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Using The Push And Pull Principle To Improve Non-Linear Level Navigation: Post-Mortem

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Abstract

This thesis studies the Player’s habits of navigation when they are in an open-world environment. It incorporates assumptions of best practices utilizing the Push and Pull level design theory that guides the Player in a free-flowing, exploratory environment and utilizes these practices in an open-world level in *The Elder Scrolls V: Skyrim*.

Keywords

Open-World, Non-Linear Level Design, Design Principles of Dissonance and Harmony.

1 INTRODUCTION

As the popularity of video games rises, open world games also have become more popular and prevalent. Titles such as *Red Dead Redemption 2*, to unlimited emergent gameplay in *Legend of Zelda: Tears of the Kingdom*, provides players with expansive worlds in which to explore. Navigating these worlds requires tactics to draw the player to intended encounters and interactions. These tactics use a Push and Pull theory to provide guidance as the player progresses.

This thesis examines how the dissonance and unity of a level composition affects the Player’s path preference in an open-world level. The researcher theorized that the Players often are attracted to a less-unified patterns rather than a harmonious structure in a space. The dissonance and unity of a level composition is created via various common design principles, such as landmarks and leading lines. The researcher compiled these assumptions of best practices and theories into an open, explorable, level in *The Elder Scrolls V: Skyrim* named “A Place We Call Home”. Playtest data gathered from a series of playtesting sessions of this thesis artifact provides a better understanding of the effectiveness in level guidance using the Unity and Dissonance of design principles in an open world level.

2 DEFINITIONS & RESEARCH

2.1 Open world levels

2.1.1 Definitions

An open world level means that the game reacts to the player’s overall gameplay, it is reactive to the player’s actions, therefore making it immersive. [1] An open world game would consist of a large scale environment that allows the players to engage the spaces in a non-linear fashion. These are some of the elements involved in a level that qualifies as an “open world level”:

- Various available paths at any given point
- Lively and dynamic NPCs

- Rich in environmental storytelling

The thesis artifact displays all these elements and constitutes an open world level. While the inclusion of all of the elements are not crucial, these are the ones that make each open-world experience unique in its gameplay [2].

2.1.2 Discussions

The beauty of open world levels is the opportunity for each Player to create their own experience. The widespread appeal of freely exploring vast game worlds is readily apparent, contributing significantly to the popularity of this gameplay style [3].

While open world games are popular for its freedom and the availability of player agency, the level designers must provide the game a critical path and gameplay pacing to mediate the Player experience. This thesis uses a quest to pace the Player with blockade without providing immersion-breaking quest markers.

2.2 Push and Pull Principles

2.2.1 Definitions

The principles of level design aim to orient and guide the players to intuitively experience what the designers intended. Veteran Level Designer with more than a decade of level design experience, Clement Melendez, studied and wrote about the principles behind level navigation and player psychology. Clement Melendez’s studies aim to explore the “tricks used to guide to a destination, lead along the critical path, and communicate without words” [4]. The principle that this thesis focuses on is the idea of Unity vs Dissonance. It extends from one of the Push and Pull principles – Influence via Composition [4].

2.2.2 Significance

Melendez points out that modern developers often start to lose trust in the Player’s abilities to put together in-game information as presented for the wrong reasons: because some players get lost or confused [4].

According to Melendez, these tools that help developers improve intuitive navigation can generate more player satisfaction, free up [player] concentration, improve flow, and make worlds feel less constrained and linear [4].

2.3 Common Level Design Principles

Designing a level means creating an experience that methodically guides the player to the designated locations. Level designers often use subtle tricks in the levels that influence player psychology, therefore guiding the player to where the designers want them to go. We call them level design principles.

2.3.1 Intuitive Guidance

David Shaver and Robert Yang, designers from Naughty Dog and NYU Game Center, outlined some of these common principles that are often the most effective on players; they outlined fourteen design principles that can be impactful to player psychology. This thesis only focuses on five of the fourteen principles outlined in this source:

- “Visual Language – Shape”

Definition: Shapes of the objects in the level compositions or the shapes of positive and negative spaces created by the objects in the level compositions.

- “Visual Language – Color”

Definition: Inherent colors of the objects or colors of lights

- “Landmarks”

Definition: Large objects that can be seen at various vantage points of the level

- “Leading Lines”

Definition: Objects that form a line which points to the intended point(s) of interest

- “Framing & Composition”

Definition: Using other objects to encircle or frame objects of interest in order to highlight it [5]

The in-depth definitions and applications of these principles will be elaborated in later sections.

2.3.2 Conveyance and Layout

The research underscores the importance of conveyance and layout within non-linear levels, as these elements enhance players' comprehension of their surroundings, fostering intuitive navigation. Since the role of a level designer entails the deliberate placement of guidance and compositions within an environment, achieved through the skillful utilization of diverse assets to shape the player's experience [6] To build an intuitive navigation in an open world level, the players can see level “as the art gallery and the level (composition) vistas as paintings. It means that a player can traverse from one composition to another” [6].

2.4 Unity and Dissonance

Deriving from Melendez's Push and Pull theory and Shaver and Yang's Common Level Design Principles, the researcher aims to focus this thesis on the theory and practicality of “Unity and Dissonance” in level design,

while applying them to the selected five common level design principles.

2.4.1 Unity

In Melendez's essay, the author outlined the definition of unity as that “all elements of a composition were designed and disposed in a logical and pleasing fashion” [4] and all of them being compatible with one another and fitting the theme [4].



Figure 1 Example of Unity in *Dishonored 2* [7]

The Unity in this example from *Dishonored 2* in Figure 1 is the repetition created by the window frames and wall structures in the scene. The unified color of the building structures also created a sense of unity and harmony within this composition.

2.4.2 Dissonance

In the context of this thesis, dissonance means odd objects or patterns that do not fit into the current harmony of the composition. It could be a contrasting light, strangely shaped structures, or vegetation that does not belong in the scene. Dissonance is an effective way to make certain elements of a composition stand out [4] and it draws the player's eye to a center of interest if there is one [4].

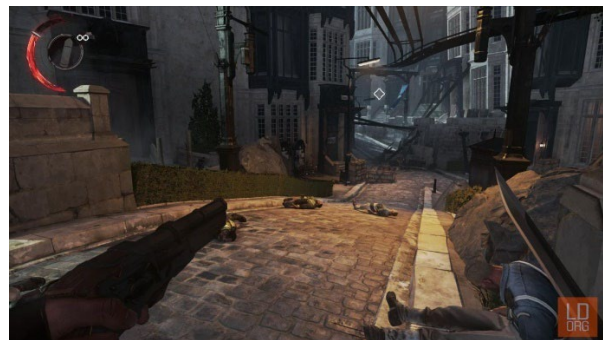


Figure 2 Example of Dissonance in *Dishonored 2* [7]

The Dissonance in this example from *Dishonored 2* in Figure 2 is created by the intertwining leading lines in the composition; the warm color in the centre of the pathway also created dissonance with the cool surroundings. All these dissonant elements are guiding the player forward.

2.4.3 Shape & Color

Shape and color are visual languages applied in level design techniques. They often communicate affordance and affect player's psychology [5].

Shapes:

The primitive shapes of the level composition can easily affect player psychology. It is commonly acknowledged that round shapes mean non-threatening, rectangular shapes mean safety and diagonal shapes mean dangerous. Colors:

Colors often communicate similar psychological themes while also give context to the level. Colors also tend to have emotional and psychological effects on human moods and behaviors. For example, warm colors might evoke anger and hostility, while cooler colors might evoke calm, sadness or neutrality [5].

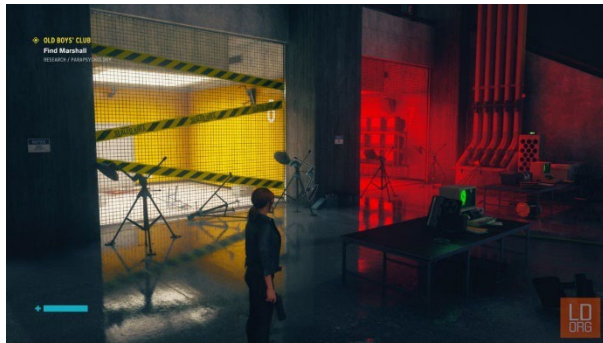


Figure 3 Example of Color Dissonance in *Control* [7]

2.4.4 Landmarks

Landmarks are large structural objects that can be observed from a distance and from different points of the map [5]. In many AAA titles, it is common practice to employ landmarks as a straightforward method of orienting players within an environment. This approach finds particular relevance in open-world levels due to their expansive size. Players frequently require orientation within such environments, and landmarks serve as vital reference points, aiding players in understanding their position relative to objectives and other points of interest. An example is the Citadel in *Half-Life 2* shown in Figure 4.



Figure 4 Example of a Landmark in *Half-Life 2* [7]

2.4.5 Leading Lines

Leading Lines is a compositional technique that arranges objects in the environment in a way that they point towards a specific area in the composition. It subconsciously draws the Player's attention to that point, making such elements stand out from the rest. The elements that can form a leading line can be various objects in the scene, such as roads, wires, unified orientation of buildings and so on [5]. These elements may

have edges that perceptually "leads a line" to the intended object, as shown in the example in Figure 5.



Figure 5 Example of Leading Lines in *Fallout 4* [7]

2.4.6 Framing

Framing is a technique derived from photography, in which the subject of interest is bordered by less interesting objects, thus focusing the player's eyes to the most important elements within the "frame". Therefore, drawing attention to the unblocked part of the composition, making it stand out [5].

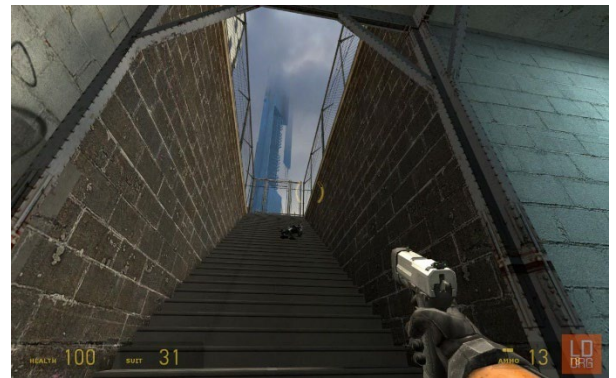


Figure 6 Example of Framing in *Half-Life 2* [7]

3 APPLICATIONS

The early stage of this thesis focuses on research and compiling articles and talks that revolve around open-world games. During the development phase of this thesis, the researcher segregated the level into sections to test out various design techniques applied with the Push and Pull principles, as shown in Figure 7. These areas are designated to test their respective unity and dissonance techniques. Through playtest and surveying, the researcher hopes to find correlation between the usage of unity and dissonance techniques and the Player's preference in picking that path.

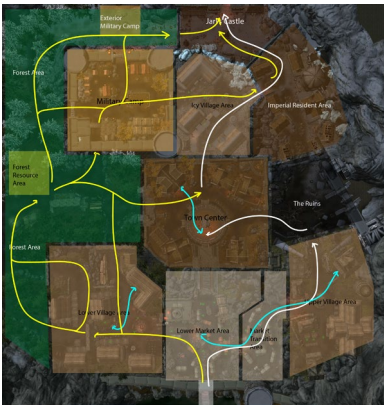


Figure 7 Artifact Layout Design [8]

The artifact for this thesis is a standalone level in *Skyrim*. The level is separated into 9 sections, each with a slightly different theme. The Player has a simple quest to navigate themselves to the end of the level and reach the castle.

3.1 Best Practices & Applications

The researcher gathered research findings and distilled them into best practices related to the Unity and Dissonance principle within the Push and Pull theory. These best practices are divided into two main sections, one of which further elaborates into three subcategories of best practices.

3.1.1 Best Practice 1 - Players are drawn to Dissonance over Unity

Dissonance in the level manifests in sectional thematic change, the color contrast between medium/large objects, and stark shapes in the player's vistas. They have impact on how the Player notices and remembers level compositions. The researcher hypothesizes that players would be more drawn to the dissonance in the composition than the unity in the composition.

3.1.2 Best Practice 1a – Landmarks help establish easily-seen Dissonance in each area

Landmarks are large objects that are easily seen from various vantage points in a level, the players are able to identify and notice them as they entered each area. Therefore, the researcher hypothesizes that using landmarks is a primary and most effective way of establishing dissonance in any given area of the level, while maintaining memorability of that area. An example of landmark usage in the level is shown in Figure 8.



Figure 8 A Large Statue as Landmark [9]

3.1.3 Best Practice 1b – Framing uses Unity to highlight contrast within the Player's view

Framing uses objects to encircle the elements of importance in order to highlight or draw the attention of the players. Framing works as an effective dissonance because enclosed shapes naturally draw attention, often utilized in advertising through the use of frames around commercials, which is the essence of framing. This concept also ties into negative space, where the area within the frame is considered positive space, contrasting with the surrounding negative space. [4] An example of framing and sub-framing is shown in Figure 9.



Figure 9 Using the Arch as a Large Frame and Gates as Smaller Frames [9]

3.1.4 Best Practice 1c – Contrasting Colors create notable dissonance within a composition and draws the player's attention

Colors with contrasting characteristics create a strong visual impact. The greater the distance between colors on the color wheel, the more pronounced the contrast, with complementary colors exhibiting the highest level of contrast. In application to level design, warmer colors tend to visually advance and stand out more prominently within a scene compared to cooler colors, which typically recede into the background. This principle can be particularly advantageous in environments dominated by cooler hues, allowing specific elements to stand out prominently. [4] The Player first experiences contrast in color in the Market area with differently colored stalls and lights. The combination of shape variations that create a local landmark for the player to orient, seen in Figure 10.



Figure 10 Color Contrasts used in Lower Market [9]

3.1.5 Best Practice 2 – Excessive Dissonance generates Unity

While dissonance within level composition is valuable, it should be applied thoughtfully rather than haphazardly. Excessive contrast can lead to monotony and repeating the same contrasts within a composition can diminish their impact over time. When enough dissonance has been applied in an area, the dissonance becomes the new Unity because the Player is growing accustomed to the new environment. Therefore, dissonance does not only appear within a global context because it is an ever-changing variable depending on the Player's experience, but dissonance also applies on a local, small-scale basis as well. For example, when the Player moves from the Market area to the upper Market area, the Player is following Unity within the market stalls but the dissonance of color contrasts and landmarks. Once the Player has gotten used to the new environment, the new Unity becomes the farmhouse area that they eventually will end up in.

4 PLAYTEST AND SURVEY

Playtests of the artifact were conducted, and 16 playtesters consented and participated. Participants were equipped with an eye-tracking device, which tracked their eye movements throughout the gameplay. After completing the playthrough, the participants were asked to fill out a survey containing questions about their playthrough experience. Details about the survey and the eye tracker will be elaborated on in the sections below.

4.1 Playtest Format

Each participant was informed and consented to the playtest with a recording of their eye tracking heatmap result and a survey afterwards. All the playtests were conducted in SMU Guildhall's Game User Research Lab on the same computer.

4.2 Using Eye Tracking Device

A Tobii Eye Tracker was set up on the computer with software capable of tracking the player's eye movements. The tracking device is calibrated beforehand to ensure the accuracy of the movement and position of the heatmap. The eye tracker software displays an overlay of the heatmap, where the color indicates the duration the player spent looking at each area. Blue represents a short duration, while red indicates a longer duration. An example of the heatmap overlay is shown in Figure 11.

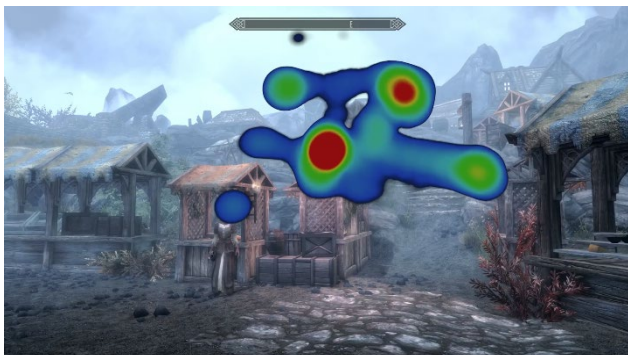


Figure 11 Eye Tracker Heatmap Example [9]

4.3 Survey Process

Each playtester completed an uninterrupted playthrough of the level, with each session lasting approximately 20-30 minutes. Following the session, the player completed a survey to assess their experience within the level. The survey was conducted online through Qualtrics XM and comprised a total of 42 questions, including multiple choice, stack ranking, and short answer questions.

5 RESULTS AND ANALYSIS

5.1 Playtester Count

A total of 16 playtesters participated in the playtest.

5.2 Playtester Demographics

All the playtesters have played video games regularly. 23% of the playtesters plays open-world games regularly. Among the playtesters, around 69% of the players have played *The Elder Scrolls V: Skyrim* before.

5.3 Data Analysis

The researcher analyzed both quantitative and qualitative data collected from the post-playthrough survey and compiled them into charts. Subsequently, the researcher analyzed the results of the eye-tracking heatmap during the playthrough. Finally, the researcher cross-compared the results from these two different sources to determine the effectiveness of the best practices within this level.

Below shows case studies of player's path preferences in three different areas.

5.3.1 Path Preferences – Lower Market Area

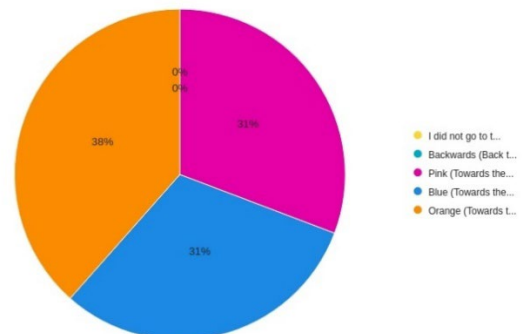


Figure 12 Player's path choice in the Lower Market Area [10]

As you can see, the spread of the player who has chosen to take either path in this area is even, with the orange path to the left being slightly higher by a margin. The

players decide to go for the left route that leads them to the lower farmhouse area.



Figure 13 Eye Tracker Heatmap Composite of Lower Market Area [9]

The composite heatmap results shown in Figure 13, reveal that players predominantly focus on the center of the screen, briefly diverting their attention to objective texts and subtitles as they appear. Notably, within this composite, players demonstrate a tendency to shift their gaze towards the right side of the screen, particularly drawn to the illuminated and red-lit market stalls. This observation suggests that players' attention is captivated by the dissonance created by the lighting and colors in that composition.

5.3.2 Ranked Effectiveness of Each Design Principle

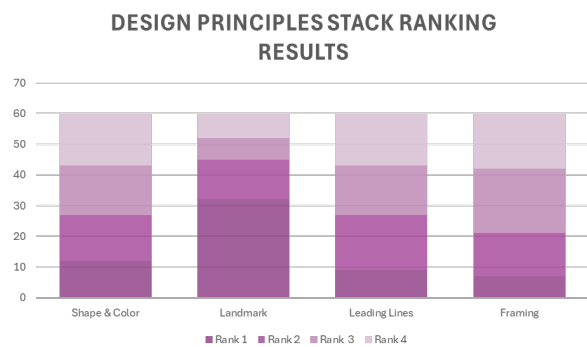


Figure 14 Effectiveness of Each Design Principles [10]

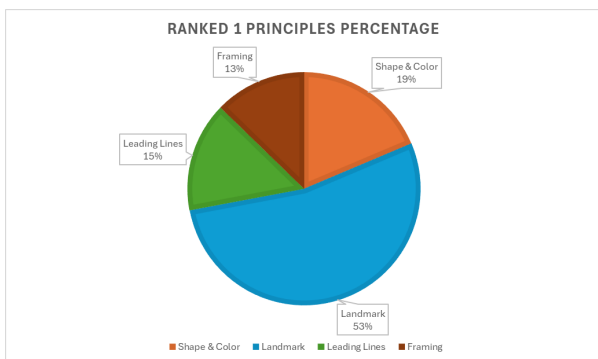


Figure 15 Percentages of Design Principles Ranked First [10]

As seen in Figure 14, when players are asked to rank the effectiveness of each design principle on a stack rank question. Landmark is the design principle that has been ranked 1 the most. In Figure 15, it shows that 53% of the

players think Landmark is the most effective principles out of all four principles across the entire level.

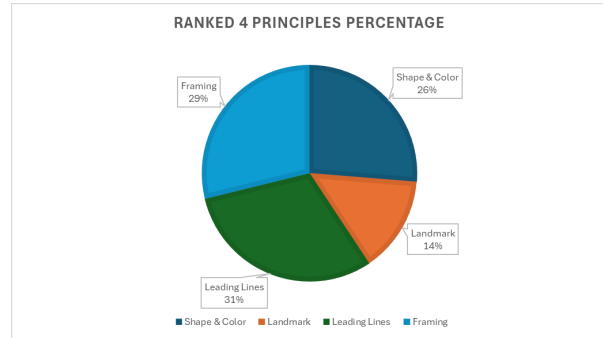


Figure 16 Percentages of Design Principles Ranked Last [10]

As seen in Figure 16, the design principle that is ranked last the most often by players is Leading Lines. 31% of players think that Leading Lines is the least effective method out of the four principles.

5.3.3 Memorable Elements from the Player's Perspective

Along with quantitative data collected from the survey and the eye tracker, the survey also collected qualitative data that explains the Player's mental images of the level after the playthrough.



Figure 17 Elements players found most memorable [10]

As seen in Figure 17, when players are asked what they found the most attractive and memorable in the lower market area, the most frequent answer would be "the market stalls", or the "red color stalls". This result shows that the players notice and remember dissonant elements within given level compositions.

6 SUMMARY

6.1 Challenges and Suggestions

6.1.1 Eye-Tracking Data Collection

When employing eye-tracking as a data collection method, it's important to recognize that the data only captures real-time player reactions to gameplay. The eye-tracking

data provides insight into what elements attracted the player's attention at any given moment. However, it does not provide context for the decisions made by the player. While recording real-time visual stimuli aids in analyzing immediate player attraction, it does not fully assess the overall effectiveness of each element in influencing player decision-making processes.

6.1.2 Objective Markers vs. Objectives

The absence of objective markers is meant to see how the player navigates in an openly explorable level without the marker. The development process shows that even though objective markers are taken out of the level, quest objectives are still critical in the context of open world level design. The researcher believes that quest design is an integral part of open world level design and open world navigation, but it is out of the scope of this research.

6.2 What was effective and what was not?

Based on the aggregated feedback from all 16 playtesters, the most effective best practice appears to be creating dissonance through the utilization of both global and local landmarks. This is closely followed by the use of shapes and colors. Conversely, Framing and Leading Lines were found to be less effective compared to other methods.

The eye-tracking data revealed that shapes and colors exert the most immediate influence in capturing the player's attention. However, qualitative findings from surveys indicate that players tend to recall landmarks more prominently than other elements within the same composition.

The results also gave insight into how each best practice influences player's experience:

- **Best Practice 1** – The eye-tracking data reveals that all players exhibited a natural inclination towards dissonant elements within each composition. Their gaze consistently gravitated towards dissonance more frequently than towards unity.
- **Best Practice 1a** – The survey data indicates that Landmarks are the most effective method for attracting attention and identifying memorable areas within a large, open level. It significantly outperforms the other methods, earning the highest ranking among the four. Particularly in an open level setting, Landmarks prove to be exceptionally effective.
- **Best Practice 1b** – The survey data shows that Framing is among the less effective methods out of the four principles. Players tend to notice other forms of dissonance before acknowledging framing as a significant factor.
- **Best Practice 1c** – The survey data, alongside the eye-tracking data, underscores that shapes and colors are highly effective in promptly capturing the player's attention within any composition.
- **Best Practice 2** – The playthrough records and eye-tracking data reveal a dynamic shift in perception: prolonged exposure to dissonance

prompts the emergence of a new sense of unity, while the previous unity transforms into the new dissonance.

6.3 Conclusion

All five best practices derived from research on design principles, the Push and Pull theory, and conveyance and layout significance are presented as effective guidance for navigating an open-world level to a certain extent. Among these, four out of five best practices are shown to be particularly effective. Notably, Landmark and Shape & Color are highlighted by players as more impactful in creating significant dissonance within an established unity, as they were ranked higher.

Through a cross-analysis of survey results and eye-tracking data, the researcher observed that what initially attracts the player's attention does not necessarily dictate their subsequent decisions. While players may notice various forms of dissonance within the composition, other factors such as quest objectives, personal interests, and interactions with living beings (NPCs) also influence decision-making processes.

Although players pay attention to most living beings (NPCs) within the scene, the impact of object compositions within a level is not negligible, as evidenced by the eye-tracking results.

Addressing the issues outlined in section 6.1 regarding factors that can affect data collection or player in-game decisions is crucial. By doing so, navigation within an open-world level is expected to become smoother, and it becomes more feasible to gather information on the factors influencing players' decisions to commit to certain paths.

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