space a different meaning or purpose.

2.3 Flow Theory

The famous psychologist, Mihály Csíkszentmihályi, proposed the concept of "Flow," which is "the mental state in which a person performing some activity is fully immersed in a feeling of energized focus, full involvement, and enjoyment in the process of the activity" [6]. This theory is applied in various fields, including game design, where designers often use it to enhance the player experience. Renowned game designer Jenova Chen used Flow Theory in his early games research to dynamically adjust a game's difficulty. This emphasis on flow helped fully immerse the players in the game activities [7]. Chen continued to incorporate flow theory in his later games, such as *Journey*, which provided an immersive gaming experience for the players.

2.3.1 The Eight Characteristics of Flow

Csikszentmihalyi specifically suggests that eight characteristics of flow affect the state of a person's entry into the "flow" state. The eight characteristics of flow are as follows:

1. "Complete concentration on the task.
2. Clarity of goals and rewards and immediate feedback.
3. Transformation of time.
4. The experience is intrinsically rewarding.
5. There is a balance between challenge and skills.
6. Actions and awareness are merged, losing self-conscious rumination.
7. There is a feeling of control over the task.
8. Effortlessness and ease." [8]

For this thesis, the researcher specifically focused on the second, fourth, and eighth characteristics and how they may be used in level design.

2.3.2 "2. Clarity of goals and rewards and immediate feedback." [8]

Csíkszentmihályi states that "flow is likely to occur when an individual faces a task with clear goals that require specific responses" [9]. Athletic competition is a good example of this sentiment. Athletes in various competitions have specific goals and responses, causing them to become fully invested in the game and enter the "flow" state.

Immediate feedback can help reduce cognitive load by providing information about the activity's progression or status. When individuals have clear goals to focus on, immediate feedback can provide them with valuable information about their progress and help them continue to improve. For example, when riding a bicycle, the individual must maintain constant energetic focus to prevent the bike from falling over, and the individual's body tilts whenever they lose their balance.

2.3.3 "5. There is a balance between challenge and skills." [8]

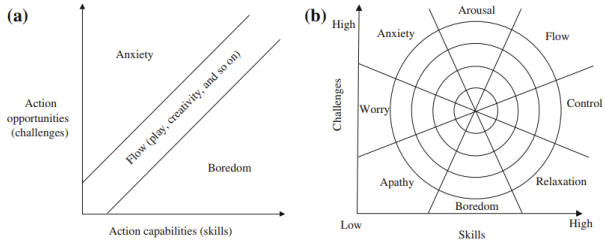

Figure 2: The original model of the flow state [9]

According to Mihály Csíkszentmihályi's Flow Theory, "flow occurs when a person's skills are fully engaged in overcoming a challenge within their ability" [10]. A flow state encourages people to learn new skills and take on more challenging tasks. The original flow state model depicted in Figure 2 highlights engagement and boredom's influence on the flow state. when the challenge exceeds an individual's ability, they will likely become anxious and stressed. Conversely, boredom and distraction can occur when an individual's skill level exceeds the scope of the challenge. Therefore, it is crucial to achieve a balance in order to experience a flow state.

However, when the challenge exceeds an individual's ability, they will likely become anxious and stressed. Conversely, boredom and distraction can occur when one's skill level exceeds the scope of the challenge. Therefore, it is crucial to achieve a balance to experience this state.

In chess tournaments, players are typically matched with opponents who have similar skill levels. This is done to ensure that the level of difficulty of the game is appropriate for both players. As players advance, they face more challenging opponents and more complex games. By maintaining a balance between the challenges they face and their own abilities, players are more likely to experience the "flow" state. If a game is too easy, they may become bored and lose interest. On the other hand, if a game is too difficult, they may lose confidence and become discouraged.

2.3.4 "7. There is a feeling of control over the task." [8]

When people are fully aware of their surroundings, have the necessary skills, and understand the consequences of their actions, they feel confident and in control.

The game *Half-Life 2* illustrates that confidence and control can be achieved through awareness, skill, and understanding of consequences. The game achieves this by introducing the gravity gun, where players initially encounter low-difficulty challenges to help them get accustomed to the new tool. The game provides a rich narrative context and a safe practice environment for practice, which enables players to master the gravity gun gradually. This approach aligns skill development with the

game's storyline, enhancing players' sense of control and engagement.

2.4 Conveyance

Conveyance is the "action of making an idea, feeling, or impression known or understandable to someone" [11]. In level design, designers use different means to direct players to certain routes or to carry out certain tasks [12]. There are many techniques for conveying information. Designers can combine color and pattern themes, use contrasting color and lighting, and employ signs, arrows, weenies, and other techniques to create a targeted design.

2.4.1 Color and Pattern Themes

A designer can use specific colors and patterns to define a project's overall style and content. In game design, designers often repeatedly use the same color or pattern to convey a particular meaning.

Consistency in the use of colors and patterns is crucial. For example, in many games, red indicates that progression is prohibited, while green indicates that progression is allowed. Designers borrow from real-life traffic signals - red for stop, green for go - and this subconsciously can affect players in the game.

Figure 3: Lambda Logo Sign in *Half-Life 2* [13]

Similarly, specific patterns can effectively guide a player's attention and convey key information. In *Half-Life 2*, for example, the Lambda logo consistently appears near pickups and hidden rewards. Over time, players learn to associate this symbol with valuable discoveries, enhancing their engagement and exploration instincts.

2.4.2 Contrasting Colors and Lighting

Contrasting colors are two colors that are located on different segments of the color wheel [14]. For example, red and blue are contrasting colors that attract attention when placed in the same frame. As a result, they are frequently used in design to emphasize specific elements. This application also extends to lighting, where high-contrast lights highlight objects that stand out from the scene.

Figure 4: Contrast in *Doom 4* [15]

In video games, vivid colors and contrasting lights are often used to draw the player's attention to important items or clues. In *Doom 4*'s desert scene (Figure 4), the base color is red, so blue key items, like pickups and interactive doors, really stand out.

2.4.3 Signs and Arrows

Signs and arrows, which can be text-based or pictorial, are ubiquitous in real life; they quickly and simply convey information to people. The brain directly guides the body to act based on the information provided by these signs. They are generally used to direct traffic, guide routes, and relay commands.

Figure 5: Signs and Arrows in *Dying Light* [16]

Similarly, signs and arrows are a convenient way to guide the player in games. For instance, in *Dying Light*, players can easily lose their way while parkouring through the level. However, an arrow on the wall, like in Figure 5, enables players to respond quickly and accurately toward the next step.

2.4.4 Visual Dynamics

Visual Dynamics refers to objects that possess visual dynamism. Such objects can easily attract attention in a stationary environment. For instance, if you are walking on the road and see smoke rising in the distance, it will immediately catch your eye, prompting you to investigate.

The researcher categorized Visual Dynamics into particle effects and dynamic items in video games. Particle effect refers to using many tiny sprites, 3D models, or other graphical objects to simulate certain "blur" phenomena, such as explosions, flames, and flowing water [17]. There are many dynamic objects, such as a leaf blown by the wind or a floating ribbon.

Figure 6: Visual Dynamics in *Call of Duty: Modern Warfare 3* [18]

Designers use flashing lights, explosions, and other attention-grabbing elements in many games to lead players to specific locations. As shown in Figure 6, the player encounters a big, distant explosion in the game *Call of Duty: Modern Warfare 3*. The resulting fire and smoke effectively guide the player forward despite the dark scene.

2.4.5 Weenies

Figure 7: Weenies: Map of Disney's Magic Kingdom in Orlando, USA [19]

"Weenie" refers to an architectural concept first employed in Disney theme parks. Weenies are buildings or structures which guide visitors from one area of the park to another. [19] As shown in Figure 7, the red boxes highlight the weenies located in Disney's Magic Kingdom in Orlando, USA. These visually appealing structures are scattered throughout the map, attracting the player's attention, and helping them to orient themselves and navigate the park.

Weenies, or landmarks, are also a type of conveyance technique. They are positioned so as to guide the player through the environment. This technique is common in *The Legend of Zelda: Breath of the Wild*. For instance, the temple in the Great Plateau and the towers like Great Plateau Tower are weenies, which give the player a sense of direction and purpose in the large, open world.

2.5 Best Practices

The researcher proposed that combining aspects of the Flow Theory with design conveyance techniques can create a set of design best practices. The researcher planned to create an immersive player experience by incorporating best practices when designing and constructing multi-staged puzzles and backtracking in the artifact.

2.5.1 Clear Goals and Appropriate Feedback

According to the Flow Theory, in order to create an engaging player experience, it is important to provide clear goals and appropriate feedback. Clear goals and appropriate feedback can be achieved through color and pattern themes, contrasting colors, contrast lighting, signs and arrows, weenies, and other techniques to create clear goals within levels and provide players with a good understanding of their objectives. By using these techniques, players can clearly understand the consequences of their actions.

In the well-known game *Super Mario Bros*, it is clear from the beginning that the player's overarching goal is to save the princess from Bowser. The player must traverse through game levels to reach the princess's location to achieve this goal. The player immediately understands their sub-objectives (travel through the level) based on their overarching objective (reach and save the princess).

Additionally, throughout the game, whether the player jumps or defeats enemies, collects coins or acquires mushrooms, the game provides appropriate sound and animation effects. For instance, acquiring a mushroom triggers a distinctive sound to play, accompanied by Mario's subsequent growth animation. With a clear purpose and appropriate feedback, it becomes easier for players to engage with the game and achieve a "flow" state.

2.5.2 Puzzles with Progressive Difficulty

To keep players engaged in a video game, it is crucial to maintain a balance between the challenge difficulty and the player's skill set. According to the Flow Theory, this balance is necessary to maintain player engagement and confidence.

The *Dark Souls* series of games developed by FromSoftware are widely known for their high difficulty level but are equally popular for their immersive gameplay. The gameplay strikes a perfect balance between skill and challenge. *Dark Souls 3*, for instance, introduces players to basic attack and defense skills through low-difficulty enemy encounters before pitting them against the first boss, Frost Knight Vador. While players may initially find it challenging to defeat the boss and die multiple times attempting to destroy him, they continue to work on their skills. Eventually, the player adapts to the difficulty level and enters a "flow" state. This sense of satisfaction and mastery encourages players to attempt more difficult challenges.

The balance between challenge and skills is especially important in puzzle design. Puzzle designers achieve this

balance by progressively increasing the difficulty level of the puzzles, allowing players to solve increasingly difficult puzzles as they increase in skill. Abruptly increasing the difficulty level is not advisable, as it can become too challenging for players. In contrast, increasing the difficulty too slowly can cause players to lose interest.

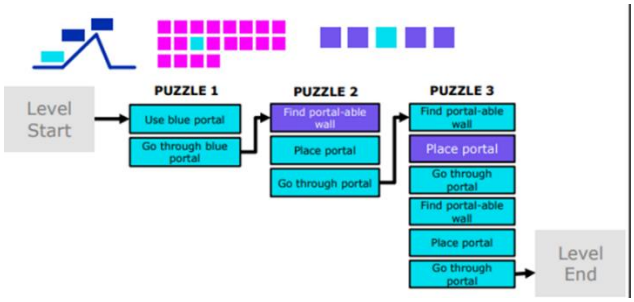

Figure 8: Puzzles' Deconstruction in *Portal2* [20]

In Figure 8, Jolie Menzel, a designer at Ubisoft, broke down the design of *Portal 2*'s puzzles in her 2016 Game Developer's Conference (GDC) talk, "Level Design Workshop: Solving Puzzle Design" [20]. Each puzzle builds upon the previous puzzle and requires the player to use their acquired skills and develop them further. This progressive difficulty design allows the player to feel a sense of accomplishment as they match their skill level to the difficulty of the challenge. The player does not get frustrated after solving the puzzle, they instead feel satisfied. This, in turn, draws the player to the next puzzle, thus resulting in the player reaching a "flow" state.

2.5.3 Providing players with a sense of control

Effective level design plays an important role in providing players with a sense of control. By blending environmental cues with a clear narrative, each level is structured in a way that clarifies objectives and empowers players. Well-designed puzzles and mechanics challenge players in a manageable manner, thereby boosting their confidence. Introductory tutorials are also essential as they equip players with the necessary skills to navigate the game successfully. All these elements work together to ensure that players enjoy the level and feel in control of their gameplay.

The Legend of Zelda: Breath of the Wild directly helps the player develop a familiar perception of the environment through weather systems, physics systems, etc. The game provides an introductory area to help players familiarize themselves with basic exploration and survival skills. Additionally, the game's physical systems mirror those of the real world, making it easy for players to predict the consequences of their actions. For example, using an axe to cut down a tree will produce a tree branch, while making noise may scare away prey. These game settings help players gain control in the large open world and explore every corner autonomously.

3 METHODOLOGY

3.1 Overview

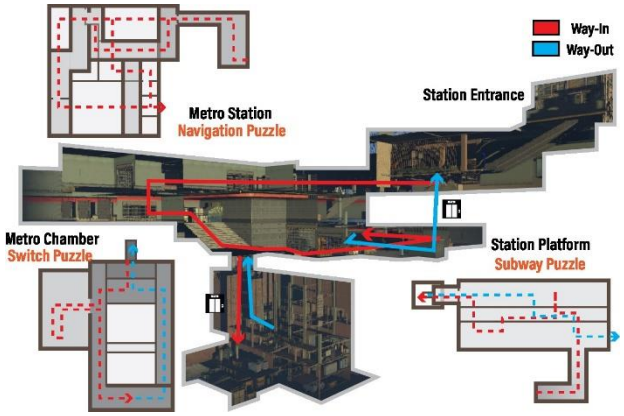

Figure 9: Artifact Layout

"Activate Metro Station" is a custom single-player level in *Dying Light 2*. The player must navigate a metro station to re-power it and then escape. While progressing, the player needs to solve several smaller environmental puzzles – backtracking through the sub-spaces accordingly. This entire level process is one large multi-staged puzzle.

The researcher created the artifact to explore the effectiveness of combining Flow Theory concepts with conveyance design techniques to improve multi-staged, backtracking puzzles.

3.2 Layout and Quest Design

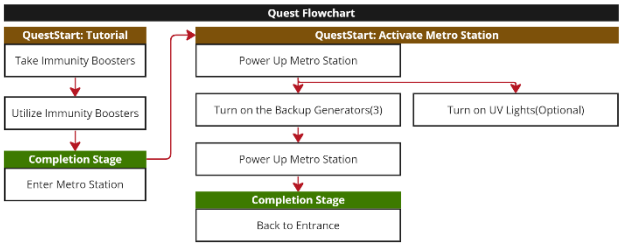

Figure 10: Quest Progression Flowchart

The level is divided into four parts: Station Entrance, Subway Station, Subway Platform, and Metro Chamber. The level quest flow is shown in Figure 10.

The level starts with the entrance to the Subway Station, which serves as a tutorial section. The area layout is simple and straightforward, with the player's objective directly ahead of them. The layout's simplicity aids the player in becoming accustomed to the level's mechanics and contextual background.

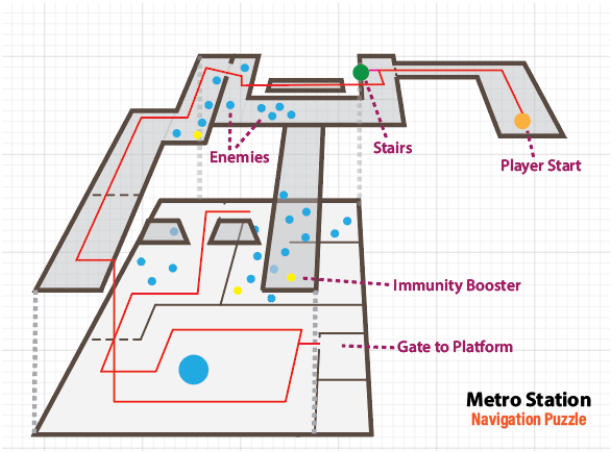

Figure 11: Navigation Puzzle Layout

Once inside the Subway Station, players will be tasked with solving a "navigation" puzzle. The Subway Station is a multi-level, multi-path structure, with both upper and lower levels and multiple paths leading to the target point (Figure 11).

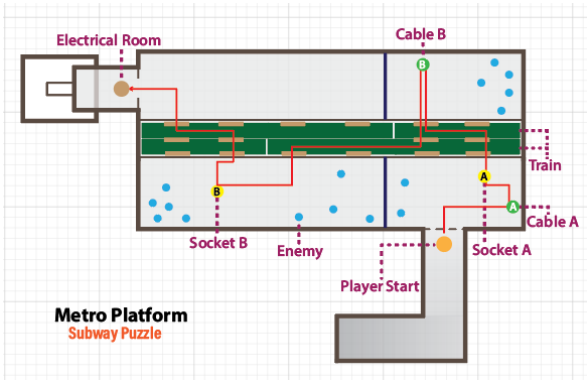

Figure 12: Subway Puzzle Layout

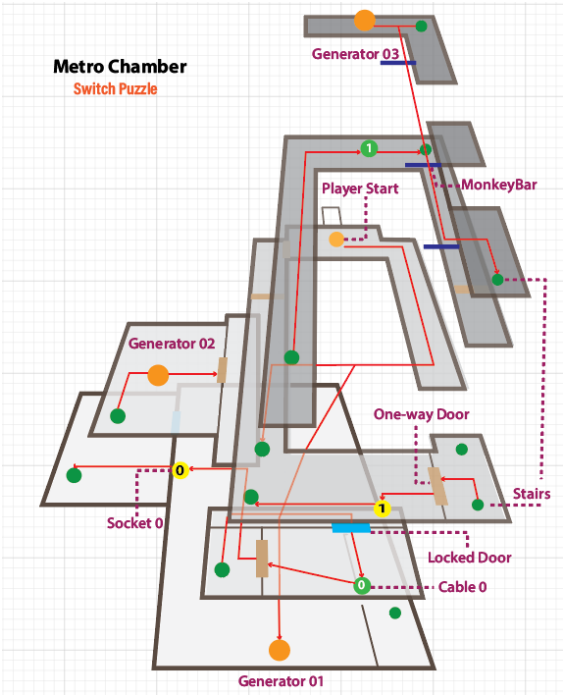

Figure 13: Switch Puzzle Layout

The next objective for the player is to reach the Subway Platform, where a puzzle awaits. The platform is split into two parts – each part involves the activation of a subway. The player must navigate the platform (which is divided by fences) and activate the subway train to reach their destination (Figure 12).

After powering up parts of the subway cars and dropping down an elevator shaft, the player reaches the Metro Chamber, a power supply area beneath the Subway Station (Figure 13). Here, the player needs to solve a series of environmental puzzles to find and turn on three backup generators, which ultimately activate the main power supply of the Subway Station. The Metro Chamber is a multi-level structure. It consists of five levels, each with a unique aesthetic feature.

On the first level, the chamber is filled with harmful chemicals. There is a locked room and a hidden passageway leading directly to the third level.

The second level has two locked rooms, one of which is connected to the locked room on the first level via an opening on the floor.

The third level is the player's entrance/exit point. It also has a staircase connecting it to the fourth level and a ladder locked by a one-way door leading directly to the fifth level.

Finally, the fourth level has several parkour challenges and is connected to the fifth floor.

The player must constantly backtrack to turn on switches in the Metro Chamber.

After activating the power switch in the Subway Station's Metro Chamber, the player must take the elevator back to the Subway Platform, open the subway car door, and return to the Subway Station entrance.

The whole level is a multi-staged puzzle involving a variety of smaller environmental puzzles. To progress, the player must repeatedly backtrack to previously visited spaces.

3.3 Application of Clear Goals and Appropriate Feedback

Figure 14: Conveyance in Artifact

Conveyance is an essential component throughout the level. For example, in the Subway Station, a yellow sign and arrow stand out against the background, pointing players where to go next (Figure 14). A yellow cable can

also be found on the ground. Following this cable leads players directly to the platform.

Figure 15: Conveyance in Artifact

Figure 16: Conveyance in Artifact

Figure 17: Conveyance in Artifact

Weenies, as defined in section 2.4.5, have been positioned in various areas to help the player better memorize and navigate the space. Examples include the placement of chemical waste on the first floor of the metro chamber (Figure 15), an office equipped with UV lights on the fourth floor (Figure 16), and a bedroom adorned with self-illuminating substances on the third floor (Figure 17). These elements serve as memorable markers that enhance the spaces and assist players in forming mental maps. This strategy allows players to easily identify objectives, recall routes, and navigate back to specific areas, underlining the essential role of weenies in creating engaging and navigable levels.

The level is populated with self-illuminating chemical substances, which serve a dual purpose in predominantly dark environments. These substances light up pathways and establish a reliable pattern for players: crucial interactive elements are located near these luminous markers. This intentional placement helps players to recognize and follow these interactions throughout the game. Additionally, different light colors are utilized to aid decision-making. Green lights indicate active doors or sockets, while red lights signal closures or deactivated power sources. This systematic use of lighting is vital, guiding players effectively through dark settings and facilitating easier interaction within the environment.

Figure 18: Appropriate Feedback in Artifact

Players receive effective and prompt feedback for every meaningful action in the artifact. For example, as shown in Figure 18, when a player inserts a cable into the corresponding socket, the subway door in front of the player opens immediately. The lights inside the subway spill out onto the platform. Immediately, the player feels a sense of accomplishment and directly associates the sockets with the opening of doors.

3.4 Multi-staged Puzzle with Progressive Difficulty

3.4.1 Multi-staged Puzzle Overall

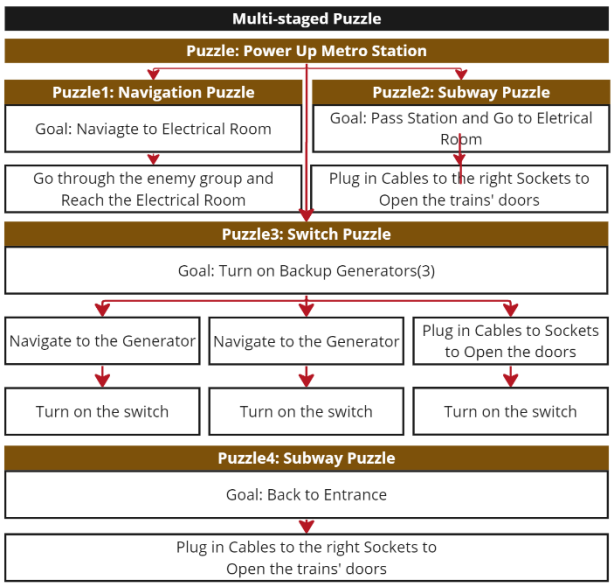

Figure 19: Puzzle Structure.

The level is comprised of a large multi-staged puzzle made up of a series of smaller puzzles. The structure of the puzzle is shown in Figure 19. The level's objective is to solve a complex puzzle to power up the Subway Station and escape.

Firstly, players must locate and activate the power in an electrical room. They start with a navigation challenge inside the station, which leads to a puzzle on the Subway Platform. After they activate parts of the subway, the player encounters a setback. The emergency power switch is damaged. As a result, the player must activate three emergency generators in the Metro Chamber to proceed. Successfully completing the Metro Chamber stage leads to the powering of the entire subway system. Finally, players solve the last puzzle on the platform to exit the station, completing the multi-staged puzzle challenge.

3.4.2 Multi-function Generators Mechanism

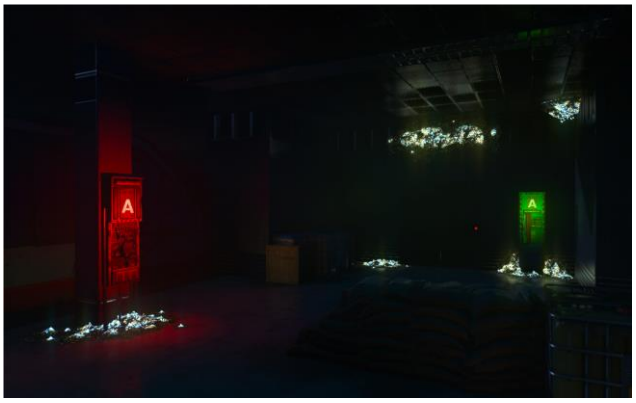

Figure 20: Sockets in Artifact

Multi-function generators are a puzzle mechanism featured in *Dying Light 2*. The player's objective is to take the cable from the working socket (green) and insert it into the non-working socket (red). By doing so, the red socket becomes active, opening a certain door.

3.4.3 Immunity System in *Dying Light 2*

Figure 21: UV Light in Artifact

In *Dying Light 2*, the player has limited immunity time in the darkness. If the player's immunity runs out, the player immediately dies. To survive longer in the darkness, the player can either use an immunity booster to increase the elapsed immunity time or find a UV lamp and stand under it. The player's puzzle-solving time is limited by their immune system, which increases the puzzle's difficulty.

3.4.4 Difficulty Curve of Multi-staged Puzzle

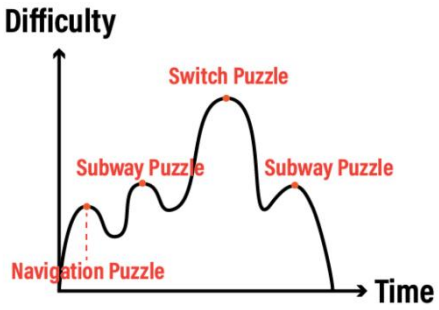

Figure 22: Puzzles' Difficulty Curve

The overall difficulty of the multi-staged puzzle is determined by various factors such as the complexity of the sub-puzzles, the immunity time, the number of enemies, and the difficulty of the enemies. The researcher created an expected difficulty curve for the level (Figure 22).

The player starts with the easy Navigation Puzzle and then moves to the slightly more challenging Subway Puzzle. As the player's skill increases, they progress to the hardest Switch Puzzle. The level comes to an end with the medium-hard Subway Puzzle. This difficulty progression helps players balance their skills and challenges in each stage of the multi-staged puzzle. The experience gets more difficult, ending with a climax at the Switch Puzzle. The player then encounters an easier challenge, as a restful/re-energizing moment, prior to exiting the level.

3.4.5 Navigation Puzzle

Figure 23: Navigation Puzzle in Artifact

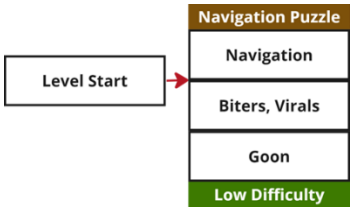

Figure 24: Navigation Puzzle Deconstruction

The Navigation Puzzle requires the player to navigate through a complex metro station environment within a limited time while facing enemies, such as Virals and Biters. The Navigation Puzzle culminates in a confrontation

with a difficult Goon enemy. The main objective of the puzzle is to help players learn to use their parkour abilities in dark environments and to develop their ability to navigate the station while dealing with enemies. Although the puzzle is not overly complicated, it requires a certain skill level to complete successfully.

3.4.6 Subway Puzzle

Figure 25: Subway Puzzle (part 1) in Artifact

Figure 26: Subway Puzzle (part 2) in Artifact

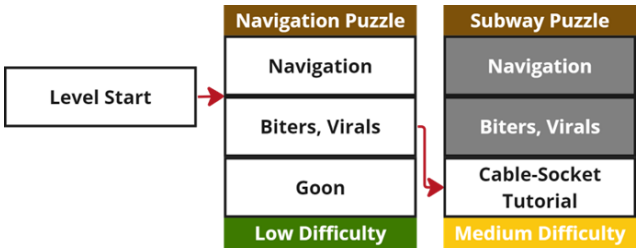

Figure 27: Subway Puzzle Deconstruction

The Subway Puzzle introduces multi-function generators. The player needs to connect a generator cable to the corresponding generator socket in order to open subway doors. Once the doors open, the player can navigate the subway cars to reach the next destination. The puzzle appears twice in the level: before the Subway Station, power is turned on in Part 1, and after the Subway Station, power is turned on in Part 2.

In Part 1, the puzzle aims to teach the player how to use multi-function generators while challenging the player with Biters and Virals.

In Part 2, the puzzle provides an easy challenge before the player backtracks to the subway entrance.

3.4.7 Switch Puzzle

Figure 28: Switch Puzzle in Artifact

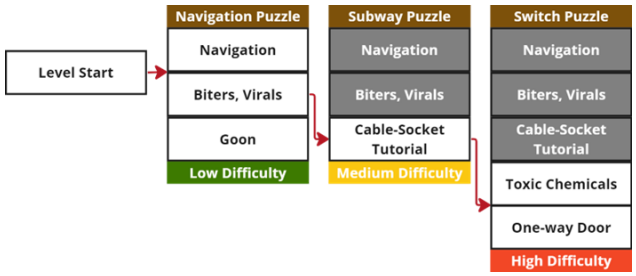

Figure 29: Switch Puzzle Deconstruction

To solve the Switch Puzzle, the player must turn on three generators in the complex Metro Chamber. The Metro Chamber contains toxic chemicals that damage the player, swinging lifts and monkey bars that the player can use for parkour, and multi-function generators that the player can use to open locked doors/spaces. The area also requires more complex navigation and has several hidden Biters and Virals to increase the difficulty.

3.5 Providing players with a sense of control

The level provides players with control through adequate skill development and a well-designed environment.

3.5.1 Skill Development

At the beginning of the level, the player is introduced to the game's basic gameplay mechanics through quest objectives and NPC dialogue. The Navigation Puzzle helps the player become familiar with the basic parkour gameplay. These puzzles ensure that the player is well prepared before accepting the higher degree of challenge in the Metro Chamber. The Metro Chamber's Subway Puzzle helps the player learn how to use multi-function generators. The Switch Puzzle tests the player's mastery of their abilities/skills.

3.5.2 Environment Design

Figure 30: Level Scene in Artifact

A well-crafted environmental narrative design must enhance the mission context to facilitate a sense of control. Given that the quest takes place in a subway station, a subway platform, and an electrical room, the level's setting must align with the player's perception and real-world understanding.

At the Subway Station, players encounter ticket machines, platform guides, and vendors. The electrical rooms prominently feature generators, industrial elements, and cables. Simultaneously, all of the settings are derived from the original *Dying Light 2* subway stations, lending a sense of familiarity to seasoned players through familiar arrangements. These environments are meticulously designed to enable players to fully immerse themselves in the characters and accomplish their missions more easily.

4 RESULTS AND DATA ANALYSIS

4.1 Playtest Overview

Ten playtesters participated in the study, all of whom completed the playtest and filled out the post-survey. Most participants had previous experience with parkour and puzzle games. Three participants were familiar with *Dying Light 2*, and two participants had never played any games in the *Dying Light* series. A few playtesters experienced motion sickness due to the fast-paced first-person character movement. This sickness may have skewed the results by reducing the participants' overall enjoyment and hindering their ability to enter a flow state.

4.2 Data Overview

4.2.1 Effectiveness on Clear Goals and Appropriate Feedback

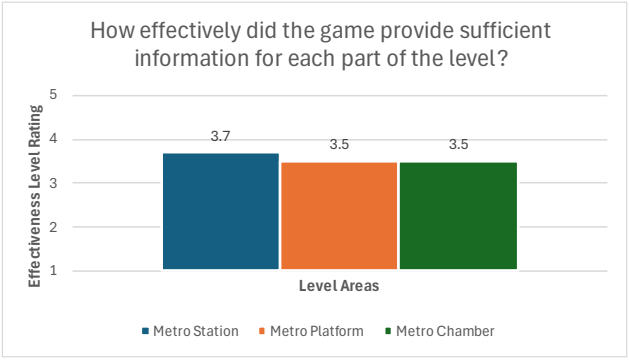

Figure 31: Perceived Goal Clarity of Puzzles

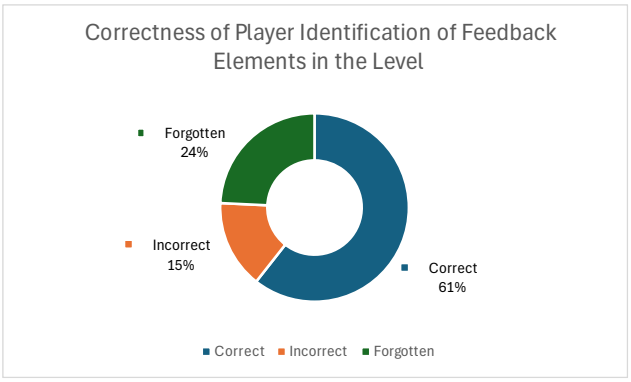

Figure 32: Perceived Feedback Appropriateness of Puzzles

To determine how effectively the game provided clear goals across different areas of the level, the researcher asked participants to rate the provided information's effectiveness on a Likert scale from 1 (Not at All Effective) to 5 (Extremely Effective). Figure 31 illustrates that playtesters consistently rated the clarity of goals in all areas above a 3 out of 5. These averages indicate that the goals were generally well perceived, demonstrating their effectiveness in guiding players.

To prove the effectiveness of feedback in the level, the researcher designed several questions corresponding to different feedback elements. The questions asked players to observe a game mechanic situation and identify the corresponding feedback elements. Based on their responses, players were either 'correct,' or 'incorrect.' If players were unable to remember the feedback element, they could respond with, 'forgotten.' The survey results (Figure 32) indicated that playtesters understood the feedback correctly 61% of the time. However, 24% of the responses indicated that the playtesters forgot the feedback during long play sessions, and 15% of the responses incorrectly understood the feedback. These suggestions show that the feedback mechanisms were mostly effective.

4.2.2 Puzzles with Progressive Difficulty

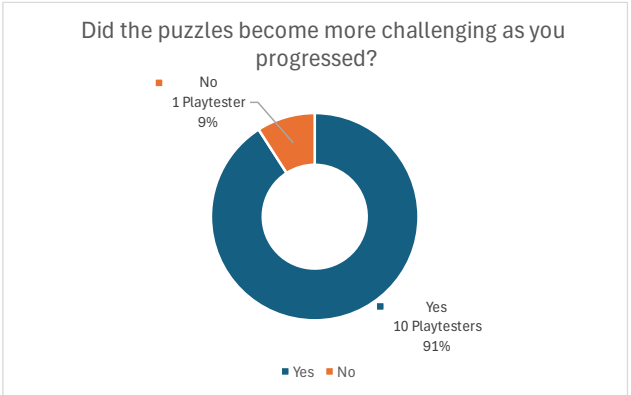

Figure 33: Perceived Progression of Puzzles' Difficulty

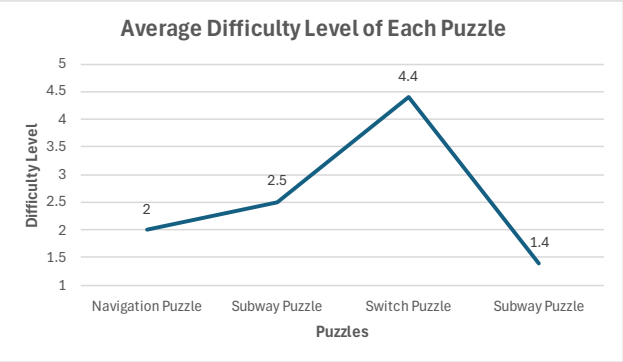

Figure 34: Average Difficulty Rating of Puzzles

Initially, the researcher asked the participants whether they felt the puzzles increased in difficulty or did not increase in difficulty. As illustrated in Figure 33, most responses indicated that 10 out of 11 playtesters (91%) perceived puzzle difficulty progressively increasing.

Additionally, playtesters were asked to rate the difficulty of each individual level section to obtain a more precise assessment. The researcher added all participants' ratings for each section and divided that value by the number of participants to determine a section average. Figure 34 shows the results of the researcher's calculations. The playtester assessments align with the researcher's intention to increase puzzle difficulty incrementally.

4.2.3 Effectiveness in Providing Players with a Sense of Control

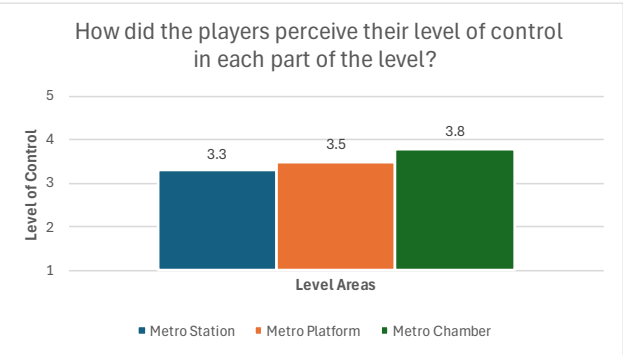

Figure 35: Effectiveness in Providing Players with a Sense of Control

To evaluate the sense of control experienced by playtesters within the game, the researcher posed three questions:

- How significantly did the player believe their choices and actions influenced the outcomes?
- How significantly could the player understand and predict the game's responses to their actions?
- How significantly did the game provide sufficient information for the player to navigate effectively?

The researcher added the scores for all three questions per level area and calculated the area average. As shown in Figure 35, the area averages were all above a 3 out of a maximum of 5. These results indicate that playtesters generally felt a sense of control throughout the level.

4.2.4 Player in a Flow State when Backtracking

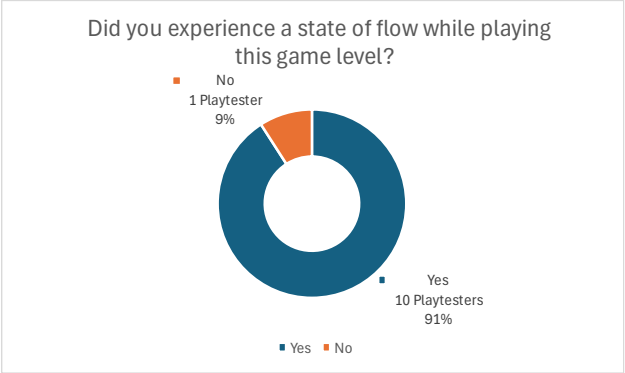

Figure 36: Player Experience of Flow State

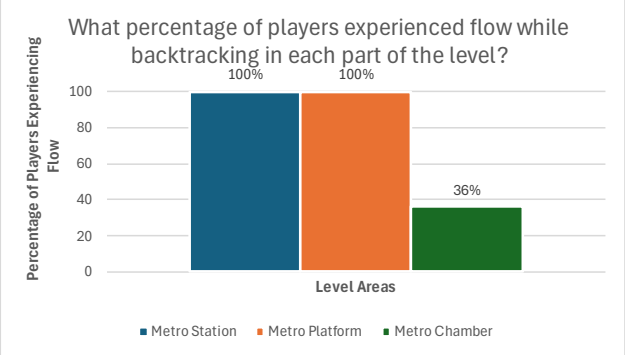

Figure 37: Correlation Between Backtracking and Flow States

In the study, playtesters were asked whether they experienced a flow state during their gameplay. The researcher wanted to gauge the playtesters' level of engagement and immersion.

Following this general inquiry, playtesters were asked how often they entered a flow state while backtracking through different level areas. As shown in Figure 36, 10 (91%) of the playtesters reported achieving a flow state while navigating the level, indicating high engagement overall. The researcher implemented two multiple-choice questions, enabling playtesters to identify areas where they experienced backtracking and flow states during gameplay. Each question allowed for multiple responses, enabling participants to specify all relevant areas where they recognized backtracking or felt they achieved a flow state. The collected data was then thoroughly analyzed to determine the overlap between backtracking and flow state experiences across different level areas. The researcher observed that playtesters consistently entered flow states at the Metro Station and the Metro Platform, even while backtracking. However, only 4 (36%) of the playtesters recognized backtracking and achieved a flow state in the Metro Chamber. These results suggest that there may be a design issue in this part of the level. The Metro Chamber is complex and overly dark, potentially leading to player disorientation and nausea. Additionally, the darkness hinders the players' ability to understand the interconnectedness/layout of the space, which is crucial for effective navigation and puzzle-solving.

4.2.5 Overall Feeling of Enjoyment for the Level

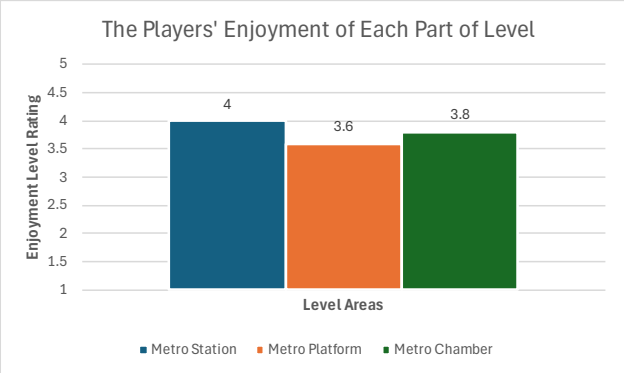

Figure 38: Players' Enjoyment of Each Part of the Level

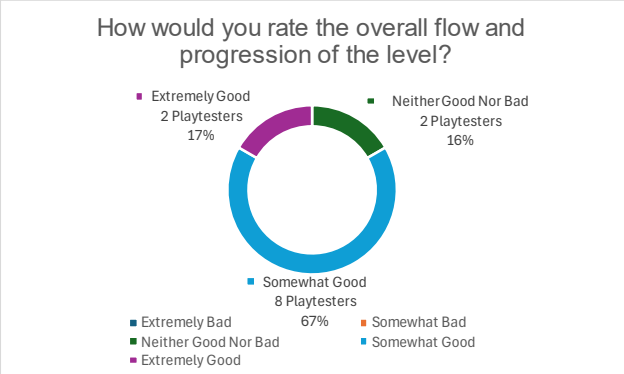

Figure 39: Players' Ratings of the Overall Flow and Progression

The researcher asked playtesters to rate their enjoyment of various level areas on a Likert scale from 1 (Did Not Enjoy at All) to 5 (Greatly Enjoyed). Ratings for each area were averaged by summing all scores and dividing by the number of responses. The ratings frequently exceeded a value of 3 and occasionally reached 4 on a scale from 1 to 5. These results indicated that the players experienced significant enjoyment across different areas.

After this detailed assessment, playtesters were asked to provide their overall sentiment towards the entire level. The general sentiment was overwhelmingly positive, with no playtesters reporting neutral or negative impressions (Figure 39). Based on these results, the researcher concludes that the level design met player expectations and contributed to a positive experience.

4.3 Metro Chamber Design Issue

Despite generally favorable reviews, as shown in Section 4.2.4, an issue has been identified in the Metro Chamber area, where only 36% of playtesters experienced a flow state. This result highlights a potential problem in the Metro Chamber's design that may require further investigation and adjustment.

4.4 Potential Causes of Problem and Corresponding Fixes

From the testing and survey feedback, several potential issues and their solutions have been identified:

1. Visibility Issues Due to Darkness: Many in-game guides, such as cables and arrows, were hard to see in dark areas, making them easy to overlook and ultimately ineffective. This lack of visibility also complicates solving complex puzzles in the dark.

Solution: Use differently colored lights as guides to aid player memory and avoid placing complex puzzles in dark settings. Alternatively, increase the overall brightness in the Metro Chamber.

2. Unfamiliar Parkour Elements: Players unfamiliar with *Dying Light 2* struggled to use certain parkour features, like the monkey bars, as they could not intuitively understand their function.

Solution: Introduce these elements earlier in the game to allow sufficient learning time.

3. Disorientation in Dark Environments: Solving puzzles in the dark for extended periods can lead to disorientation and physical discomfort, including dizziness and headaches.

Solution: Before starting the game, inquire about potential 3D motion sickness issues from players. If present, offer a windowed mode to mitigate discomfort.

4. Lack of Awareness in Puzzle Rules: Players failed to apply their understanding of previously established puzzle behavior in the Metro Chamber.

Solution: Include incorrect socket options during tutorials to enhance rule reinforcement and help players internalize gameplay mechanics more effectively.

5 CONCLUSIONS

As demonstrated in Section 4.2, the researcher implemented all three best practices in the level - clear and Appropriate Feedback, Puzzles with Progressive Difficulty, and Providing Players with a Sense of Control - and achieved varying degrees of success. Implementing these practices can help players better enter the flow state during multi-staged puzzle solving, which improves the backtracking experience. If the issues outlined in Section 4.4 are addressed, players will likely experience improved flow states and increased enjoyment.

6 REFERENCES

[1] "Backtracking (Concept) - Giant bomb," Giant Bomb, [Online]. Available: https://www.giantbomb.com/backtracking/3015-239/.

[2] J. Perry, "Puzzle design 1: RPG Puzzle Types," Final Boss Blues, 11 11 2012. [Online]. Available: https://finalbossblues.com/puzzle-types/.

[3] Peardian, "Structure of the Water Temple from "The Legend of Zelda: Ocarina of Time."

[4] W. contributors, "Backtracking," 24 Jan 2024. [Online]. Available: https://en.wikipedia.org/wiki/Backtracking.

[5] T. L. Bacon, "A guide to backtracking | Video game design," YouTube, 2018.

[6] W. contributors, “Flow (psychology),” Wikipedia, 27 1 2024. [Online]. Available: https://en.wikipedia.org/wiki/Flow_(psychology).

[7] J. Chen, “Implement Flow in Games,” [Online]. Available: https://jenovachen.info/implement-flow.

[8] L. Ellefson, “Use the Eight Elements of the ‘Flow State’ to Be More Productive,” 20 3 2024. [Online]. Available: https://www.msn.com/en-us/money/other/use-the-eight-elements-of-the-flow-state-to-be-more-productive/ar-BB1kdOMU.

[9] M. Csíkszentmihályi, “Finding flow: the psychology of engagement with everyday life,” *Choice Reviews Online,* vol. 35, pp. 35-1828, 1997.

[10] M. Csíkszentmihályi, Flow and the Foundations of Positive Psychology: The collected works of Mihaly Csikszentmihalyi, 2014.

[11] “Conveyance,” Encyclopedia.com.

[12] J. R. Wheeler, “Game level design: 35 ways to Guide the player - Jacob Ryan Wheeler - medium,” Medium, 2022.

[13] Valve, “Half-Life 2,” Valve, 2004.

[14] D. H.-G. Contributor, “Contrasting colors - A beginner’s guide,” GetApp, 19 Jul 2022. [Online]. Available: https://www.getapp.com/resources/contrasting-colors/.

[15] “Doom 4,” 2016.

[16] “Dying Light,” 2015.

[17] W. contributors, “Particle system,” 11 Dec 2023. [Online]. Available: https://en.wikipedia.org/wiki/Particle_system.

[18] “CALL OF DUTY MODERN WARFARE 3,” 2011.

[19] I. GASKATOURS, “Mapas-Disney-Magic-Kingdom-Orlando - GaskaTours, Inc.,” GaskaTours, Inc., [Online]. Available: https://gaskatours.com/es/mapas-de-parques-tematicos-en-orlando/mapas-disney-magic-kingdom-orlando/.

[20] J. Menzel, “Level Design workshop: Solving Puzzle Design,” GDCVault, 2016. [Online]. Available: https://www.gdcvault.com/play/1023139/Level-Design-Workshop-Solving-Puzzle.

7 ACKNOWLEDGEMENTS

I would like to express my gratitude and extend my acknowledgments to the following individuals:

- Professor Katie Wood Clark, my thesis advisor, whose patience and guidance were invaluable during the thesis process.
- Professor Mike Porter, whose insightful suggestions greatly enriched the content of this thesis.
- All the testers who generously dedicated their time and energy to participate in playtesting and complete the survey.