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Exploring the Use of Color as an Informational Layer in Video Game Design

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Resumo

Este estudo aprofunda a utilização da cor como uma camada de informação no design de videogames. Apesar da prevalência da cor nos videogames modernos, existe uma escassez de investigações sobre como a cor funciona especificamente como uma camada de informação. Esta pesquisa tem como objetivo colmatar essa lacuna, investigando as formas pelas quais a cor guia os jogadores, indica objetos ou personagens essenciais e fornece sinais visuais para mecânicas de jogo. Por meio de uma revisão abrangente da literatura, abordando uma ampla gama de tópicos, incluindo o uso geral da cor, a história dos videogames e vários aspectos do design de videogames, este estudo estabelece uma base para a compreensão da cor nos videogames. Com base nos conhecimentos adquiridos a partir da revisão da literatura, desenvolve-se uma taxonomia que compreende seis componentes: estética, navegação, emoção, progressão, significados e identificadores. A taxonomia serve como uma estrutura analítica para a subsequente análise de conteúdo, que examina sistematicamente os videogames para discernir padrões no uso da cor como uma camada de informação. As descobertas destacam os papéis multifacetados da cor no design de videogames e sublinham a sua importância no aprimoramento da jogabilidade. Ao desvendar o uso intrincado da cor, esta pesquisa contribui para o próspero campo do design de videogames.

Palavras-chave: Cor; Camada Informativa; Design de Videogames; Taxonomia.

Abstract

This study delves into the utilization of color as an informational layer in video game design. Despite the prevalence of color in modern video games, there is a scarcity of research on how color functions specifically as an informational layer. This research aims to address this gap by investigating the ways in which color guides players, indicates essential objects or characters, and provides visual cues for gameplay mechanics. Through a comprehensive literature review covering a broad range of topics including the general use of color, history of video games, and various aspects of video game design, this study establishes a foundation for understanding color in video games. Based on the insights gained from the literature review, a taxonomy is developed that comprises six components: aesthetics, navigation, emotion, progression, signifiers, and identifiers. The taxonomy serves as an analytical framework for the subsequent content analysis, which systematically examines video games to discern patterns in the use of color as an informational layer. The findings highlight the multifaceted roles of color in video game design and underscore its significance in enhancing gameplay. By unraveling the intricate use of color, this research contributes to the prosperous field of video game design.

Keywords: Color; Informational Layer; Video Game Design; Taxonomy.

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Abbreviations and Symbols

AOE	Area of Effect
CGA	Color Graphics Adapter
CTA	Calls -to - Action
DLC	Downloadable Content
EGA	Enhanced Graphics Adapter
FADT	Formal Abstract Design Tools
FPS	First Person Shooter
GPUs	Graphic Processing Units
HP	Health Point
HUD	Head Up Display
IBM	International Business Machines
MDA	Mechanics, Dynamics, Aesthetics
MOBA	Multiplayer Online Battle Arena
NES	Nintendo Entertainment System
NPC	Non-Playable Character
PXG	Player Experience Tools
QTE	Quick Time Event
RPG	Role-playing game
SNES	Super Nintendo Entertainment System
SVGA	Super Video Graphics Array
VGA	Video Graphics Array

Introduction

The emergence of video games can be traced back to the late 1950s and early 1960s, during which scientists at universities began exploring new ways of interacting with computers through Human-Computer Interaction research. This groundbreaking period laid the foundation for what would become a booming industry in the 1970s. The early video game industry expanded rapidly with the advent of arcade video games, gaming consoles, and home computer games. The increasing accessibility and affordability of these technologies led to a significant increase in the popularity of video games.

However, during the infancy of video game development, technology was still rudimentary, and hardware limitations resulted in games that were mostly colorless or possessed a very limited color palette. Kent elaborates on this by stating that “early vector-graphics hardware could not generate colors, so many companies placed colored plastic overlays on their games to create the illusion of color” (Kent, 2010). This was in stark contrast to other media such as film, television, and comic books, which had already been employing color as a vital tool for setting mood, evoking emotions, and telling stories.

In recent years, the video game industry has experienced exponential growth, establishing itself as the largest entertainment industry in the world in terms of both revenue and customer base. Color has now become an essential component in video games, used for creating immersive and captivating worlds.

However, despite its rapid growth in recent years, the video game industry is still relatively new compared to other well-established industries, and as such, presents ample opportunities for research. Through our investigations, we have discovered that, although there have been many studies on various aspects of video game design, there is a noticeable gap in the literature concerning the use of color as an informational layer. An informational layer refers to a

component or aspect of a system or environment that conveys information to users to enhance understanding, facilitate navigation, or aid decision-making. Previous research has mainly focused on visual aesthetics and player performance but has not delved into the specific ways color can guide the player, indicate important objects or characters, and provide visual cues for gameplay mechanics.

Focusing on what was done before, it is worth mentioning a couple of works. Starting with the work entitled *Colors and Emotions in Video Games* (2010), Evi Joosten, Giel van Lankveld, and Pieter Spronck conducted an experiment to examine if the lighting of the room can influence players' emotions. For the experiment a level for *Neverwinter Nights* (2002) was built. The level consists of five rooms - one neutral room and four rooms colored light blue, dark green, yellow, and red - that were designed to correspond to different emotions: surprise, fear, joy, and anger, respectively. The results of the experiment indicated that the color manipulations had little effect on experienced players, however, some players reported feeling a heightened emotional response in certain rooms. Specifically, the red room elicited a negative emotional response, and the yellow room elicited a positive emotional response. The study provides evidence for the potential impact of color on players' emotional experiences in video games.

Also, there were attempts to measure the influence of color on the player's performance. In their work, Igor Knez and Simon Niedenthal — "Lighting in Digital Game Worlds: Effects on Affect and Play Performance" created three equally different mazes, using Half Life 2 engine editor — Hammer. Each room had its own color: warm (reddish), cool (bluish) and neutral (grayish) lighting. They found that players performed fastest in the warm (reddish) maze, regardless of their level of experience (Knez & Niedenthal, 2008). On a similar note, "The Effect of Lighting, Landmarks, and Auditory Cues on Human Performance in Navigating a Virtual Maze" by Daryl Marples, Duke Gledhill, and Pelham Carter (Marples et al., 2020), aimed to test the findings of Knez and Niedenthal's study. The authors conducted research into the impact of lighting, landmarks, and audio cues on player performance. The results revealed that players were able to complete mazes faster when presented with a path that was slightly brighter in comparison to the other paths, and auditory cues had an impact as well. Furthermore, the colorization of the environment was found to not have a significant impact on navigation, which contradicts the results of the study conducted by Knez and Niedenthal.

Recognizing this gap in research, my study had aimed to explore the usage of color as an informational layer in video game design. We had intended to accomplish this through a combination of literature review and content analysis. The literature review had covered a broad range of topics, from the general use of color to the history and evolution of video games and

their design. This comprehensive analysis had granted us a deep understanding of how color was used in everyday life, and how it had been integrated into video games over time.

Following the literature review, the content analysis had focused on examining video games to identify patterns and understand how color was used as an informational layer. With the knowledge acquired from the literature, we had proceeded to create a taxonomy that included components such as aesthetics, navigation, emotion, progression, signifiers, and identifiers.

The significance of this research lies in its potential to contribute to the field by highlighting an often-overlooked aspect of video game design. By identifying how color is used as an informational layer, this research aims to pave the way for more in-depth future research.

First, we examine color to gain a deeper understanding of its role and importance. Following this, we transition to the subject of video games, studying their history and the evolution of color usage with the advancement of technology. In the subsequent chapter, we delve deeply into video game design, providing valuable insights into the game creation process. After assimilating all this information, we define the term “informational layer” and analyze various games. In the discussion section, we deliberate on our findings and their implications. Finally, in the conclusion, we summarize all of the collected material and outline potential future work.

1. Color

Color is essential to our daily experiences, playing a pivotal role in shaping our perceptions and interactions with the world. Its significance is evident in various contexts, including navigation, fashion, architecture, and the visual arts. Color is a crucial aspect of design and aesthetics, and it can be used to evoke emotions, communicate ideas, and create visually appealing experiences. Therefore, understanding the principles and properties of color is essential for designers seeking to create compelling products.

Everything that surrounds us, we perceive through color, but what is color? The dictionary¹ provides us with the general definition, color is a characteristic of an object or substance based on how it reflects light. It is usually identified by observing the object's hue (what we normally refer to as the specific color), saturation (the intensity of the color), and brightness (how light or dark the color is). The eye senses color through its rod cells, which are sensitive to luminance and function at low light levels, and cone-cells, that are responsible for color vision. However, the perception of color takes place in the mind and is nearly always at an unconscious level. From a physics point of view, color refers to the visual sensation related to distinct wavelengths of light. While white light, which encompasses all wavelengths, is seen as devoid of color, light with a single wavelength corresponds to a particular hue. The assortment of colors observed in a rainbow occurs due to the selective bending, or refraction, of light with varying wavelengths by a prism (Sears & Zemansky, 1949).

There is another way of looking at color. For most people, color is not just a technical or scientific phenomenon but a highly expressive and emotional element of life. While color may be rooted in the physical properties of light and reflection, it is often perceived as a means of distinguishing objects, conveying ideas, and eliciting emotions. Whether it is the color-coded

¹ (*Definition of Color* | *Dictionary.com*, 2019)

lines of a subway system, calming blue hospital rooms, or the use of warm hues to create a sense of excitement, color is an essential tool in design and aesthetics. As Linda Holtzschue writes in her book *Understanding Color: An Introduction for Designers*, color is “stimulating, calming, expressive, disturbing, exuberant, symbolic. It pervades every aspect of life, embellishes the ordinary, and gives beauty and drama to everyday objects.” (2017, p. 1)

1.1 Perception of Color

Based on the aforementioned definitions, it is apparent that multiple variables and mechanisms affect color perception, which is a product of the interaction of light with the eye and the brain. Numerous factors, including visual acuity, cultural background, and personal experiences, influence an individual's interpretation and recognition of color. Furthermore, the perception of color can be influenced by environmental factors, including lighting and the surrounding context.

For instance, the colors perceived through reflected light are inherently unstable and susceptible to changes. Relocating an object from one type of lighting to another, such as from daylight to fluorescent light, or when the intensity of the light source changes, can cause a noticeable shift in its apparent color. This is called color constancy and it is a perceptual phenomenon where the human brain perceives the colors of objects as relatively constant, even under varying lighting conditions. Our visual system achieves color constancy through complex processing and integration of information from different parts of the visual scene. This allows us to recognize and differentiate objects based on their color, regardless of the lighting conditions. The brain considers the context of the scene, the light source, and the interactions between objects and the environment to maintain a consistent perception of colors.

Altering the positioning of a color against other colors can also cause it to appear as multiple colors, this is known as simultaneous contrast. For instance, two identical lemons placed on different colored tablecloths, such as red and orange, will appear distinct, with one having a more orange-yellow hue and the other having a more red-yellow hue.

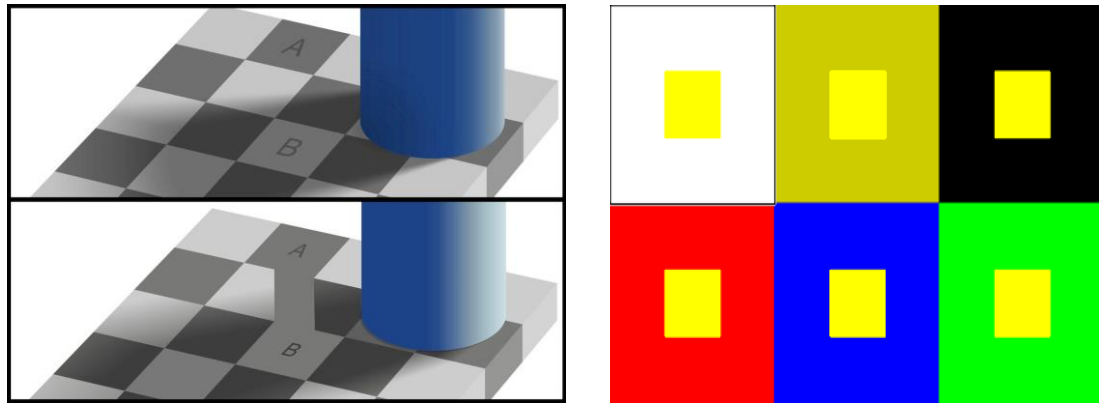


Figure 1: Color constancy (right), simultaneous contrast (left).

At the same time, colors observed through direct light are comparatively more stable since as long as the wavelength of light does not change, the color will be consistently perceived as the same. Nevertheless, despite this stability, it is challenging to translate colors of light into real-world colors. For example, the color of a carpet differs significantly from its representation on a screen, and both differ from the color displayed on a printed page.

Ultimately, the instability of colors is further exacerbated by the subjective element of human perception and the concept of qualia, which refers to individual experiences of sensory phenomena. People may perceive and interpret colors such as “true red” differently, whether observed as direct or reflected light. Moreover, when colors are employed symbolically, their meanings can vary depending on the culture and context in which they are presented. It is also crucial to recognize the prevalence of color vision blindness, which affects approximately 1 in 12 men and 1 in 200 women. Color blindness is not a uniform condition; there are various types, such as deuteranopia, a common form of “red-green” color blindness and tritanopia a common form of “blue-yellow” color blindness, with total color blindness being much rarer. These conditions are characterized by the inability to perceive or differentiate between specific colors or, in rare cases, all colors (NHS, 2017).

While color perception subjectivity is an important aspect of color theory, this thesis will not analyze individual variations in color perception in the context of video games. Instead, the focus will be on exploring the usage of color in video games as an informational layer without considering differences in color perception due to factors such as experience or culture. Although color perception subjectivity can impact a player's experience with a game, it is not a central concern in this work. It is worth noting that game developers are becoming increasingly aware of the potential for individual variations in color perception. They are working to create games that are accessible and inclusive to a diverse range of players. Increasing accessibility and inclusivity

includes developing systems that allow players to customize color settings or provide alternative visual cues to accommodate different levels of color vision. When a player starts a game, they may have certain expectations regarding the use of color. However, the game provides indicators and explanations that allow the player to understand and adapt to the color choices made by the developers. Moreover, the player will accept the given color relation during the play sessions.

1.2 Psychology of Color

Despite the disparities in the perception and interpretation of color among individuals, they have consistently captivated human interest. As societies and cultures developed over time, various colors acquired distinct associations and symbolism. For instance, colors have been used to convey emotions, status, or power, as well as to represent abstract concepts or natural elements. Furthermore, specific colors have become deeply ingrained in different cultures' traditions, art, and literature, shaping how people relate to and understand the world around them.

Johann Wolfgang von Goethe was a German writer, poet, and philosopher who also made significant contributions to the field of color theory. His color theory was based on his observations of the physiological effects of color on the human eye and mind. In his book *Zur Farbenlehre*², originally published in 1810, Goethe proposed a holistic approach to color that emphasized the subjective experience of color rather than its physical properties.

Goethe's theory differs from the prevailing scientific view of his time, which was based on the work of Isaac Newton and focused on the physical properties of light. Goethe's approach was more phenomenological and sought to describe color perception from the viewer's perspective.

Goethe identified six primary colors: yellow, orange, red, violet, blue, and green. He also proposed that each color had a symbolic significance and emotional effect. For example, he believed yellow was associated with warmth and joy, while blue was associated with coolness and melancholy.

² Translates as *Theory of Colours*.



Figure 2: Johann Goethe's color wheel.

Despite its initial controversy, Goethe's *Theory of Colours* has had a lasting influence on the field of color theory. It has inspired many subsequent artists and thinkers to explore the subjective and psychological aspects of color perception (von Goethe, 1810/1967).

One such explorer, inspired by the work of Goethe, was Robert Plutchik³. In his book *EMOTION: Theory, Research, and Experience* (Plutchik & Kellerman, 1980), he proposed a theory of emotions that classified them into eight primary emotions: joy, sadness, anger, fear, trust, disgust, surprise, and anticipation. The theory suggests that different hues and shades of color can elicit different emotional responses in individuals and that these responses are rooted in our evolutionary history. In *The Nature of Emotions* (2001), Plutchik presented the “wheel of emotions,” a color wheel that mapped each primary emotion to a corresponding color. The color wheel included more nuanced emotions, such as love, submission, and remorse, as well as a gradient of intensities within each emotion. Plutchik's work has influenced fields such as art, advertising, architecture, branding, and psychology, and his color wheel continues to be used as a tool for understanding the psychology of color.

³ It is important to note that both Goethe's and Plutchik's theories on color largely represent Western perspectives and may not encompass the diverse cultural interpretations of color found globally.

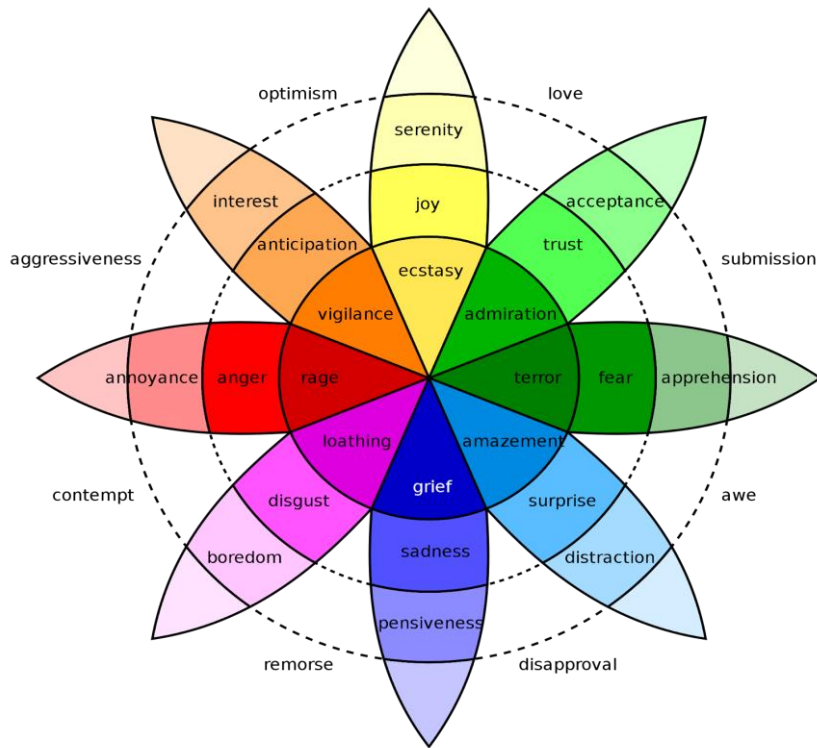


Figure 3: Plutchik's wheel of emotion.

1.3 Usage of Color

With the advancement of research in color and its psychological effects, a correlation has been established between our psychological associations and meanings for different colors and their influence on the usage of color in diverse contexts. As a result, the practical application of this knowledge has been widely utilized in fields such as design, marketing, and healthcare. By strategically implementing colors in these areas, it has been possible to elicit specific emotions or moods, influence behavior, and communicate ideas more effectively.

Hospitals often use colors like green, blue, beige, white, and pastels in patient rooms to create a calming environment that promotes healing and reduces stress. Roger Ulrich's (1984) study demonstrated that visually stimulating and positive environments could enhance patient recovery. Similarly, Nada Ibrahim and Malak Al-Mansour's (2015) research in dental clinics showed that warm colors lead to higher satisfaction, lower stress levels, and a more relaxed physiological response, which can also apply to hospitals.

Specific colors have various effects: green can reduce anxiety and promote tranquility, blue can lower stress and blood pressure, beige creates a welcoming atmosphere, white signifies cleanliness and hygiene, and soft pastels encourage relaxation. By understanding color influences, hospitals can create environments that foster healing and well-being.

The psychology of color has been shown to significantly affect learning and behavior in educational settings, such as schools and classrooms. A study by Jennifer D. Ballen and Hersh C. Waxman (2018) examined the effects of classroom color on student learning and teacher behavior. Their findings revealed that students in classrooms with warm colors, such as yellow and orange, reported higher levels of engagement and motivation, while those in classrooms with cool colors, like blue and green, experienced lower levels of stress and anxiety. Furthermore, teachers in warm-colored classrooms reported more positive and supportive behavior than those in cool-colored classrooms.

Incorporating these insights, schools increasingly use color in classrooms to optimize learning, engagement, and student behavior. Various colors, including blue, green, yellow, red, and neutral shades, impact the classroom environment differently. Blue, for instance, fosters a calming atmosphere, enhances creativity, and promotes productivity, making it an ideal choice for math or science classrooms. On the other hand, green encourages relaxation, reduces stress, and creates a tranquil environment, making it suitable for art or music classrooms.

Yellow stimulates the brain, promotes creativity, and enhances energy and positivity, making it ideal for social studies or language arts classrooms. Red, while increasing heart rate and blood pressure, can also boost energy and excitement, so it should be used sparingly in classrooms. Neutral colors like beige, gray, or white create a professional and calming environment, ideal for business or technology classrooms.

Educators should carefully consider these color choices and their effects when designing classroom environments, as they can impact student success and the overall atmosphere in which learning occurs.

In a broader context, color, as a visual cue, can not only have psychological effects but also serve as a carrier of information. One such example is the standardized color scheme of traffic lights worldwide, which consists of three colors: red, yellow (amber), and green. The red light serves as a signal for drivers to come to a complete stop at the stop line or before entering the intersection. For pedestrians, a red light corresponds with a *Don't Walk* or hand signal, indicating that it is unsafe to cross the street. The yellow light functions as a warning that the light is about to change from green to red, signaling drivers to slow down and prepare to stop if it is safe to do so. For pedestrians, the yellow light typically denotes that the crossing signal is about to change, and they should not begin to cross. Finally, the green light indicates that it is safe for vehicles to

proceed through the intersection as long as the way is clear. For pedestrians, a green light is generally accompanied by a *Walk* signal or a walking person symbol.

In certain countries or situations, traffic signals may feature supplementary signal phases or hues, such as a green arrow to permit left or right turns with protection, a flashing red light to direct stop-and-go traffic flow, or a flashing yellow light to alert drivers to proceed with caution. These additional signals convey more specific information to drivers and pedestrians in various traffic scenarios, enhancing situational awareness and promoting safer travel practices.

An important aspect to consider in the design of traffic signals is color vision deficiencies, such as deuteranopia. For individuals with deuteranopia, distinguishing between red and green can be challenging. Here, the standardized positioning of traffic light signals, with red on top, yellow in the middle, and green at the bottom, becomes crucial. Even if the colors are difficult to distinguish, the consistent positioning allows these individuals to interpret the signals correctly.

Furthermore, traffic lights are often designed with different brightness and saturation levels for each light, and the green light is sometimes given a more bluish tint, all to assist those with color deficiencies like deuteranopia⁴.



Figure 4: Standard traffic lights (left); traffic lights perceived by a person with deuteranopia (right).

Color is an essential feature of traffic signs, as it conveys information and promotes safe travel practices. The use of specific colors in traffic signs is standardized across most countries to ensure universal recognition and understanding of the information conveyed. For instance, red is commonly used to indicate prohibitions or requirements, such as stop or yield signs. Yellow or amber signals caution or warning, such as in school zones or construction areas. Green typically

⁴ One of the most common forms of color blindness: a red-green color blindness.

signals a permissive action or direction, such as indicating that it is safe to proceed or indicating the direction of an exit. Blue is often used to denote guidance or information, such as indicating the location of services or amenities. In addition to these standard colors, orange is often used in temporary or work-related signs. In contrast, black and white are used for regulatory signs, such as speed limits or parking restrictions.

Road markings represent an essential category of traffic signs and are typically used to guide and regulate traffic flow. Among the commonly employed colors for road markings, white remains predominant due to its high contrast on concrete surfaces, rendering it readily discernible by drivers. White road markings are frequently used to indicate the centerline of a road or lane boundaries, crosswalks, stop lines, or pedestrian paths.

In contrast, yellow road markings are another crucial color utilized in roadworks or construction zones. During these circumstances, yellow markings take precedence over white markings and are designed to provide drivers with clear guidance and safety instructions. Drivers are obligated to follow new, temporary yellow road markings, as they are designed to regulate traffic flow in changing or potentially hazardous situations.

Moving beyond roadways, color also plays a significant role in architecture and urbanism. In the books *Color in Architecture* (Linton & Loukides, 2012) and *Colour for Architecture Today* (Porter & Mikellides, 2009), the authors examine the application of color theory in architectural design. For example, they discuss how colors can influence the perception of space, with light colors creating the illusion of increased spaciousness and dark colors fostering a sense of intimacy. Furthermore, bright colors can emphasize architectural features or design elements, while muted colors can recede into the background and yield a more subtle effect. The authors also explore the concept of color as information, emphasizing its role in enhancing navigation and orientation within urban spaces and buildings. They illustrate how colors can convey information in various contexts, such as wayfinding, identification of functional spaces, and improving built environment legibility. Additionally, *Colour for Architecture Today* highlights the significance of color coding in complex environments like airports, hospitals, and educational institutions (Porter & Mikellides, 2009).

While two previous works explore color theory and its application in architectural design, Küller's article (1999) and Mahnke's book (1996) both emphasize the importance of color in urban environments for wayfinding, orientation, and the creation of a sense of place. They highlight the informative aspect of color in enhancing the overall functionality and user experience in different settings. A key aspect that unites these works is their focus on using color to improve safety, accessibility, and navigation in urban spaces, such as through the use of bright or contrasting

colors on crosswalks, bicycle lanes, and pedestrian infrastructure, or by differentiating between zones or districts within a city.

Building on the concept of color as a means of conveying information - maps, whether digital or analog, are used to navigate urban and outdoor areas. They use color to convey information effectively and efficiently, helping users understand spatial relationships and make sense of complex data. Analyzing the works of Tyner (2014) and Dent et al. (2009), it becomes clear that color can be applied in various ways on maps to enhance their readability and usability.

Color can be used to represent different categories or groups of data. For example, political maps often use distinct colors to differentiate between countries, states, or provinces. In this context, colors have no inherent order or value but are used to separate and identify regions visually.

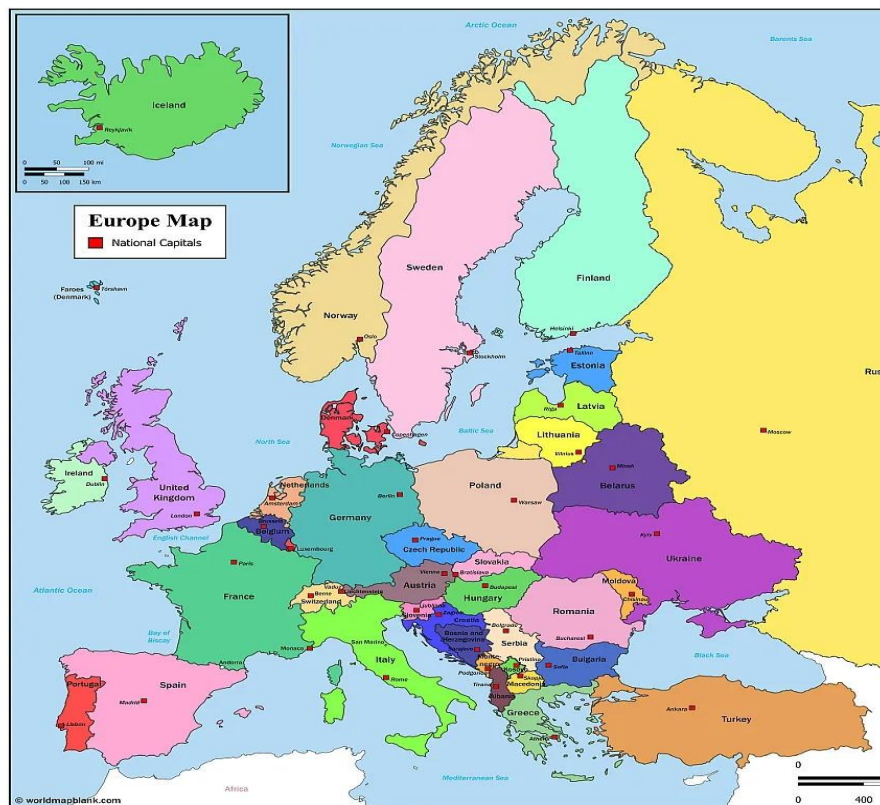


Figure 5: Political map of Europe.

Sequential color schemes are used to represent data that have an inherent order or progression, such as elevation, temperature, or population density. Sequential schemes usually employ a range of colors that transition smoothly from one hue to another, with lighter colors

representing lower values and darker colors representing higher values. This approach helps users understand the relative differences between data points and identify patterns or trends.

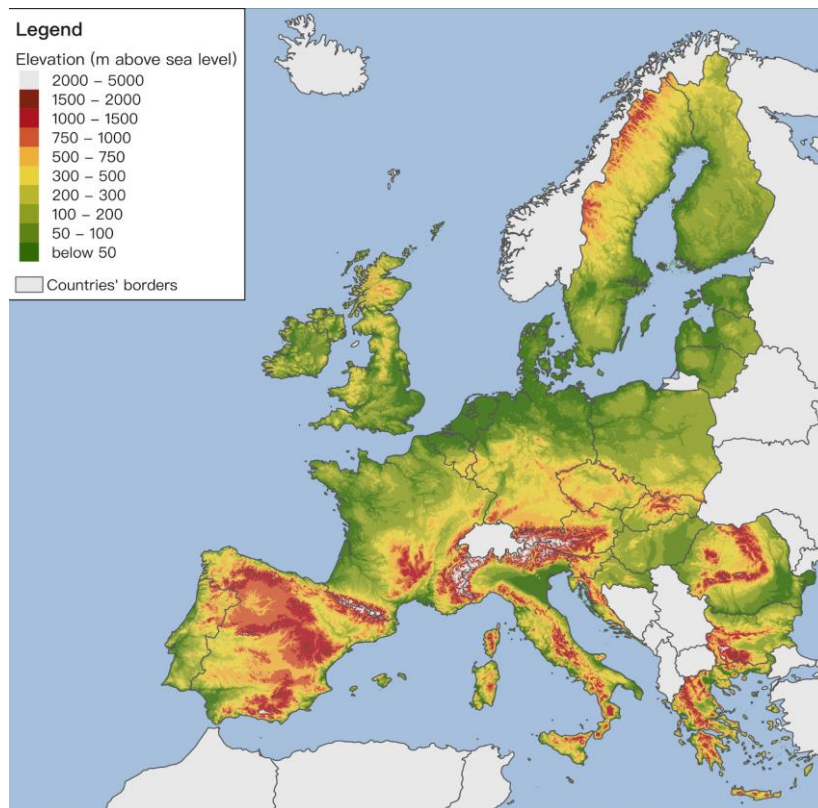


Figure 6: Topographic map of Europe.

In figure 7 we see how diverging schemes are used for data with a central value or breakpoint, such as the difference between two time periods or the deviation from an average value. These schemes typically employ two contrasting colors that diverge from a neutral midpoint, helping users identify areas with positive or negative changes or deviations from the central value.

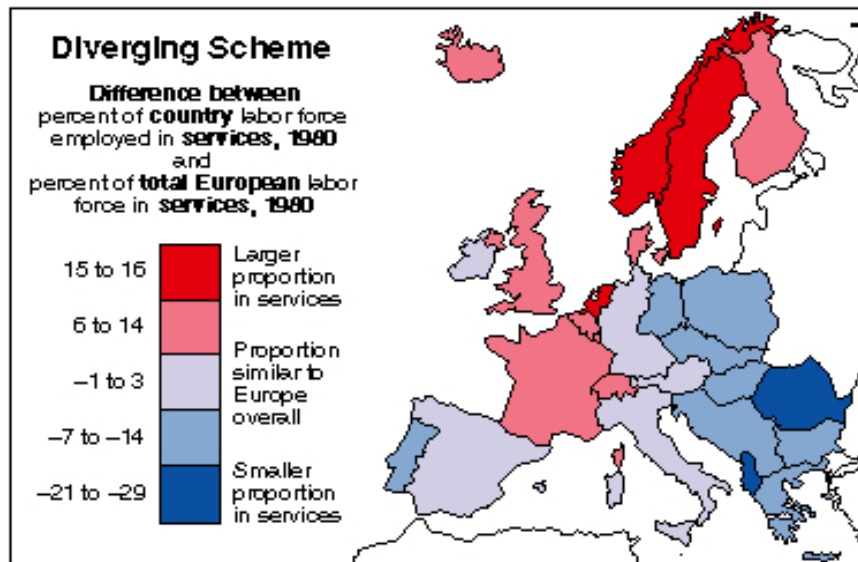


Figure 7: Diverging map of Europe.

In addition to that, as can be seen in figure 8, there are thematic maps and navigational aids. In thematic maps, color can be used to represent specific themes or variables, such as land use, vegetation, or demographic data. Different hues or shades can be assigned to each theme or variable, making it easy for users to identify specific patterns or distributions across a geographic area. For navigational aids, color can highlight important features or landmarks on a map, such as major roads, rivers, or points of interest. They can help users to better orient themselves and plan their routes.



Figure 8: Vegetation map of Europe.

Moving beyond maps, a common item used more frequently than maps is the banknote. The primary function of color in this context is to enable users to swiftly and effortlessly distinguish between various denominations. Euro banknotes employ color to convey information, aiding users in swiftly and effortlessly distinguishing between different denominations. Each denomination of the Euro banknote features a unique color, simplifying individuals' identification and differentiation process. The color scheme for Euro banknotes consists of €5: Gray; €10: Red; €20: Blue; €50: Orange; €100: Green; €200: Yellow-brown; €500: Purple.

In addition to color, Euro banknotes exhibit variation in size, with higher denominations being larger than lower denominations. This difference in size further assists visually impaired individuals in distinguishing between the banknotes with greater ease.



Figure 9: Euro banknotes different in size and color.

Shifting our focus to consumer products, the role of color in product design is essential, as it is an effective communication tool that conveys information about a product's purpose, features, and target audience. Garber, Hyatt, and Boya (2008) emphasize that the appearance of nondurable consumer goods and their packaging, including color choices, can significantly influence consumer behavior. By allowing consumers to quickly understand and differentiate between products, color streamlines the decision-making process and enables users to select the most appropriate option for their needs. As a visual cue, color assists in identifying a product's function and features, ultimately improving the user experience and contributing to increased sales and customer satisfaction through effective packaging design.

For instance, cigarette packs frequently use different colors to signify the strength or flavor of the cigarettes. Red might indicate strong or full-flavored cigarettes, while blue could represent a lighter or milder version. Green packaging may suggest menthol cigarettes, while other colors might correspond to various special flavors or limited editions.

Another example is shampoo bottles, which employ color-coding to differentiate between products designed for different hair types, such as purple for blonde or silver hair, blue for anti-dandruff formulations, or green for oily hair. This color-coding enables consumers to swiftly identify the right product for their specific needs.

Similarly, cleaning products often utilize color to indicate their intended purpose or the surfaces they are designed for. For example, green might be associated with eco-friendly or natural cleaning products, blue with glass cleaners, and orange with degreasers or heavy-duty cleaning agents.

Medications and dietary supplements frequently adopt color-coding to distinguish between different types, strengths, or intended uses. According to Simas da Rocha et al. (2020), incorporating color-coding can significantly enhance clarity and understanding for consumers. For example, blue could be associated with a restful night's sleep, while vibrant red might be connected to swift alleviation of pain (Morton, 2011). This color-coding system helps users easily identify and select the appropriate medication for their specific needs.

In food packaging, color serves as a means to convey information about a product's flavor, nutritional content, or target demographic. For instance, red packaging might suggest spicy flavors, while green could denote a healthier or organic option. Furthermore, color can cater to specific age groups, such as utilizing bright, bold colors for children's products or opting for more muted, sophisticated hues for adult-oriented items.

Transitioning to digital environments, color plays a vital role in conveying information in user interfaces (UI) of websites, applications, and software, as discussed by Lidwell, Holden, and Butler in their work *Universal Principles of Design* (2010) and Gaultney in *The Role of Color in Human-Computer Interaction* (2011). It helps guide users through an interface, improving usability, accessibility, and overall user experience.

One way color conveys information in interfaces is by establishing a visual hierarchy. As Lidwell et al. (2010) explain, color can guide users' attention to the most important elements on a page or screen. Different colors or shades can be used to group related elements, improving the overall organization and readability of the interface.

Colors can also differentiate buttons and calls-to-action (CTA), making them stand out from the background and other interface elements. Color coded buttons and CTA's help users quickly identify interactive elements and understand their purpose. For example, a bright color like green or blue might be used for a primary CTA, while secondary actions might use more muted colors (Gaultney, 2011).

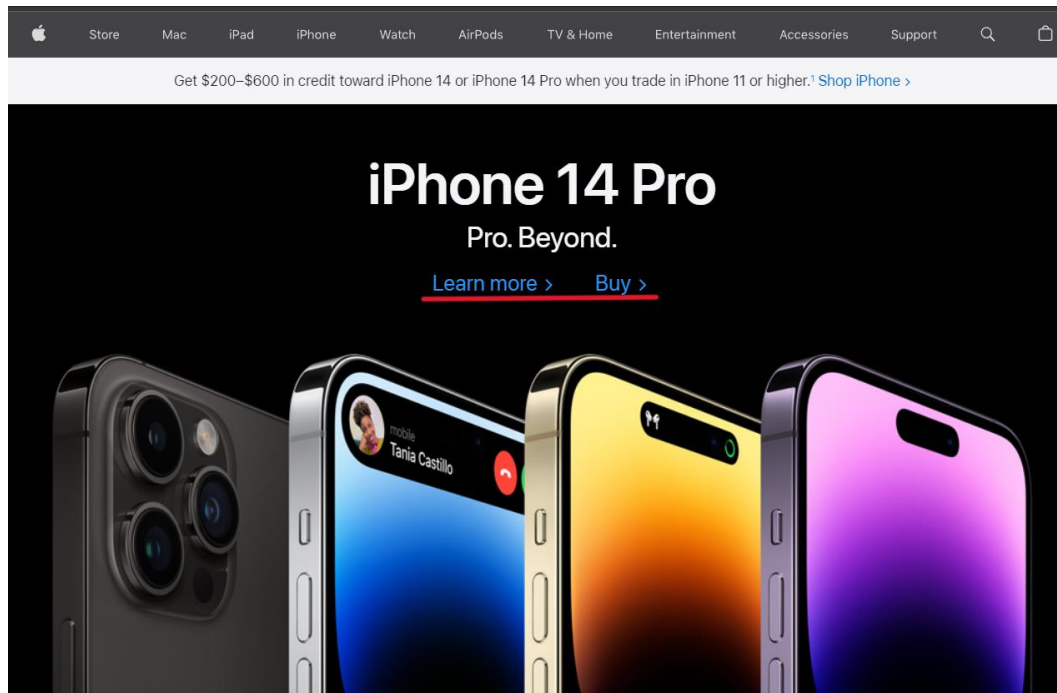


Figure 10: Blue call to action (Apple Inc,2023).

Additionally, color can highlight the active state of a navigation item, helping users understand their current location within an application or website. Highlighted navigation item improves usability by providing a clear visual cue for users to navigate between different sections or pages (Lidwell et al., 2010).

Colors can also be used to convey the status of a system or provide feedback to users about the results of their actions (Gaultney, 2011). For example, red might indicate an error or a critical issue, while green could signify success or completion. Yellow or orange might be used for warnings or intermediate states.

In interfaces, color can be used as a visual cue to suggest interactivity or functionality, as Lidwell et al. (2010) described. For example, underlined blue text is commonly understood as a hyperlink, while a grayed-out button might indicate a disabled or unavailable action.

Lastly, color can be used to ensure that interfaces are accessible to users with visual impairments or color vision deficiencies. High-contrast color combinations can improve readability and visibility, while avoiding color combinations that are problematic for users with color blindness can make interfaces more inclusive, as emphasized by Gaultney (2011) and Lidwell et al. (2010).

1.4 Usage of Color in Visual Media

Color is a fundamental element in various forms of visual media, such as film, television, photography, graphic design, digital art, and video games. Its versatile nature allows it to convey information, emotions, and atmosphere, and enhance aesthetics and visual appeal. The study of color vision, as explored in Gegenfurtner and Sharpe's book *Color Vision: From Genes to Perception* (1999), provides valuable insights into how humans perceive and process color, which can be applied to visual media.

In visual media, color is instrumental in creating specific moods and atmospheres. For instance, in the film *The Godfather* (1972), dark, desaturated colors create a somber and tense atmosphere, reflecting the nature of the crime world. In contrast, the vibrant colors in *The Wizard of Oz* (1939) evoke feelings of fantasy and wonder as Dorothy travels through the magical land of Oz.

Additionally, color can elicit particular emotional responses from the audience. The film *Amélie* (2001) employs bright, saturated colors to create a whimsical and enchanting mood, while *Schindler's List* (1993) uses black-and-white cinematography with the strategic use of red to emphasize the gravity of the Holocaust and focus on specific elements, such as the girl in the red coat.

Color also serves a symbolic function in visual media, representing various themes, ideas, or concepts. For example, in *The Matrix* (1999), the green tint symbolizes the artificial reality of the Matrix, while the blue tones represent the real world. Similarly, in the film *Vertigo* (1958), the color green is artfully used to reflect themes of mystery and to signify the protagonist's increasing obsession with Madeleine.

Moreover, color guides the viewer's attention and establishes a visual hierarchy within a composition. Artists, creators, and designers can emphasize specific elements and highlight the most important information or focal points by using contrasting colors or adjusting saturation levels.

Color is a powerful tool for enhancing storytelling and communicating narrative information. Techniques such as color grading can create visual continuity between scenes or suggest a specific time of day, while color symbolism can represent character traits, emotions, or plot developments. Overall, color is an indispensable component in visual media, contributing significantly to mood, emotion, symbolism, and narrative, as well as augmenting the overall aesthetic and visual appeal.

2. Exploring Video Games

Now, as we gather the background knowledge of the color, we can proceed to understand video games as a medium, on the way to explore color as an informational layer in video game design.

There are many definitions of what a video game is. From very technical, as in the book *Fundamentals of Game Design*: “a video game is a digital entertainment product that uses computer software technology to generate interactive experiences. These experiences involve real-time interaction between the user and the system, with feedback presented through graphical, auditory, and sometimes tactile outputs” (Adams & Rollings, 2006), to the most abstract as in the book *Half-real: video games between real rules and fictional worlds*: “a video game is an interactive medium that provides players with challenges and problems to solve in a rule-based environment. They are forms of play that allow players to engage in a structured experience, exploring different roles, narratives, and outcomes based on their decisions and actions” (Juul, 2005/2011).

Hence, our comprehensive definition of video game is as follows:

A video game is an electronic or digital form of interactive entertainment where players engage with a virtual environment, following a set of rules and objectives, by interacting with visual and auditory elements displayed on a screen. Video games can be played on various platforms, including personal computers, consoles, handheld devices, and smartphones.

Video games are complex systems composed of various layers. Key layers include the narrative, gameplay, aesthetic, sound, user interface, and technology. Each of these layers contributes to the overall experience, from the narrative that provides context and motivation, to

the gameplay mechanics (which will be discussed in greater detail later in this thesis) that present challenges, the aesthetics and sounds that create atmosphere and immersion, the user interface that facilitates control and interaction, and the technology that underpins the game's functionality.

Video games often involve challenges, problem-solving, competition, and storytelling, providing players with a dynamic and immersive experience. The level of interactivity and the use of multimedia elements differentiate video games from other forms of media, such as film, music or literature. Throughout their evolution, video games have increasingly harnessed the power of color to enhance player experiences, create immersive worlds, and convey essential information, despite initial technological limitations. But that was not always the case.

2.1 The History of Color Evolution in Video Games

In exploring the history of color in video games, this section relies on the expertise and research presented in three notable references: *History of Digital Games: Developments in Art, Design and Interaction* by Andrew Williams (2017), *High Score! Expanded* by Rusel DeMaria (2018), and *The Ultimate History of Video Games* by Steven L. Kent (2010). Drawing on these works allows for a comprehensive understanding of the evolution of color in video games over time.

In the early days of video gaming, developers were limited by the technology available at the time. The first ever video game, *Tennis for Two* developed in 1958 (Kent, 2010, p. 18), and the first commercial game *Pong* (1972), were constrained to be constrained to monochromatic graphics. Despite these limitations, these games laid the groundwork for the industry's future, capturing players' imaginations and paving the way for more advanced technologies.

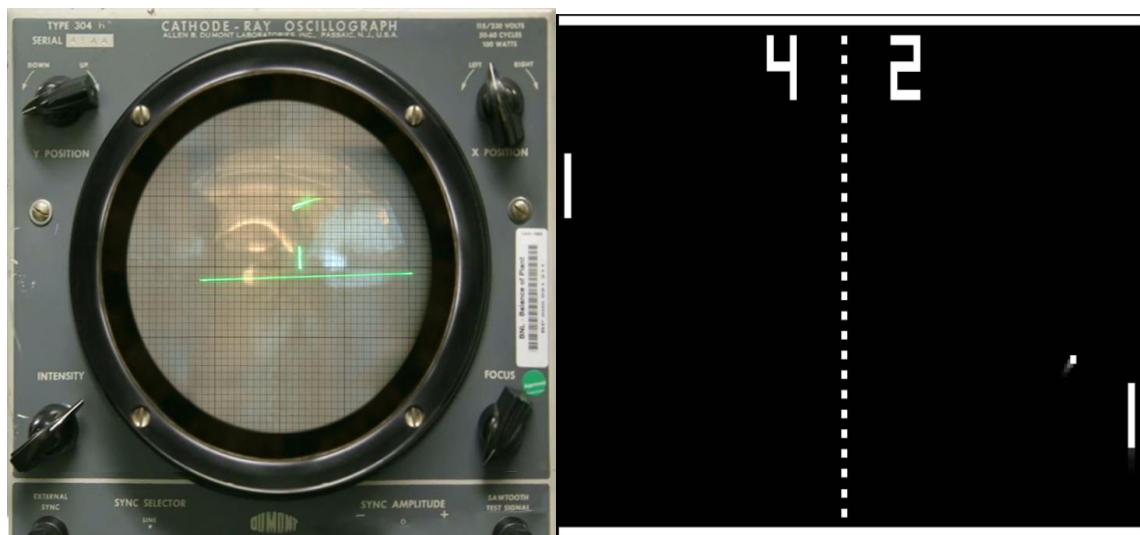


Figure 11: *Tennis for Two* developed in 1958 (left), and *Pong* released in 1972 (right).

As arcade games gained popularity in the late 1970s, developers sought ways to incorporate color into them. One solution was using plastic overlays on arcade machines, such as in *Space Invaders* (1978). These overlays were placed over the screen to give the illusion of color graphics, adding depth and visual interest to the gameplay experience.

The introduction of *Galaxian* (1979) marked a significant milestone in video game history, as it was the first game to feature multi-colored animated sprites. This achievement was made possible through advancements in hardware technology, allowing game designers to create more visually appealing and engaging experiences for players.



Figure 12: *Galaxian* (1979).

Between 1977 and 1980, Nintendo released a series of home consoles in Japan known as the Color TV-Game series. These consoles featured built-in color games and were designed to be connected to a color television set. The Color TV-Game series showcased Nintendo's early efforts in developing home video game systems with color graphics, laying the groundwork for the company's future success.

The Apple II (1977) was an early home computer with color graphics capabilities, providing both 6-color and 16-color palettes. The Apple II's color capabilities played a significant role in its popularity and helped set a new standard for home computing and gaming.

In 1981 IBM released the IBM PC. Initially, the IBM PC supported CGA (Color Graphics Adapter), which was the first color graphics card for IBM-compatible computers. CGA allowed for a maximum of 16 colors, but due to its limitations, it could only display four colors at a time at a resolution of 320x200 pixels.



Figure 13: Microsoft *Flight Simulator* (1982).

Early home consoles, such as the Atari 2600 (1977) and Intellivision (1979), brought color to home gaming for the first time, although with limited palettes. The Atari 2600 supported a palette of 128 colors, while the Intellivision had a 16-color palette. Despite these limitations, the consoles represented a significant leap forward in home gaming, as they allowed players to experience more visually appealing games compared to the previous systems.

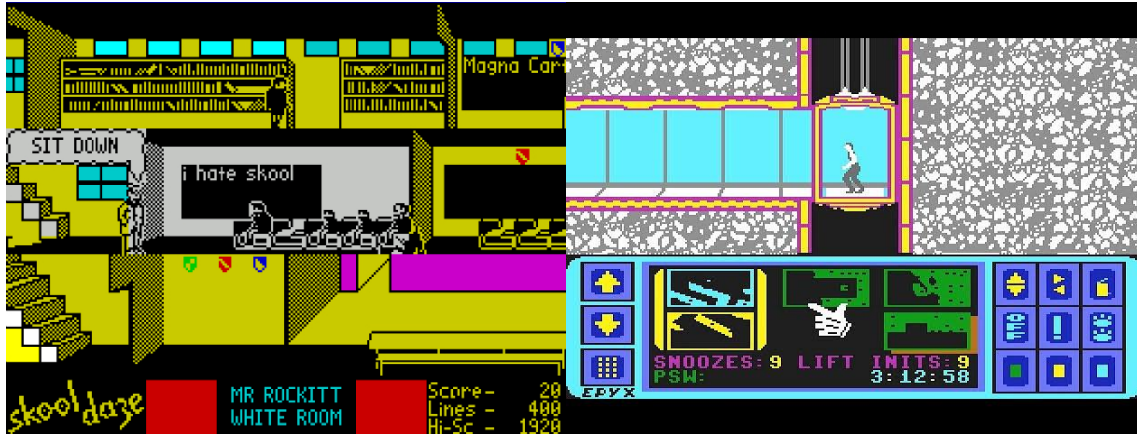


Figure 14: *Pitfall!* (1982) (left) and *Utopia* (1981) (right).

The 8-bit home computer era saw the introduction of the ZX Spectrum (1982) and the Commodore 64 (1982), both of which featured enhanced color capabilities. The ZX Spectrum, popular in the UK and Europe, featured a 15-color palette, while the Commodore 64, which saw widespread success in the US and other countries, provided a 16-color palette. These systems enabled game developers to create more visually engaging games, increasing the overall appeal of home gaming.

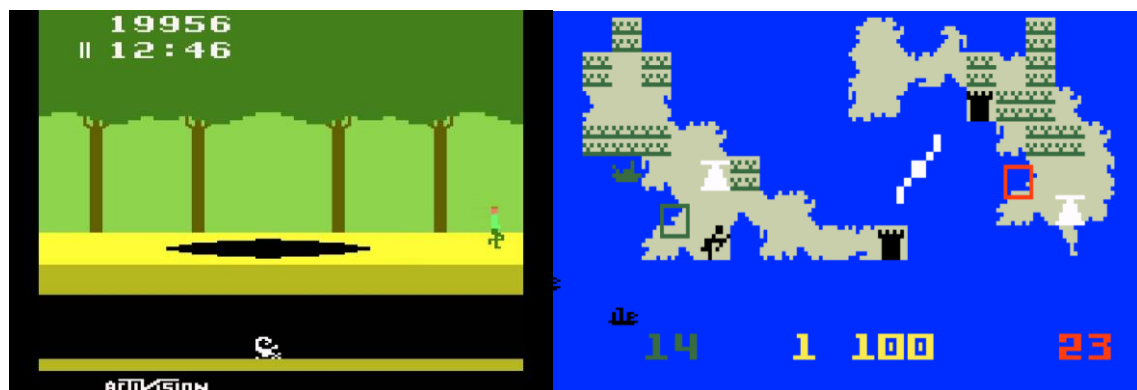


Figure 15: *Skool Daze* (1984) (left) and *Impossible Mission* (1984) (right).

The 8-bit home console era marked a significant improvement in color palettes for home gaming systems. The Nintendo Entertainment System or shortly NES (1983) and Sega Master System (1985) provided expanded color palettes that allowed for more detailed and vibrant visuals in games. The NES supported a palette of 54 colors, while the Sega Master System had a 64-color palette. Iconic games from this era, such as *Super Mario Bros* (1985) on the NES and *Phantasy Star* (1987) on the Sega Master System, showcased the capabilities of these systems and played a crucial role in the growing popularity of home gaming.



Figure 16: *Super Mario Bros* (1985) (left) and *Phantasy Star* (1987) (right).

In 1984, IBM introduced the EGA (Enhanced Graphics Adapter) as a successor to CGA. EGA offered an improved palette of 64 colors and supported higher resolutions, up to 640x350 pixels. While EGA could display 16 colors simultaneously, the choice of colors was more flexible than with CGA, allowing for more visually appealing games and software.



Figure 17: *King's Quest* (1984).

VGA (Video Graphics Array) emerged in 1987 as a new standard for computer graphics, developed by IBM for their Personal System/2 (PS/2) line of computers. VGA provided significant advancements over its predecessors, supporting a 256-color palette and a resolution of 640x480 pixels. With VGA, games could display up to 256 colors simultaneously, which enabled richer visuals and more complex designs in PC gaming.



Figure 18: *Sid Meier's Civilization* (1991).

The 16-bit era, marked by the release of the Sega Genesis (1988) and Super Nintendo Entertainment System, also known as SNES (1990), brought a significant increase in available colors for video games. The Sega Genesis supported a 512-color palette, while the SNES boasted an impressive 32,768-color palette. This advancement in color capabilities allowed for more detailed and vibrant visuals in iconic games like *Sonic the Hedgehog* (1991) on the Sega Genesis and *The Legend of Zelda: A Link to the Past* (1991) on the SNES.



Figure 19: *The Legend of Zelda: A Link to the Past* 1991 (left);
Sonic the Hedgehog 1991 (right).

The early 1990s witnessed the introduction of Super VGA (SVGA), which expanded upon the capabilities of VGA by offering higher resolutions and color depths. SVGA's advancements

laid the groundwork for modern graphics processing units (GPUs) that nowadays support millions of colors and high-definition resolutions, greatly enhancing the visual fidelity of video games.



Figure 20: *Duke Nukem 3D* (1996).

The 32/64-bit console era ushered in the age of 3D graphics, with the Sony PlayStation (1994), Sega Saturn (1994), and Nintendo 64 (1996) leading the charge. These consoles brought more advanced color capabilities and higher-resolution graphics to the forefront, showcased in landmark titles such as *Panzer Dragoon* (1995) on the Sega Saturn, *Super Mario 64* (1996) on the Nintendo 64, and *Final Fantasy VII* (1997) on the PlayStation.



Figure 21: *Panzer Dragoon* (1995).



Figure 22: *Super Mario 64* (1996).



Figure 23: *Final Fantasy VII* (1997).

High-definition gaming and increased color depth became the standard with the release of the PlayStation 2 (2000), Xbox (2001), and GameCube (2001). These consoles offered improved color depths and higher-resolution graphics, enabling more visually stunning games like, *Star Wars Rogue Squadron II: Rogue Leader* (2001) on GameCube, *Halo: Combat Evolved* (2001) on the Xbox and *God of War* (2005) on the PlayStation 2. The advancements in color and graphical capabilities during this era further contributed to video games' growing appeal and immersive nature.



Figure 24: *Star Wars Rogue Squadron II: Rogue Leader* (2001).



Figure 25: *Halo: Combat Evolved* 2001



Figure 26: *God of War* (2005).

The next generation of consoles, the Xbox 360 (2005) and PlayStation 3 (2006), raised the bar for gaming by introducing advanced High-definition graphics and a wider color gamut. These consoles supported higher color depths and more detailed textures, further enhancing the visual quality of games such as *Gears of War* (2006) on the Xbox 360 and *Uncharted: Drake's Fortune* (2007) on the PlayStation 3. The improved graphical capabilities offered by these consoles allowed for more immersive and visually stunning gaming experiences.



Figure 27: *Gears of War* (2006).

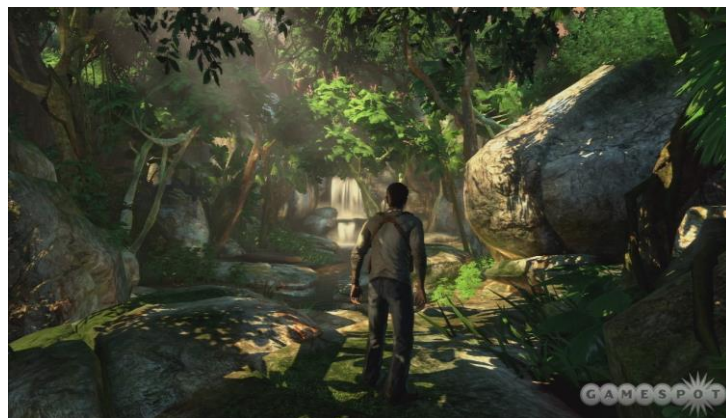


Figure 28: *Uncharted: Drake's Fortune* (2007).

The era of photorealism and advanced lighting began with the release of the PlayStation 4 (2013), Xbox One (2013), and advancements in PC gaming. Developers pushed the boundaries of color and lighting techniques, creating realistic and breathtaking visuals in games like the *God of War* (2018) series and *Forza Horizon 4* (2018). The improved hardware allowed for higher-resolution textures, more complex shaders, and advanced lighting techniques, resulting in more lifelike and immersive gaming experiences.



Figure 29: *God of War* (2018).



Figure 30: *Forza Horizon 4* (2018).

Ray tracing, a cutting-edge rendering technique, was introduced in modern GPUs like NVIDIA's RTX series, taking color and lighting to a new level. Ray tracing provides more realistic reflections, shadows, and global illumination in games, significantly enhancing visual fidelity. With the release of the PlayStation 5 (2020) and Xbox Series X & S (2020), ray tracing also became a prominent feature in console gaming. Games like *Demon's Souls* ⁵(2020) on the PlayStation 5 and *Gears 5: Hivebusters* (2020) on the Xbox Series X & S showcase the stunning visual improvements that ray tracing brings to gaming, elevating the overall experience and setting a new benchmark for realism in the medium.

⁵ Remake of the game initially released in 2009



Figure 31: *Demon's Souls* (2020).



Figure 32: *Gears 5: Hivebusters* (2020).

2.2 Business Aspect of Video Games

Over the past few decades, the video game industry has seen remarkable growth, establishing itself as a highly influential and profitable entertainment medium. It has outpaced other entertainment sectors, such as film and music, in terms of revenue generation.

In 2020, the global video game market was estimated to be worth \$159.3 billion, demonstrating the industry's immense success. This accomplishment is a result of continued advancements in technology, the proliferation of gaming platforms, and the diversification of

video game genres, enabling the industry to surpass other entertainment sectors like film and music in terms of revenue generation (Field Level Media, 2020).

The business aspect of video games encompasses many elements, including marketing efforts, distribution channels, and diverse monetization approaches. According to Matthew Perrotta (2020), to generate income, video game companies have employed an assortment of business models tailored to their specific needs and target audiences.

One such model is traditional sales, which entails selling physical copies of games through retailers or digital copies via online platforms like Steam or the PlayStation Store. Consumers typically pay a one-time fee for a game in this model. Over the years, as technology has advanced, platform manufacturers have begun using unique colors to distinguish their products. For example, Sony opted for blue-colored boxes for PlayStation 4 games and switched to white for PlayStation 5 boxes. Microsoft, on the other hand, maintained a consistent green color palette for two generations of their consoles. Nintendo, another player in the gaming console market, uses a distinct red color and smaller box size to set itself apart from competitors.

Furthermore, there are also various, color marked editions of games available to cater to different consumer preferences. These editions, such as standard, deluxe, gold, and ultimate, often offer different levels of content and bonuses for players.

A standard edition typically includes the base game, while a deluxe edition comes with additional content, such as extra in-game items, digital artbooks, or soundtracks. A gold edition features all the story content available, and a ultimate edition contains everything offered in the other editions, plus exclusive bonuses or access to future downloadable content (DLC). These various editions allow gamers to choose their preferred level of content and investment when purchasing a video game.



Figure 33: Different game boxes per platform: PC; PlayStation 4; PlayStation 5; Nintendo Switch; Xbox Series X & S

A distinct approach is subscription services, where companies like Xbox and PlayStation provide subscription-based services such as Xbox Game Pass or PlayStation Plus tiers. Users pay a monthly fee to access a library of games, with these services gaining popularity for their affordability and convenience.



Figure 34: Different editions of the *Far Cry 6* (2021).

Microtransactions have emerged as a popular monetization strategy in recent years. Microtransactions in video games encompass various forms, offering different options for players and allowing developers to monetize their games in diverse ways. Players can purchase in-game currency with real money, which can then be used to acquire items, services, or features that enhance their gaming experience. It is a common practice to have multiple in-game currencies of different colors, that signify its rarity, and the items players can buy with these currencies.



Figure 35: *Clash of Clans* premium currency, of green color, that can be bought with real money, and in-game yellow currency that can be bought with premium currency or earned through playing the game.

Downloadable content is another popular form of microtransaction, where players can buy additional content, such as new storylines, maps, or characters, to expand the base game. Season passes offer a bundled approach, granting access to multiple DLC packs or other exclusive content at a discounted price. Cosmetic items, which enable players to personalize their characters without affecting gameplay, often use specific colors to indicate rarity. Common items are typically gray, while rare items are usually orange or purple. These in-game items are frequently found in microtransactions.

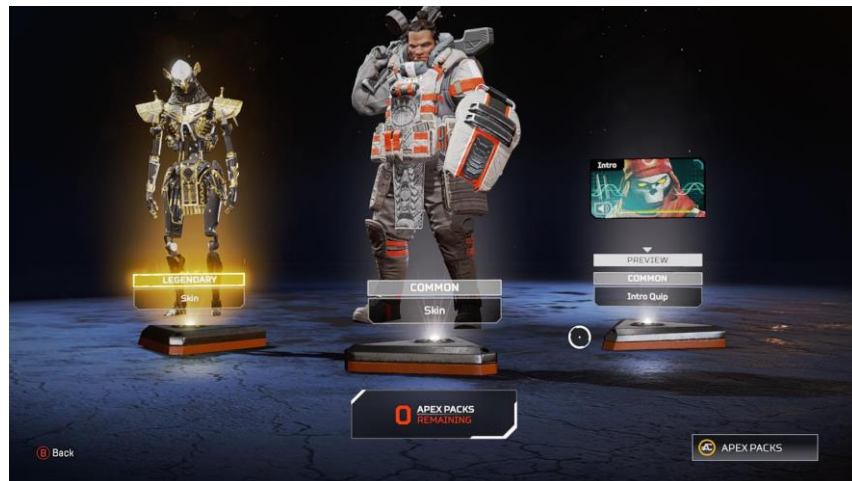


Figure 36: *Apex Legends* skins rarity.

Overall, these various types of microtransactions enable developers to generate revenue while providing players with choices on how to personalize and enhance their gaming experience. The diagram (see Figure 2.) demonstrates the value of the video game consumer market in the world in the period from 2011 to 2021. A gradual decrease in the package market, physical copies of the games, from \$22.4 billion in 2011 to \$8.4 billion in 2021 is observed, while there is a steady increase in the DLC market from initial \$5.3 billion to \$28.9 billion in 2021. Notably, in the middle of the given period the two markets were almost equal in their value, but it took the DLC market only 3 years to reach the highest rate of package market of around \$22 billion and to outdo the latter by \$6.5 billion in 2021.

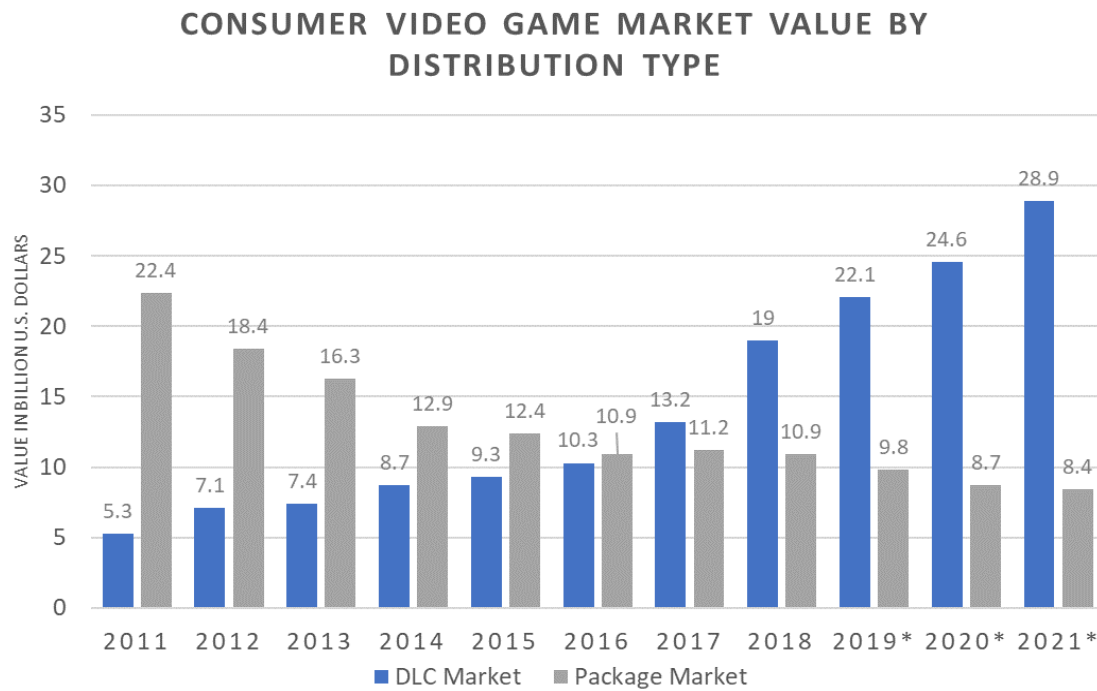


Figure 37: Video game consumer market value worldwide from 2011 to 2021, by distribution type (Statista, 2022).

In addition to these models, many games, especially in the mobile gaming market, utilize a free-to-play model that allows users to download and play games at no initial cost. Revenue is generated through in-game purchases or microtransactions, including cosmetic items, in-game currency, or additional content. Finally, some games, particularly in the casual and mobile gaming sectors, incorporate advertising as a means of revenue generation. These ads can appear as banners, pop-ups, or sponsored in-game content.

The immense growth and success of the video game industry can be seen not only in its revenue figures but also in its cultural impact. Video games have evolved from simple, niche forms of entertainment to a significant cultural force influencing various aspects of society, including art, education, and social interaction.

2.3 Social Aspect of Video Games

The social aspect of video games is another crucial element that contributes to their cultural significance, as gaming has evolved from a solitary, often stigmatized hobby into a widely accepted form of entertainment and social interaction. Today, video games facilitate communication, collaboration, and the formation of communities, transcending geographical

boundaries and connecting players from diverse backgrounds. The social side of video games has also contributed to gaming culture's growth and mainstream acceptance.

Communities are integral to the social aspect of video games, as they create a sense of belonging and connection among players who share common interests. These communities often manifest as online forums, websites, social media groups, subreddits, Discord channels, or in-game guilds and clans. Players can discuss game strategies, share experiences, and build friendships with fellow gamers.

Examples of such communities include speedrunning communities, which focus on completing games as quickly as possible. They share their knowledge, tactics, and achievements on platforms like speedrun.com and through live streaming events such as Games Done Quick. Modding communities are centered around modifying existing video games to create new content, enhance gameplay, or fix technical issues. Two of the most famous modding websites are nexusmods.com and moddb.com (Sanford, 2016). Additionally, competitive gaming communities exist where players discuss strategies and follow professional teams. There are also fanart and fanfiction communities where creative gamers express their love for games through art and storytelling, sharing their work and collaborating on fan projects. Websites like DeviantArt and Archive of Our Own (AO3) are popular hubs for sharing fanart and fanfiction across various gaming fandoms.

Retro gaming communities are another example, dedicated to preserving and celebrating the history of video games, often focusing on older consoles and titles. They share their collections, memories, and knowledge through forums, social media groups, and websites dedicated to retro gaming.

The social aspect of video games extends beyond the previously mentioned communities, as it also encompasses the evolution of gaming clubs and the rise of esports. While computer clubs were more prevalent in the past, they fostered close relationships among members who shared a common interest in improving their gaming skills. This enthusiasm for competition eventually paved the way for local tournaments, which have grown into large-scale gaming events with millions of viewers worldwide.

Esports, or electronic sports, have become a vital part of the gaming landscape. Competitive gaming has developed into a thriving industry that attracts professional players, teams, sponsors, and spectators globally. Esports typically involve organized, multiplayer tournaments featuring various game genres. For instance, Multiplayer Online Battle Arena (MOBA) games like *Dota 2* (2013) and *League of Legends* (2009), First-Person Shooter (FPS) games such as *Counter-Strike: Global Offensive* (2012) and *Overwatch 2* (2022), and Battle Royale games like *Fortnite* (2017) and *Apex Legends* (2019) have all become popular esports titles. Additionally, the popularity of

mobile gaming has led to an increase in mobile game tournaments, with games like *Arena of Valor* (2016) and *Clash Royale* (2016) emerging as notable examples. This diverse range of esports offerings further expands the reach of competitive gaming within the gaming community, showcasing the rich and dynamic nature of the social aspect of video games.

To promote and raise awareness about their tournaments, organizations utilize publications. The video game industry is teeming with various events, including new releases, updates, game jams, conferences, showcases, and tournaments. Like other media, video games have their dedicated journalists and publications to keep up with this dynamic landscape. The presence of these publications, both online and in print, highlights the growing importance and impact of gaming across different aspects of culture and society.

There are publications dedicated to developers, academics, and researchers, serving as a platform for sharing knowledge, insights, and analyses of video games and the gaming industry. The other type caters to the general public, providing news, upcoming releases, and interesting facts about their favorite games. Journalists like Jeff Grubb, Jason Schreier, and Patrick Klepek work in this field, contributing to the ongoing discourse and understanding of games.

Content creators in the gaming industry can be seen as a new form of grassroots journalists, as they independently produce content related to video games, such as game reviews, critiques, tutorials, walkthroughs, news, and updates. These individuals, often game enthusiasts themselves, work independently or collaborate with fellow enthusiasts, offering a genuine and relatable perspective on gaming. Their scope extends beyond merely covering news and new releases, providing a diverse range of content to their audience.

Many content creators showcase their gameplay by streaming live gaming sessions on platforms like Twitch or uploading recorded videos with commentary on YouTube. Live streams, in particular, offer a unique interactive experience, as viewers can engage with the streamer and other viewers through chat functions in real-time.

Some content creators use video games as a storytelling medium, producing machinima (machine cinema) by recording and editing gameplay footage to create original content. This form of content highlights the creative potential of video games beyond their intended gameplay experiences.

These content creators also help foster communities around the games they play, uniting like-minded individuals who share a passion for gaming. These communities engage in discussions, share experiences, and support one another, further enriching the social aspect of gaming.

Content creators not only entertain and inform their audience, but also contribute to the visibility and popularity of games. They can influence consumer behavior, generate hype for

upcoming releases, and even impact game development by providing feedback and suggestions. As a result, content creators have become an integral part of the gaming industry and its ever-evolving culture.

One thing in particular, that has a strong community around it and often organized by content creators or video games resources, is the game jams. These are events where participants come together to create and develop video games within a short timeframe, typically ranging from 24 hours to a week. Game jams have emerged as a crucial aspect of the gaming community. They offer a platform for game developers, artists, designers, writers, and other enthusiasts to collaborate, learn, and challenge themselves in a creative and supportive environment.

Numerous game jams are held around the world, both in-person and online, with well-known examples including the Global Game Jam, Ludum Dare, and itch.io-hosted jams. These events often feature specific themes or constraints, spurring participants to think creatively and develop games that fit within those guidelines. The main goals of game jams encompass innovation, collaboration, skill development, networking, and fun. These events encourage participants to think outside the box, experiment with new ideas, and foster teamwork among diverse groups of individuals. Participants can improve their skills in various areas of game development, meet like-minded people, and form partnerships for future projects. Game jams also emphasize a spirit of fun and creativity, pushing individuals to create something they can be proud of within the limited time available. The core experience and aim of game jams is game design.

3. Video Game Design

As we delve deeper into the world of video games, it is essential to explore the creative force behind these immersive experiences: game design. In this chapter, we will discuss the core concepts, principles, and methodologies underpinning video game design. Understanding the intricacies of game design will allow us to create useful insight for video game developers on the usage of color as an informational layer in video game design.

Game design is a multidisciplinary process that combines creativity, technical expertise, and an understanding of player psychology to shape the rules, systems, mechanics, and aesthetics of a game. The goal of game design is to create a balanced and cohesive experience that is fun, enjoyable, and memorable.

At the heart of game design lies the establishment of rules and systems that define the boundaries and constraints within which players interact. These structures govern how players make choices, solve problems, and progress through the game, ultimately shaping the core gameplay experience.

Game mechanics, the fundamental building blocks of a game, are carefully designed and balanced⁶. Balanced game mechanics ensures that each player's actions, interactions, and strategic decisions contribute to the overall challenge and depth of the game. Furthermore, designers must carefully align mechanics with narrative and world-building elements, as these provide the player with context, motivation, and emotional resonance.

World-building, storytelling, and aesthetic⁷ elements are paramount in creating a cohesive and appealing game experience. Game designers collaborate with writers, artists, composers, and sound designers to develop a unified aesthetics that helps establish the game's theme and integrates seamlessly with the narrative and gameplay mechanics.

⁶ Indie or more experimental games sometimes are purposefully unbalanced.

⁷ Aesthetics will be further discussed in the chapter 4.

Moreover, user interface (UI) design is a crucial aspect that facilitates player interaction with the game's systems and mechanics. A well-designed UI enhances the gameplay experience by providing clear, intuitive controls and feedback.

This holistic approach to game design ensures that players are fully immersed in the game world, leading to a deeper emotional investment in the experience. In the next section, we will delve deeper into the practices that guide this complex design process.

3.1 Design Practices

Throughout the years, certain practices have been formulated to help game designers create engaging and successful video games. Game design practices are multifaceted, encompassing a wide array of methodologies, techniques, and approaches used to craft and refine video games. At their core, these practices promote iterative processes, a player-centric mindset, efficient communication, and collaboration. They offer essential frameworks to guide the game design process, ensuring it remains organized and leads to a quality, engaging end product. However, it is crucial to note that these practices are not fixed or universal. They can and should be adapted to suit different contexts, team sizes, resources, and creative visions.

In the AAA industry, which often involves large teams with hundreds or even thousands of developers, these practices might appear more procedural and standardized. The iterative design process, for example, involves ongoing refinement of game elements through cycles of prototyping, playtesting, and feedback. Changes are made based on observations, player feedback, and data collected during playtesting, enabling designers to identify and address issues, fine-tune gameplay, and optimize the player experience (Fullerton, 2004/2014).

However, in smaller or independent teams, the design process can be more fluid, experimental, and even subversive. Independent developers, unburdened by the constraints that large studios might face, often have the freedom to experiment with unconventional ideas, innovate beyond established design patterns, and bring unique, creative visions to life. This is not to say that indie developers do not use established practices. They do, but they often blend these practices with unique approaches, guided by their creative objectives.

Moreover, game design is an inherently creative field, and purpose and innovation are integral to this process. Whether a team is developing a blockbuster, AAA title, or an indie game, the aim is to create something engaging, compelling, and meaningful. This often involves balancing established practices with the need for creativity and innovation, which sometimes means pushing boundaries or even breaking traditional design patterns. This blend of established

practices and innovative approaches is what makes the field of game design so dynamic and exciting.

Player-centered design places the needs and preferences of players at the forefront of the design process, ensuring games are accessible, enjoyable, and engaging. This approach requires understanding player motivations, designing for different player types, and catering game mechanics and systems to the target audience's preferences (Desurvire et al., 2004).

Iterative design allows for flexibility, scalability, and easier updates or expansion by designing game components modularly. This approach streamlines the development process by simplifying testing, debugging, and maintenance, as well as enabling designers to create reusable assets and systems that can be easily adjusted, combined, or repurposed for various game scenarios or future iterations (Schell, 2008).

Effective communication and teamwork are essential in the inherently collaborative nature of game design. Professionals from various disciplines work together to ensure that all aspects of a game contribute to a cohesive, engaging experience. Designers often use design languages, shared documentation, and regular meetings to facilitate collaboration and maintain a clear, unified vision for the game.

These game design practices guide the overall development process and are instrumental in shaping the game mechanics — a critical component of the game's structure. The iterative design process allows for the continual refinement of mechanics, ensuring they provide a balanced, engaging experience. A player-centered approach ensures that the mechanics cater to the preferences and play styles of the target audience. Modular design facilitates the fine-tuning of mechanics, enabling designers to adjust, combine, or repurpose them as needed. Moreover, effective communication and teamwork enable a collaborative approach to mechanics design, ensuring they align with the game's overall vision and contribute to a cohesive, engaging player experience. In the following section, we will investigate the concept of game mechanics, exploring their definition, importance, and their role in shaping gameplay and player experience.

3.2 Mechanics

Following our exploration of video game design practices, it is crucial to consider a fundamental component of game design: game mechanics. As defined by Adams in *Fundamentals of Game Design* (2009), mechanics refers to “The challenges presented to a player and the actions the player is permitted to take, both to overcome those challenges and to perform other enjoyable activities in the game world” (p 640, 2006/2009). These mechanics form the structural backbone

of any video game, shaping the gameplay and defining the player's interaction with the game world.

The role of mechanics in gameplay is far from passive; rather, they actively shape the play experience. As discussed by Adams & Dormans in *Game Mechanics: Advanced Game Design* (2012), game mechanics drives the game's dynamics, creating a context for meaningful play. Mechanics and dynamics serve as the underlying system that determines the actions a player can take, the rules that guide these actions, and the consequences of these actions. This intricate system of cause and effect directly influences the player's experience and interaction with the game.

Game mechanics come in various types, each with its unique contribution to the gameplay. Sicart (2009), in his work *Defining Game Mechanics*, categorizes mechanics into several types. For instance, physics mechanics define the game world's rules; social mechanics govern the interaction between players, and progression mechanics deal with the player's progression in the game. This variety of mechanics provides a rich toolkit for game designers to create diverse and engaging gameplay experiences.

In the hands of game designers, these mechanics become the building blocks of engaging and balanced gameplay experiences. By strategically combining different mechanics, designers can generate a range of player experiences and emotions. This interplay between mechanics and design is further emphasized in *Game Mechanics: Advanced Game Design* (Adams & Dormans, 2012), underscoring mechanics' pivotal role in game design.

An essential concept to consider when discussing game mechanics is the Mechanics, Dynamics, Aesthetics (MDA) framework, developed by Robin Hunicke, Marc LeBlanc, and Robert Zubek in 2004. The MDA framework emphasizes the interplay between mechanics (the particular components of the game), dynamics (the behavior of the mechanics acting on player's inputs and each other's outputs over time), and aesthetics (the desirable emotional responses evoked in the player, when interacting with the game system). Mechanics, the first component of the MDA framework, are thus foundational to the game design process.

Having examined the perspectives of several authors and texts, it becomes evident that game mechanics, though varying in form and function, embody a shared essence. They represent the rules and procedures that govern the interaction between the player and the game. These mechanics structure the game world's physical laws and dictate player progression. They provide a crucial structure, guide gameplay, and create a context for meaningful play. Regardless of their differences, they serve as the tools designers use to generate dynamics and, ultimately, shape the player's experience. Hence, our definition of game mechanics is as follows:

Game mechanics are the rule-based systems or procedures within a game that facilitate and structure interaction, driving the dynamics of gameplay and directly influencing the player's experience and emotional response.

This definition is the one that this thesis will adopt and keep in view in subsequent analyses of video games.

In summary, game mechanics is the bedrock of game design, deeply influencing gameplay and player experience. Visual elements in a game not only contribute to the aesthetic appeal, creating the game's look and feel, but they can also serve as crucial indicators within the gameplay mechanics. Mechanics can subtly guide players' interaction, for instance, through distinctive colors or shapes indicating specific interactive objects or paths. However, it is important to note that these elements function within both the aesthetic and mechanical realms of game design, intricately tying the players' sensory and emotional experience to their interactive engagement with the game world. As we transition into discussing video game design languages, it is essential to understand that these languages are often built around game mechanics. Therefore, understanding mechanics is a fundamental steppingstone in our exploration of video game design, especially when considering the role of color as an informational layer.

3.3 Design Languages

Video game design languages extend beyond merely serving as tools and terminologies for conveying ideas or mechanics. They are woven into the very essence of game design itself, forming a vital component of the game's expressiveness. The design languages can manifest in various forms – be it visual, like concept art, wireframes, or mock-ups; textual, such as design documents or scripts; or even abstract forms like game design patterns. These languages create a common vocabulary and structure that allow designers to not only articulate their vision and foster collaboration among team members, but also ensure consistency and coherence across all game elements. More than just facilitators of the design process, these design languages become a part of the game's substance, influencing player interactions and shaping gameplay outcomes. Over time, such numerous design languages have emerged, each offering a unique perspective and approach, thereby enriching the field of game design.

Doug Church proposed another notable design language in the article *Formal Abstract Design Tools* (FADT) (1999), which emphasizes the formal elements of game design, such as rules, resources, and objectives. FADT provides a systematic approach to analyzing and designing

games by examining their structure and identifying the core elements that contribute to the gameplay experience.

Game Design Patterns by Staffan Björk, Jussi Holopainen, and Sus Lundgren (2003), as well as *Pattern Language for Game Design* by Christopher Barney (2020), are two significant sources providing collections, or libraries, of reusable solutions to address common challenges encountered in game design. These compilations of patterns offer valuable resources that designers can utilize when crafting the structure and elements of their games.

The patterns are not design languages in and of themselves; rather, they are components that can be selectively applied and arranged to create a project-specific design language. By identifying and integrating suitable patterns from these libraries, designers can streamline the development process, maintain consistency, and enhance the overall player experience. As such, each individual game project can possess its own unique design language, tailored to its specific needs and constructed from the patterns available in such resource libraries.

Lastly, the language proposed in *Assessing the Core Elements of the Gaming Experience* (Cairns et al., 2010), *Player Experience Goals* (PXG) focuses on the emotional and psychological aspects of the gaming experience. This framework helps designers identify and articulate the desired emotional responses, cognitive challenges, and social interactions they want to elicit in players, allowing them to create games that resonate with their target audience.

Each design language provides a unique lens through which to view and approach game design, addressing different aspects of the process and focusing on varying elements of the game experience. However, within these languages, there are also design syntaxes - the specific rules and principles that guide the use of these languages. Understanding these syntaxes is as crucial as understanding the languages themselves because they further refine the communication and implementation of game design ideas. In the upcoming section, we will look into design syntaxes, exploring their definition, importance, and how they interact with game design languages to shape the creation and interpretation of games.

3.4 Design Syntaxes

Design syntaxes are the rules and conventions that guide the arrangement and composition of elements within a game. Katie Salen and Eric Zimmerman in *Rules of Play: Game Design Fundamentals* (2004) emphasize the importance of these syntaxes in structuring designs coherently and consistently. These syntaxes ensure that the different components work harmoniously together to create a seamless and engaging experience for players. Understanding

and applying design syntaxes can significantly enhance a game's overall quality and facilitate communication and collaboration among team members.

Design syntax encompasses various aspects of a game, ensuring a coherent and intuitive experience for players. It deals with the layout, organization, and visual hierarchy of UI elements, such as menus and heads-up displays (HUDs), as well as the arrangement and interplay of gameplay elements, including characters, objects, and environments. Tynan Sylvester in *Designing Games: A Guide to Engineering Experiences* (2013) underlines the need for consistency across controls, mechanics, visuals, and audio for creating a familiar and predictable environment. This enables players to quickly learn and adapt to the game's systems and rules.

The visual hierarchy guides the player's attention and conveys important information, helping them easily understand and navigate the game world. Consistent affordances allow players to comprehend the possibilities and limitations within the game. The structure and pacing of challenges, rewards, and narrative significantly impact player engagement and accomplishment. Designers, as indicated by Salen and Zimmerman, must carefully balance challenge, reward, and story and character progression to create a satisfying and immersive experience.

Narrative design syntax involves organizing plot elements, characters, and dialogue to create a compelling and cohesive story, employing consistent themes, motifs, and narrative structures for an engaging and immersive experience.

Design syntax also applies to visual style, ensuring a cohesive aesthetic through the consistent use of colors, shapes, textures, and other visual elements. Ernest Adams and Joris Dormans, in their book *Game Mechanics: Advanced Game Design* (2012), highlight the importance of design syntax in character designs and environmental elements that build an immersive game world. The syntax of audio and sound design refers to the structured use of sound effects, music, and other auditory elements, creating a consistent soundscape that engages players by employing reliable sound cues, themes, and motifs.

Having explored the theoretical underpinnings of game design, we now transition from the abstract to the concrete. The effective application of design languages and syntaxes relies on a suite of tools, facilitating the transformation of these theories into engaging video game experiences.

3.5 Tools

In the complex and multifaceted world of video game design, various tools are employed to streamline the design process, enhance collaboration, and bring the creative vision to life. These

tools aid in developing, refining, and implementing various aspects of a game, such as mechanics, aesthetics, and narratives, ensuring that all components align with the principles and syntaxes discussed in the previous section. Some tools are specialized software applications, while others are methodologies or frameworks that guide the design process.

Firstly, we will discuss one of the tools that allows examining and evaluating the various components of a game to understand what makes it engaging, immersive, and enjoyable for the player. A comprehensive guide is Clara Fernández-Vara's *Introduction to Game Analysis*, originally published in 2009 and later revised in 2016. It offers a robust interdisciplinary framework drawing on concepts from game studies, literary theory, film studies, and other relevant fields, for understanding and evaluating video games from such perspectives as gameplay, narrative, aesthetics, culture, and technology. It explores core mechanics, player interactions, narrative structure, character development, and visual and sound design.

Fernández-Vara's approach is designed for students, researchers, and game enthusiasts interested in studying video games critically and systematically. It outlines different methods and techniques for analyzing games, and provides guidelines for conducting game analysis, including how to choose appropriate games for study, formulate research questions, and coherently present the findings.

For gameplay analysis, Fernández-Vara stresses the significance of understanding core mechanics, player interactions, and the overall game flow. By doing so, designers can identify potential improvements or adjustments that enhance the player's experience and lead to more engaging gameplay. The game analysis explores narrative structure, character development, and integration of story elements into gameplay, emphasizing cohesive storytelling that supports gameplay. Visual design analysis focuses on art style, color palettes, and visual consistency, underscoring the need for a cohesive visual language that contributes to game world immersion and supports mechanics and narrative. Lastly, the book examines sound design, emphasizing the importance of a cohesive and engaging soundscape that complements other game aspects and provides crucial player information and feedback.

Analyzing various aspects of games is beneficial, as it enables developers to identify the factors that contribute to a game's success and pinpoint mistakes to prevent them in future projects. Game design patterns have been established to achieve this effectively, similar to other industries. Design patterns are reusable solutions to common problems encountered in software design, including video game design. These patterns offer a proven and efficient framework for addressing specific design challenges, enabling developers to build more stable, maintainable, and scalable systems.

Christopher Alexander, a renowned architect and design theorist, introduced the concept of design patterns in his influential 1977 book, *A Pattern Language: Towns, Buildings, Construction*. Alexander's design patterns were originally conceived for architecture, urban planning, and community design, but the concept has since been widely adopted and applied in various fields.

Alexander's design patterns aim to solve recurring design problems and challenges by offering a set of rules and guidelines that can be applied in different contexts. Each pattern in the book addresses a specific problem or need, and the collection of patterns forms a coherent system that can be used to design complex structures, from individual buildings to entire cities.

The concept of design patterns has been particularly influential in software design, where various authors and practitioners have adapted and expanded upon them. For example, “The Gang of Four” programming patterns refers to a set of 23 software design patterns popularized in the book *Design Patterns: Elements of Reusable Object-Oriented Software* (Gamma et al., 1994). This book was written by four authors: Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides, who are collectively referred to as the “The Gang of Four”. These patterns provide general solutions to common design problems encountered in software development, making the code more flexible, modular, and maintainable.

The 23 design patterns can be categorized into creational, structural, and behavioral patterns. Creational patterns deal with the process of object creation. They help to abstract the instantiation process and make the system more flexible and adaptable to change. Some examples of creational patterns include Singleton, Factory Method, Abstract Factory, Builder, and Prototype. Structural patterns focus on how classes and objects can be composed to form larger structures. They facilitate the design of relationships between entities, enabling developers to create more flexible and efficient code. Structural patterns include Adapter, Bridge, Composite, Decorator, Facade, Flyweight, and Proxy. Behavioral patterns define how objects and classes interact and communicate with each other. They help to manage the complexity of relationships and communication between objects, making the system more maintainable and scalable. Behavioral patterns include Chain of Responsibility, Command, Interpreter, Iterator, Mediator, Memento, Observer, State, Strategy, Template Method, and Visitor.

The “Gang of Four” design patterns have become a standard in software development, and many developers use them as a foundation for creating robust, scalable, and maintainable software applications. By applying these patterns, developers can solve common design problems and improve their code's overall quality and structure.

Beyond general and programming design patterns, video game developers can draw on interaction design patterns to improve the user interface and user experience. These patterns, like

those described in Jenifer Tidwell's *Designing Interfaces* (2005/2009), address specific interaction-related issues and improve overall user experience.

Interaction design patterns are reusable solutions to common problems or challenges in designing interactive systems, such as websites, applications, or video games. These patterns provide a standardized approach to addressing specific interaction-related issues and improving the user experience. Interaction design patterns can be seen as a collection of best practices tested and proven effective in various contexts. The most common patterns are navigational: help users find their way through a system; feedback and communication: patterns that provide users with information about the results of their actions or the state of the system, like progress indicators, tooltips, or error messages; layout and composition: patterns that organize and structure the interface elements to create a visually appealing and easy-to-use layout, like grids, cards, or responsive design techniques; data presentation: patterns that help users make sense of complex data or large amounts of information, such as tables, charts, or data visualization techniques, enhancing the readability and comprehension of the content. So, game design patterns represent a collection of tried-and-tested solutions to recurring design challenges that arise during the development process. By utilizing game design patterns, designers can rationalize their time and resources better.

Notable works that emphasize the importance of game design patterns include *The Art of Game Design: A Book of Lenses* by Jesse Schell (2008), *Level Up! The Guide to Great Video Game Design* by Scott Rogers (2009) and *Pattern Language for Game Design* by Christopher Barney (2020). These books provide insights and guidelines for incorporating game design patterns in the development process, helping designers create more compelling and immersive experiences. The primary benefit of game design patterns is their ability to streamline the development process. By relying on established solutions to common design problems, designers can focus on refining and customizing solutions to fit their specific game. This approach can save time and resources, allowing designers to devote more attention to other aspects of the game.

Game design patterns also contribute to consistency within the gaming industry, establishing a shared language among designers. This shared understanding facilitates communication and collaboration between team members, making it easier to discuss ideas, share feedback, and iterate on designs. Players also benefit from this, as they become familiar with certain design patterns, they can more easily navigate and understand new games that employ similar mechanics, reducing the learning curve and making the game more approachable.

Furthermore, game design patterns can help designers balance innovation and familiarity. While it is essential to introduce new and unique elements to keep players engaged, relying on established patterns provides a sense of structure and familiarity that players can relate to.

Designers can combine these patterns with innovative ideas to create a compelling gameplay experience that feels both fresh and intuitive.

In conclusion, game design patterns play a crucial role in the video game development process, providing designers with a toolbox of reusable solutions to common design challenges. By leveraging these patterns, designers can create more engaging, enjoyable, and accessible games that resonate with players and contribute to the continued growth and evolution of the gaming industry.

In the next chapter, we will focus on a more specific aspect of game design – the use of color. We will discuss how color, often considered for its aesthetic contribution, also plays a critical role as an informational layer in video games.

4. Color as an Informational Layer in Video Games

To begin our analysis of color as an informational layer, we must first define what we mean by the term “informational layer”. An informational layer refers to a component or aspect of a system or environment that conveys information to users to enhance understanding, facilitate navigation, or aid decision-making.

In architecture and urban design, informational layers can comprise signage, color coding, maps, or digital displays that enable people to navigate and interact with the built environment more effectively. Similarly, in digital systems like websites or applications, informational layers encompass elements like text, icons, and other visual cues that equip users with the necessary information to understand and utilize the system.

In natural environments, such as parks, nature reserves, or hiking trails, informational layers manifest as trail markers, interpretive signs, and educational displays that assist visitors in navigating the area and learning about the surrounding environment.

In data visualizations, including charts, graphs, and maps, informational layers consist of captions, scales, labels, and annotations that help viewers comprehend the underlying data and the relationships between different data points.

In educational materials, informational layers include text, illustrations, diagrams, and multimedia elements that enable students to understand and learn from the content.

In the context of video games, the informational layer encompasses visual, auditory, and interactive elements that communicate vital information to players, enabling them to make informed decisions and better understand the game world.

By exploring these various examples, we can establish a solid foundation for understanding the concept of informational layers and delve deeper into the specifics of how color is used as an informational layer in video games.

Functioning as an informational layer in video games, color is a critical visual cue that enhances the player's understanding and communicates without words. As colors permeate the environment and are an attribute of objects, they can effectively guide players through the gameplay, provide essential feedback, and create a more immersive and enjoyable experience.

4.1 Functional Aspects of Color

To construct our taxonomy of functional aspects of color in video games, we began by examining a comprehensive list of potential aspects derived from multiple sources, including academic research, industry reports, and video game design literature that we used in this work so far. This initial list served as a broad framework encompassing various ways color can be used in game design.

Our list of functional aspects included aesthetics, navigation, emotion, progression, mechanics, content variation, and signifiers and identifiers. We found these aspects to cover a broad spectrum of color utilization in video games, each representing a unique way color contributes to the overall game design and player experience.

One of the most influential resources in our investigation was an article titled *Color in Games: An In-depth Look at One of Game Design's Most Useful Tools* (Tulleken, 2015), which provides a detailed analysis of color use in video games. This article identifies several aspects of color usage, including emotion, branding and fashion, visual hierarchy, progression, mechanics, signifiers and identifiers, content variation, and technology. Additionally, the article discusses techniques to increase the number of perceptual colors, color blindness in games, and the concept of impossible colors.

To create a clear and accessible taxonomy, we sought to distill this complex range of aspects into a more streamlined and focused list. We examined each aspect individually, considering its relevance and significance to the core functionality of color in game design. While undeniably crucial in specific contexts, some aspects, such as branding and fashion, did not encapsulate the functional use of color in games broadly. Therefore, we chose to leave them out of our final taxonomy.

In contrast, technology was deemed integral to the functional use of color in games, but it was also recognized that it overlapped significantly with mechanics. Considering the close relationship between technology and game mechanics, we merged these aspects. However, we

maintained the title “Mechanics”, acknowledging the role of technology without deviating from the primary focus on the functional uses of color in game design. Although, upon further deliberation, we found that elements of game mechanics touch on many aspects discussed in our “Signifiers and Identifiers” section.

This significant overlap made us reconsider the need for a separate “Mechanics” section. We found that colors in game mechanics mainly serve as signals. They can show differences in item quality, reveal how non-player characters (NPCs) behave, or sometimes even act as a core gameplay element. These functionalities will be covered in our “Signifiers and Identifiers” section.

When refining our taxonomy, another adjustment was made: the merging of progression and content variation upon realizing their shared conceptual territory. Both encapsulate the idea of change and evolution within the game's journey, whether through the player's advancement or the diversity of game content. This merge resulted in a consolidated "Progression" aspect in our taxonomy.

Thus, our final taxonomy of functional aspects of color in video games includes the following:

- Aesthetics
- Navigation
- Emotion
- Progression
- Signifiers and identifiers

This list covers a range of color functions in video games while being succinct and manageable for discussion and analysis.

4.1.1 Aesthetics

In video games, aesthetics encompasses much more than just visual appeal. It embodies a game's visual, auditory, and interactive elements that together construct a game's overall atmosphere and identity. As Jonathan Frome discusses in his paper *Eight Ways Videogames Generate Emotion* (2007), various aesthetic aspects, such as visual design, sound, narrative, and gameplay, work in tandem to evoke emotional responses from the player.

Visual design, which involves elements like character and environment design, lighting, textures, and color schemes, forms the heart of a game's aesthetic. It plays a dual role, creating an intriguing and memorable game world while reinforcing gameplay and narrative elements.

User Interface (UI) Design is another vital aspect of aesthetics in game design. A thoughtfully designed UI, with clear, visually pleasing elements such as menus and heads-up displays (HUDs), allows the player to interact seamlessly with the game world without obstructing the aesthetic experience.

Animation adds life to characters and environments, becoming a potent medium for expressing movement and emotion. Whether it is realism or a unique visual identity, quality animation is critical in conveying gameplay mechanics, including character actions and interactions with the environment.

Style and theme, influenced by elements like genre, setting, narrative, and artistic direction, significantly mold the aesthetics of a game. As discussed in Grant Tavinor's *The Art of Videogames* (2009), a well-chosen and consistently applied style and theme can enhance player engagement.

With the aesthetic aspect detailed, we now segue into another significant role of color in video games, demonstrating the diverse and interconnected ways color contributes to game design.

4.1.2 Navigation

Navigation in video games is a critical function where color proves its indispensable worth. After thoroughly examining Jixiong Xiao's work, *A Study of Navigation Aids in Video Games* (2020), it becomes clear that the navigational aspect is not merely about directing players toward a destination but about creating a holistic understanding of the game environment.

Color is a visual signpost, guiding players toward their objectives or showing them their next destination. This type of guiding can be achieved through brightly colored markers or trails, leading players intuitively through the game world.



Figure 38: *Bioshock Infinite* (2013), golden statue indicates player's destination.

Another navigational role of color is differentiating zones and areas within the game. Safe zones, enemy territories, and puzzle areas can each have their unique color schemes to enable quick recognition and contextual understanding.



Figure 39: *Subnautica* (2014), different zones.

The indication of affordances and constraints is another important navigational function of color. For example, color can denote surfaces that support specific actions, or color-coded barriers can suggest accessible and inaccessible paths. In Figure 40, we can see how a climbable white wall stands out from other walls of the room, besides it is surrounded with green color, telling the player that is the correct path.



Figure 40: *Doom Eternal* (2020), climbable wall surrounded with green light.

Color is an important tool in video game navigation, facilitating intuitive gameplay experiences. This interactive dynamic between color and player is not limited to physical navigation. It also transcends into the emotional sphere, creating a deep connection between the player and the game world. This multifaceted use of color paves the way for our next area of exploration: emotion.

4.1.3 Emotions

Color is a potent instrument in the orchestra of video game design, as it can evoke and manipulate emotions, enriching the player's experience and immersion. Its application in this context can be multifaceted and profoundly impactful. Utilizing different shades and palettes, designers can foster unique experiences. A dark, muted palette might imbue a sense of tension for a horror game, while vibrant hues could create an environment of joy for a casual game.

Simultaneously, color contributes to character development and storytelling. It can offer valuable insights into characters, reflecting their personalities, emotional states, or roles in the unfolding narrative. Game designers can enhance the narrative's depth and the player's emotional connection to the characters by associating specific color schemes with different characters.

The emotional pacing of a game can also be controlled using contrasting colors. Intense action sequences might use a high-contrast palette, while quieter moments might feature subdued tones. This technique can create an emotionally dynamic and engaging player experience.

In essence, the insightful application of color can significantly enrich the emotional layers of video games. With this foundation of understanding, we now transition to exploring the integral role of color in another critical dimension of game design: progression.

4.1.4 Progression

Color is instrumental in communicating progression in video games, providing a visual narrative that assists players in comprehending their development, accomplishments, and objectives.

Primarily, color functions as a visual cue, mapping the player's progression in the game. Color-graded level design can indicate a shift that mirrors a player's advancement, marking proximity to the goal. Additionally, different color palettes can denote variations in game stages, providing a clear sign of progression.

Color also has the role of illustrating a player's achievements in the game. An advancement in skills or resources often corresponds with distinctive colors, stimulating a sense of satisfaction and motivation in players.

Furthermore, color introduces variety and novelty to maintain the player's interest. The use of changing color schemes or the introduction of new colors throughout the game ensures the experience remains dynamic and captivating.

Color is a powerful tool for indicating the difficulty of game elements. For instance, game designers might use darker, intense colors for high-level enemies or challenging areas, signaling players to brace for increased difficulty.

Lastly, color portrays environmental changes and story progression. As players move through the game's narrative or levels, the game might employ evolving color palettes to symbolize the passage of time or a shift in the story's tone. Figure 41 displays such changes in *Bioshock: Infinite*. In the beginning of the game, on the left, colors are bright, and the sky is clear, on the right, we see darker color palette and storm is rumbling.



Figure 41: *BioShock Infinite*, change of the color palette during the playthrough.

In conclusion, color contributes significantly to illustrating progression in video games. It communicates achievements and assists in presenting the narrative and environmental shifts. Thus, the next facet of our discussion will be how colors function as signifiers and identifiers.

4.1.5 Signifiers and identifiers

Colors are indispensable as signifiers and identifiers in video games, providing players with essential visual cues to navigate and understand the intricacies of the game environment.

Color plays a pivotal role as **signifiers** in video games, guiding players through gameplay by providing essential visual cues and information. One primary function of color as a signifier is highlighting interactive objects and elements in the game. For instance, a distinctive color or glow effect may be used to accentuate interactable elements like doors, switches, or hidden items. Additionally, color can denote affordances and game mechanics, such as power-ups or abilities, rendering their function and purpose instantly recognizable.

Moreover, color is crucial in defining game physics and mechanics in some games, which is a powerful way it serves as a signifier. Games like *Portal* (2007) or *Q.U.B.E.* (2011) use color to establish the behavior of different objects: a specific color might indicate that a surface is bouncy, another that it is slippery, and so forth. This kind of color-coding enables players to anticipate the implications of their interactions with different elements in the game.

Color-coding is also extensively used in inventory management and crafting systems. *Diablo 3* (2012) and *Borderlands 3* (2019) (Figure 42) are prime examples where color-coding is employed to differentiate item quality and type. In *Diablo 3*, items range from common white items to extremely rare orange (legendary) items. The color gradient instantly communicates the value of each item, aiding in decision-making during crafting or loot management. Similarly, *Borderlands 3* uses color to denote weapon rarity and quality. Using color-coding not only

streamlines inventory navigation, but also adds an element of excitement when a uniquely colored item drops, signifying a potentially powerful find.



Figure 42: *Diablo 3* loot (left), *Borderlands 3* loot (right).

Furthermore, color is invaluable for player feedback and signaling danger. Through visual effects, sounds, or environmental changes, color allows players to understand the consequences of their actions and make informed decisions. It also acts as an alarm bell, signifying impending danger or indicating a potential shift in game mechanics.

As **identifiers**, colors facilitate the instant differentiation between characters and enemies. They provide players with immediate visual cues to distinguish their attributes, abilities, or affiliations. Unique color schemes or striking patterns might be employed for each enemy type, faction, or character class, painting a visual dictionary for players to quickly reference.



Figure 43: *Rise of Nations* (2003), different factions marked with different colors.

Identifying items and weapons is also greatly simplified with ingenious color-coding systems. These systems often reflect a gradient of rarity or power levels, intuitively guiding players in their choice of equipment and contributing to strategic gameplay decisions.

The effective use of color in video games offers a multitude of benefits. By their functional nature, colors act as a conduit for non-verbal communication, transmitting crucial information to the player. Therefore, by strategically using color, game designers can create a more intuitive and accessible experience, subtly influencing player interactions and decisions.

4.2 Analysis of Games

For this research, we established the following criteria to select the games:

- Single-player
- Action genre
- Access
- Unique art style

Our chosen criteria serve as the lens through which we examine the role of color in video games. Firstly, we focus on single-player games, known for their immersive and personal player experiences. These games allow us to examine color's role in crafting this immersive environment, from mood setting to environmental cues.

We also consider action video games, marked by their need for quick decision-making and reflexive responses from the players. The use of color in these games is crucial in conveying immediate and clear information, and guiding player actions in high-intensity moments.

Another criterion is access, or our ability to access these games for study. This criterion ensures that the games selected are available for thorough examination and analysis. It is a practical aspect, yet crucial to guarantee that the research can be conducted comprehensively and effectively.

The fourth criterion, unique art styles, is chosen to explore the diversity of aesthetic experiences in video gaming. Games with distinctive and creative art styles often employ color in innovative ways, pushing the boundaries of how color can enhance visual communication and aesthetic appeal.

These criteria collectively provide a comprehensive framework to explore the multifaceted role of color in video gaming, leading to a deeper understanding of its impact on gameplay, player engagement, and game aesthetics.

With these criteria, we picked the following games: *Hellblade: Senua's Sacrifice* — an action-adventure game developed and published by the Ninja Theory studio in 2017, *Ghostrunner* — an action-platform video game co-developed by One More Level and Slipgate Ironworks, in 2020, *Hi-Fi Rush* — rhythm-based action game developed by Tango Gameworks and published by Bethesda Softworks in 2023.

4.2.1 *Hellblade: Senua's Sacrifice*

Hellblade: Senua's Sacrifice is set during the Viking Age and follows Senua, a Pict warrior from Orkney, who embarks on a quest into the Norse underworld, Hel, to save the soul of her dead lover from the goddess Hela. The game's portrayal of Hel as a terrifying, otherworldly realm is particularly effective because of its use of color and lighting.

In *Hellblade: Senua's Sacrifice*, **aesthetics** plays a significant role in establishing the game's atmosphere. The game relies on that atmosphere to empower its narrative and mechanics. The environment of Hel is filled with haunting, desolate landscapes that often use darker, muted tones. The game also uses vibrant colors and more complex visual elements in some areas, serving to intensify Senua's hallucinations and the game's mythological elements. The visual design powerfully communicates the feeling of being somewhere inhospitable and nightmarish, demonstrating how aesthetics is meticulously used to create an immersive gaming experience.

Navigating through the enigmatic landscapes of Hel, the role of color becomes even more critical for the players in *Hellblade: Senua's Sacrifice*. Being a linear game, it does not offer players much freedom as to where to go, but still, the game uses many techniques for aiding player navigation. We will start by observing the landmark that players encounter right at the beginning of their journey. Though not rich in color, this dark and ominous structure shows the player their destination.



Figure 44: The landmark in the beginning of the journey.

Moving forward, the player sees another navigating aid: the red flags. Flags show the way to the final destination (Figure 45), but they can serve as a more spatial navigational aid (Figure 46).

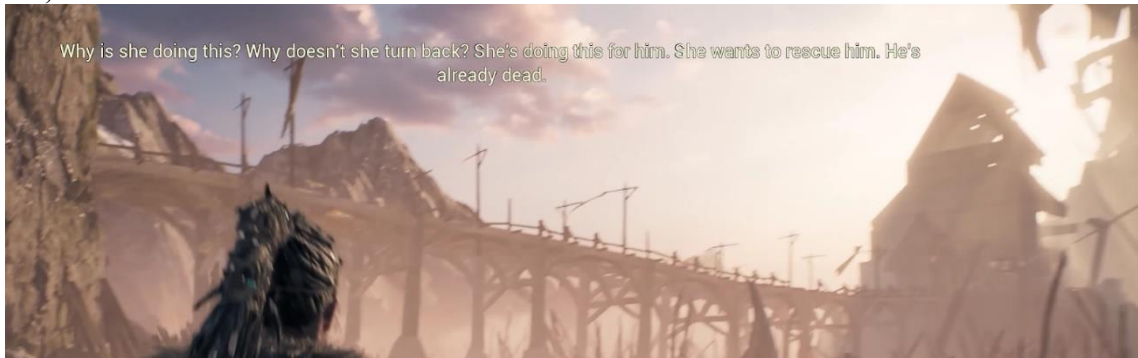


Figure 45: Flag road to the final destination.



Figure 46: Red flags indicate spatial navigation.

Another color that is used to navigate the player is white. White indicates the way in the form of breadcrumbs, spots for traversal, accessible doors, lowering bridges.



Figure 47: White as navigational aid

Traveling further into Hel, the amount of light decreases, so the torch's fire, light's reflection, or a beam piercing from the outside can serve as a navigational aid for the player and signaling safety from the monster in the darkness. For instance, in figure 48 on the left, the torch's fire serves as breadcrumbs for the player, indicating places the player has already visited, which helps navigate the dark maze. Next to it, on the right, a beam of light creates a safe zone in the dark cave.



Figure 48: Torch's fire (left), beam of light (right).

In addition, as the story progresses, Senua's state becomes more unstable, and she starts seeing the blue shape that leads her to her destination.



Figure 49: Blue shape leading the player.

There are multiple puzzles in this game. In this example, the player has to find runes in the world to open the doors and to progress. When the player is in the area of an answer but cannot quite see it yet, there are glowing red runes floating around the screen, telling the player that the answer is close. When the player gets closer, so that the answer is on the screen already but is not spotted yet, the floating runes turn blue, signaling to the player the proximity to the solution to the puzzle (Figure 50).



Figure 50: Red floating runes (left), blue floating runes (right).

The **emotional** aspect of *Hellblade* is deeply intertwined with the game's use of color and visual design. The aesthetics of the underworld is carefully constructed to reflect the gloom and fear associated with the realm of the dead. This design choice creates a bleak, threatening atmosphere full of eerie shadows and unsettling sights, invoking specific emotions in the player, effectively showcasing how color and design can be used to drive emotional responses.

The following example is particularly intriguing as it simultaneously functions as both a navigational aid and a **progression** indicator. The game uses color to mark progression in a series of challenges that occur later on in the game. These challenges require the player to interact with blue boulders, which change their color to gray once the associated task is complete. At the same time, boulders serve as navigational markers. A blue boulder signifies an unfinished challenge, guiding the player toward it. Conversely, a gray boulder indicates that the task has been completed, and the player does not need to revisit that location.



Figure 51: Blue-colored boulder (left), gray-colored boulder (right).

Just as color guides players through Hel's dark and complex landscapes, it also serves as a critical **signifier** in *Hellblade*. The use of color as a signifier is seen in the game's puzzle mechanics. These puzzles must be activated by approaching and focusing on the gate's red rune

or runes. After the player finds all the runes, he/she can return to the gates, the rune will be lit in blue, not in red, as can be seen in the Figure 52, and interact with them to open.

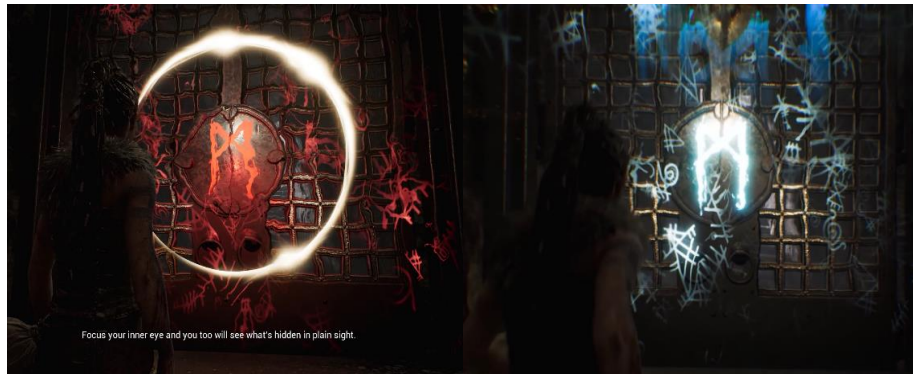


Figure 52: Gate's rune lit red (left), gate's rune lit blue (right).

The green circle around the runes signifies Senua's ability, Focus. Besides using Focus for puzzles, it can also be used in combat. Some enemies can go into the shadows, (as shown in Figure 53 on the left) and become invulnerable to damage. To have the ability to attack them, the player has to use Focus. When Senua's ability Focus is used, the time slows down, and the enemies get stunned and cannot attack, defend themselves or move (Figure 53 on the right). While Focus is active, the player can do serious damage to the enemies.



Figure 53: Enemy in the shadows (left), enemy is stunned by the Focus ability (right).

Focus is slowly accumulated over the battle with every successful strike and defensive measure that Senua takes, Figure 54 on the left. When she gains enough Focus, the mirror on her hip will flash and give her a single charge of Focus, Figure 54 on the right, up to a maximum of three.



Figure 54: The Focus gauge is partially filled (left), the Focus gauge is filled (right).

During combat, the player has to be very careful. If they sustain too much damage, before receiving the final blow, the red blood stains on the screen will obscure the vision.



Figure 55: Blood obscure the vision and signals critical health state.

If the player dies too many times, it can mean the end of the game. At the beginning of her journey, Senua is cursed with black rot, which starts at her hand (Figure 56 left), and with each death progresses further up (Figure 56 right), and when it reaches the head, the game is over.



Figure 56: Senua is cursed with black rot (left), rot progresses further up (right).

Color in *Hellblade: Senua's Sacrifice* not only contributes to the navigation or signifies important objects or interactions to the player but also carries an informational layer that marks progression. One way this manifest is through the game's collectibles, the Lorestones. These stones are scattered around the Hel and provide the ability to learn more about the Northmen. In Figure 57 on the left, the player can see that the middle rune of the stone is red. Once the player fully focuses, the middle rune's color changes to blue (Figure 57 right), audio starts to play, and the stone is marked as complete.



Figure 57: Unactivated Lorestone with red rune (left), activated Lorestone with blue rune (right).

In the context of *Hellblade: Senua's Sacrifice*, the concept of **identifiers** is not present in a classical sense. The game is a single-player experience, with Senua navigating through an antagonistic environment filled with enemies. As such, the traditional use of identifiers to differentiate between factions or allies and enemies becomes redundant. Instead, every element within this game universe is inherently adversarial. The player, therefore, finds themselves in a

world where the boundaries of friend and foe are clear-cut and uncomplicated, and trust is limited strictly to the protagonist herself.

In our analysis of *Hellblade: Senua's Sacrifice*, we observed how color plays multiple roles within the gameplay, including aesthetics, navigation, emotion, progression, signifiers, and identifiers.

In terms of aesthetics, *Hellblade* uses color and visual design to create haunting, desolate landscapes, enhancing the sense of the gloom and fear associated with the realm of the dead. The aesthetics further intensify Senua's hallucinations and the game's mythological elements, solidifying the feeling of being somewhere inhospitable and nightmarish.

The game utilizes distinct colors to guide the player through the intimidating and enigmatic environment of the Viking underworld, Hel. From the dark, ominous structures signaling the player's destination, to the red flags indicating the path, and the white signs providing hints for action, color serves as a critical navigational tool.

The game's use of color and aesthetics contributes significantly to the emotional aspect. The gloomy and threatening atmosphere is filled with eerie shadows and unsettling sights, invoking specific emotions in the player, and effectively demonstrating how color and design can be used to drive emotional responses.

Interestingly, how color marks progression within the game serves as a navigational aid as well. This is particularly noticeable in the cases of the Lorestones and the blue challenge boulders. The changes in color signify successful interaction and mark the player's progress in the game, making it a tangible experience.

As signifiers, colors in *Hellblade* play a pivotal role in facilitating the interaction between the player and the game world. The distinct use of colors in runes and combat sequences provides an essential layer of information, helping the player decipher which actions to take or what to anticipate. Lastly, as for identifiers, the traditional use of differentiating factions or allies and enemies is not prevalent in *Hellblade*, as it is a single-player game where every element is inherently adversarial.

Therefore, color in *Hellblade: Senua's Sacrifice* is not merely an aesthetic choice but a dynamic tool that actively shapes the player's experience, guiding their actions, marking their progress, enhancing the game's aesthetics, and evoking emotions.

4.2.2 *Ghostrunner*

Ghostrunner is a gripping first-person perspective action game set in a grim, cyberpunk world of a distant, post-apocalyptic future. The story unfolds within Dharma Tower, humanity's

last shelter after a world-ending cataclysm caused by an unspecified calamity. A tower-city is the place where the remaining human population lives in stacked layers.

The protagonist is a cybernetically enhanced warrior, one of the few remaining “Ghostrunners”, designed for protection and peacekeeping before the disaster. After waking up with most of his memories wiped out, the Ghostrunner embarks on a perilous journey upward through the tower.

Regarding **aesthetics**, the game excels at creating a profoundly atmospheric dystopian world. The neon lights that pierce through the darkness, illuminating the metal and concrete of the towering cityscape in various vivid colors, add a unique visual dimension to the game. Each layer of the tower is distinct, a testament to the meticulous visual design that helps to differentiate various sections of the game world.

Sharing similarities with *Hellblade: Senua's Sacrifice* in its linear gameplay structure, *Ghostrunner* also restricts the potential paths to a destination. Nevertheless, the game affords players some degree of autonomy to explore the intricately designed cybernetic world for collectibles and to devise strategies for upcoming battles.

The following section of this analysis will focus on *Ghostrunner's* use of color as visual cues for **navigation**. Yellow is the most dominant of colors that carries some information in this game. From the very first moment of gameplay, the player is introduced to yellow elements, such as a ledge with yellow edges and yellow cables, as seen in Figure 58 on the left. All of these elements show the point for navigation and will be seen throughout the whole game and seeing them in the beginning like this gives the player a pretty good idea of what to expect. The walls also have yellow, which tells the player that these are wall-running spots. To support the previous statements, on the ceiling and on the other side of the abyss, players can see yellow cables, Figure 58 on the right.

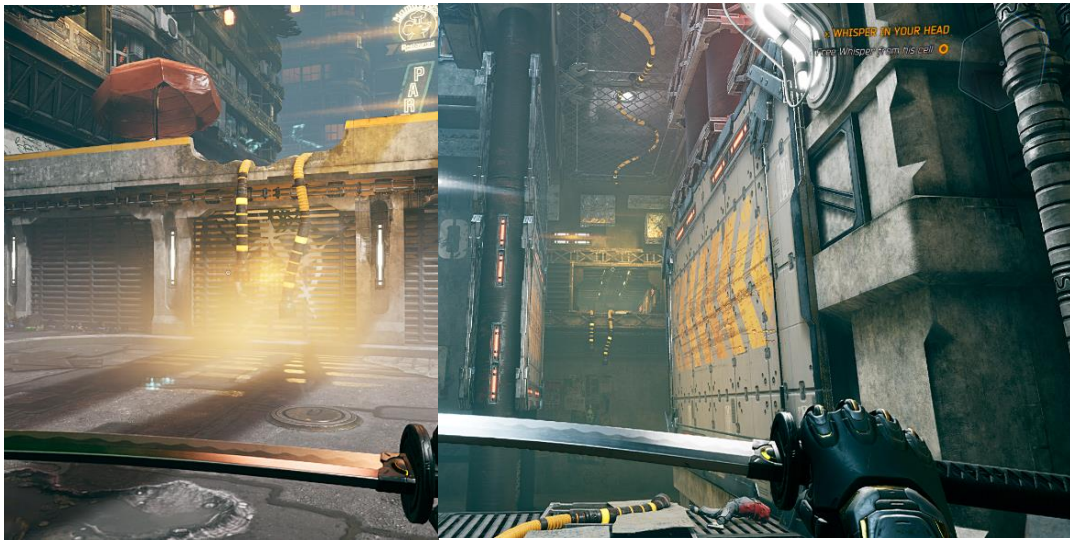


Figure 58: Ledge with yellow edges and yellow cables (left), yellow ledge, wall and cables on the ceiling (right).

Now we will look at airborne traversal. The ability to connect with the grapple hook is acquired early in the game, so it is a very frequently used ability. In Figure 59, we can see how the yellow-colored hooks stand out against the gray concrete background. Further on in the game, players can attach to the rails to travel. In the figure, we can see that the rail is colored yellow, and the ledge where it ends has some sort of yellow cloth over it together with yellow lights.



Figure 59: Yellow hooks against concrete walls (left), yellow-colored rail and yellow ledge (right).

However, the game does not always use only yellow color. In Figure 60 we see a combat arena with less vibrant colors, allowing the player to focus more easily on enemies. Comparing the combat arenas with regular spaces or spaces for traversal, we can see that the colors in fighting areas are less saturated, and the surfaces for traversal are orange. Also, in the same figure, we can see a marker, which is rarely used as a navigational aid but is still used to show the exact destination to the player.



Figure 60: Combat space with less saturated navigational colors and a marker

Another feature specific to combat scenarios are arrows that indicate the direction of incoming enemy attacks. These arrows are signifiers. While this might seem self-evident, we still categorize them as a navigational aid, as they inform the player where the attack is originating from and indicate the direction they should avoid moving towards.



Figure 61: Arrows indicating enemies.

The player must first complete specific objectives to exit the arenas or other areas. If these objectives are not finished, the player will encounter a red gate and will not be able to exit, as shown in Figure 62 left. However, once all tasks are complete or no enemies are present, the gate turns green, as illustrated in Figure 62 right.



Figure 62: Red closed gate (left), green open gate (right).

Regarding the **emotional** aspect, navigating through a grim, post-apocalyptic future where humanity's last shelter is the Dharma Tower induces a sense of desperation and urgency. This is further emphasized by the protagonist's plight throughout his perilous journey upward the tower. The emotions evoked by this context will likely influence the player's feelings and reactions during the gameplay.

In the context of *Ghostrunner*, the concept of **progression** is not as strongly signified by color as it is in some other games. The game does not use a color-coded system to demonstrate the player's advancement through the storyline or game world. Rather, progression is mainly tracked by the game's level system and the player's ascent through the dystopian tower-city.

Now that we have analyzed how *Ghostrunner* uses color for aesthetics, navigation, emotional aspect and progression, let us focus on how the game employs colors as **signifiers**. Yellow, the dominant color for navigation in *Ghostrunner*, serves a dual purpose, acting as a signifier as well. Notably, as can be seen in Figure 63 on the left, the yellow color often indicates objects in the environment with which the player can interact. However, the same color can also signal potential danger, as depicted in Figure 63 on the right. Here, despite the familiar yellow color, coming into contact with the depicted object requires the player to restart from the last checkpoint, which might confuse the player.

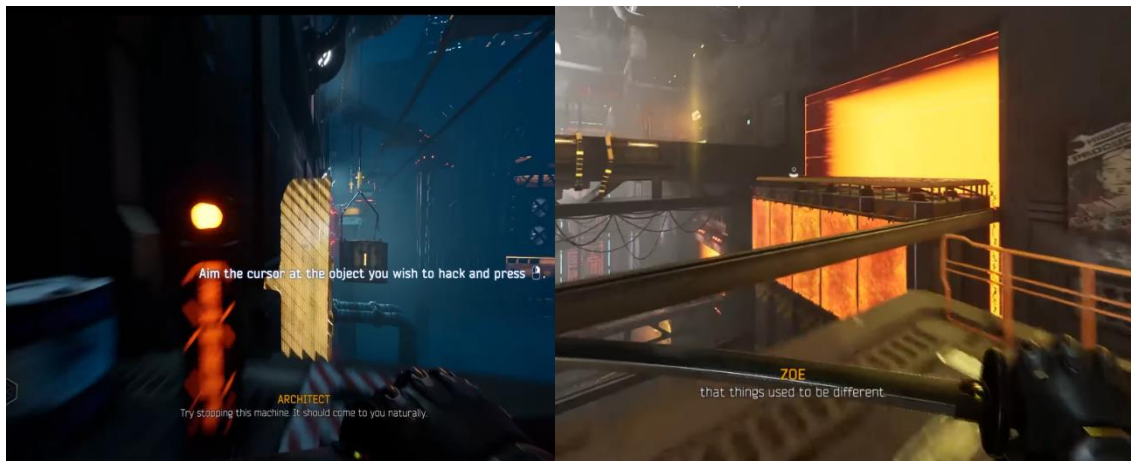


Figure 63: Interactable object (left), dangerous yellow (right).

Talking about danger, in this game, red is used to denote danger, as it is widely perceived. In Figure 64 on the left, we can see that the repeated walls made of red balls are advancing at the player, and they must avoid them. In Figure 64 on the right, we can see a solid red wall the player cannot pass through.



Figure 64: Red balls that cause damage (left), red impregnable wall that causes damage (right).

Staying on the red and danger, let us see how red is used as a signifier with enemies. In Figure 65 left, the enemy's weapon glows red before the attack, signaling that the enemy is about to attack. In the following Figure 65 right, the enemy's front is protected with the red force field, which will push the player away. To strike this enemy player has to come from behind or above, as shown in the picture.

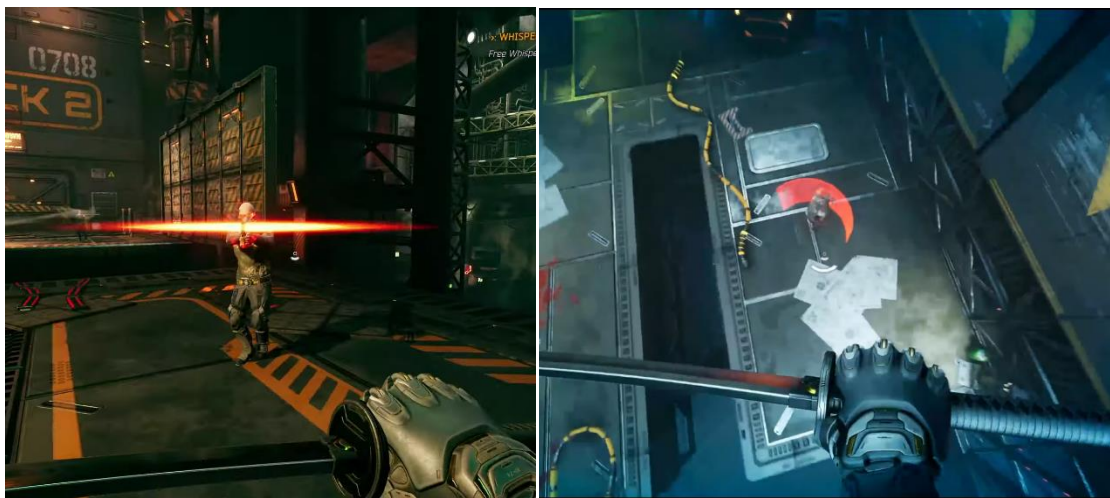


Figure 65: Enemy's weapon glow (left), enemy's red force shield (right).

As the player progresses in the game, they encounter enemies protected by a blue shield (Figure 66 left). While enemies are in this blue bubble, they are invulnerable to the damage, so the player must destroy the device that grants them this shield. In Figure 66 right, we can see how the shielded enemies look from afar.



Figure 66: Enemy with the blue shield (left), enemy with the blue shield from afar (right).

While discussing the enemies, mentioning one boss fight - Hel - is essential. This enemy is similar to the player's character but has an extensive arsenal of ranged attacks colored in yellow. Nevertheless, most of the fight is done in melee, and her sword is also colored yellow (Figure 67).



Figure 67: Boss Hel, and her yellow sword

Moving to other signifiers. Blue color is used to show power-ups (Figure 68 left). There are three types of power-ups in total, but they use the same color; they differ only in the icon. In Figure 68 right, we can see a collectible. All collectibles are colored yellow.



Figure 68: Blue power-up (left), yellow collectible (right).

The blue color is used for the electric circuits that can be interacted only with the help of one of the power-ups, which gives the ability to attack from a distance, Figure 69 left. White color is not used much in this game. However, it is essential and always in front of the player's eyes, Figure 69 right. It is used to show the center of the screen and where the character will attack. Also, it shows the amount and the availability of the dash. Depending on the improvements that the player picks, they can have one or two dashes. When the dash is used, the representative white strip turns hollow. Also, while in the air, the player can slow down the time, and the white strip shows how much time the player can stay in this state.

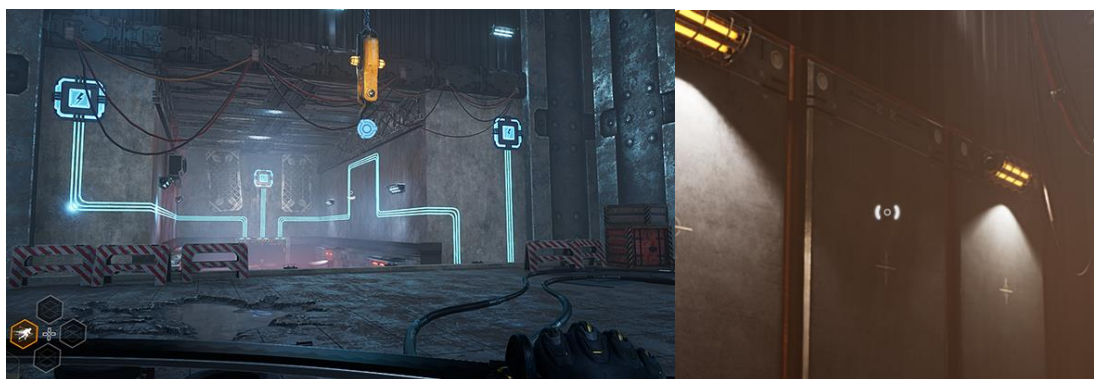


Figure 69: Blue electric circuits (left), white indicators (right).

Ghostrunner uses blue, red, and yellow colors in puzzles. In Figure 70 on the left, we have three colors, and the player's goal is to turn the pipes to complete the circuit. Once complete, in Figure 70 on the right, the pipes turn yellow along with the red energy box, and the yellow projectile is shot that leads the player forward.



Figure 70: Start of the puzzle (left), finished puzzle (right).

Lastly, Figure 71 shows how another element uses three colors to signify its state. On the left, the panel's screen is lit in cyan, a combination of blue and green, which means it is ready to be used. In the middle, the panel lit in yellow signifies that the moving of some surface or opening of the doors is in progress. On the right, the panel is lit in red, telling the player that the interaction is complete.

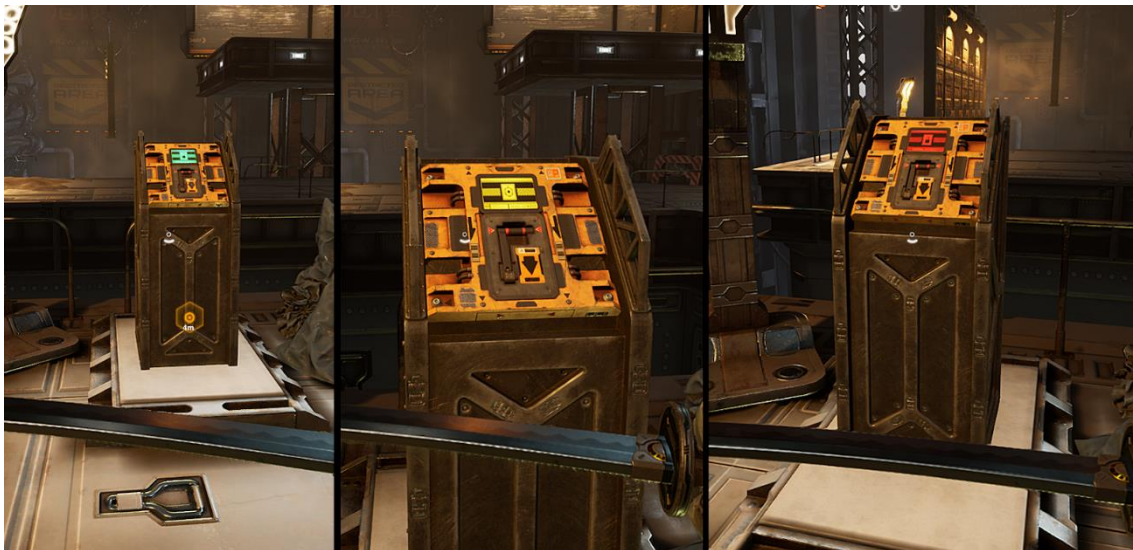


Figure 71: Interactable panel changes colors

Finally, addressing **identifiers**, *Ghostrunner*, much like *Hellblade: Senua's Sacrifice*, is a single-player game. In such an environment, there are no allies, and thus no need to differentiate

between friend and foe. The player only encounters hostile entities, rendering the traditional use of color as an identifier less relevant in this context.

In *Ghostrunner*, color is multifaceted, adding depth to aesthetics, navigation, emotions, progression, and identifiers. Aesthetically, the game beautifully utilizes neon lights that cut through the darkness, illuminating the dystopian world in vivid hues and emphasizing the grim atmosphere. This chromatic choice not only enhances the visual appeal but also contributes to the emotional ambiance of the game, amplifying feelings of being in a desolate, post-apocalyptic world.

In navigation, color is crucial in guiding the player through dystopian environments. The game consistently uses yellow to mark traversable ledges, grapple points, and wall-running surfaces, creating a visual language that the player quickly comes to understand—this use of color aids in intuitive level navigation, reducing confusion and enhancing the flow of gameplay.

Transitioning to signifiers, *Ghostrunner* further leverages color to indicate interactive opportunities, and potential dangers. Notably, yellow again takes center stage, signifying both interaction points and hazards, thereby adding an unexpected layer of complexity to its interpretation. Red denotes threats like dangerous walls, enemy shields, and attacks, staying true to its traditionally danger-associated hue.

Lastly, progression and identifiers needed more substantial presence to have any value for the research.

4.2.3 *Hi-Fi Rush*

Hi-Fi Rush is a fast-paced, rhythm-action game set in a vibrant, colorful dystopian world. It follows the protagonist, Chai, a rocker armed with a scrap metal guitar, on his quest to bring down a tyrannical megacorporation using the power of music.

While Chai might be the unlikely hero in this story, his vibrant energy and the eclectic personalities of his companions are mirrored in the game's vivid visual design. Combining toon shading visuals with a playful aesthetic, *Hi-Fi Rush* transforms every combat encounter into a high-energy concert, every platforming sequence into a rhythm-based puzzle, and every boss fight into an unforgettable music event.

In terms of gameplay, *Hi-Fi Rush* combines elements of character-action games and rhythm games, providing a unique blend that feels fresh and exciting. The combat system encourages players to engage with the rhythm, offering visual and audio cues to nail the perfect timing for attacks. Visual and audio cues, that help the player feel the beat, result in a seamless blend of

rhythm and action, where each enemy is defeated, each arena navigated, and each boss conquered feels like a perfectly timed note in an epic musical composition.

Hi-Fi Rush is very delightful when talking about **aesthetics** in the realm of cyberpunk games, as it diverges from traditional dread-filled landscapes and instead showcases a lively, animated environment. The game's vibrant, colorful world immediately captivates the players, immersing them in settings ranging from pulsating cityscapes to industrial factories. These locales are rendered in a rich, vivid color palette, intricately synced with the rhythm of the diverse soundtrack, establishing an immersive and compelling visual experience. The playful aesthetic, combined with cel-shaded visuals, converts every combat and platforming sequence into an interactive spectacle, creating a unique and captivating visual appeal that permeates every aspect of the game.

The fast-paced action of *Hi-Fi Rush* necessitates a fluid and intuitive **navigation** system to keep up with the game's rhythm. While linear, the game employs an array of visual cues to keep the player directed and engaged. The abundance of visual cues ensures players keep the beat, even when transitioning from one encounter to the next.

To facilitate seamless navigation, *Hi-Fi Rush* employs an assortment of arrows, indicators, and lines that guide the player along the right path. Their strategic placements maintain the game's tempo without compromising the player's sense of direction. Unlike other games, *Hi-Fi Rush* embraces a variety of colors to highlight navigational cues, preventing any single one from dominating the navigation.

Figure 72 on the left illustrates the use of a red arrow to indicate the direction the player should follow. Furthermore, the game often uses yellow and black colors, reminiscent of construction sites, to highlight the direction or delineate the borders of a location. In Figure 72 on the right, due to the general hue of the location, a red arrow would not be effective. Therefore, white arrows are used instead. However, we still see the same yellow and black combination of color to indicate direction or the location's borders.



Figure 72: Red arrow (left), white arrow (right).

Two next examples once again showcase multiple uses of color for player direction. In Figure 73 (left) the player runs through the corridor. The floor is marked with white lines on the sides that make the player run within them. In the middle of the corridor, there is a dashed yellow line shaped like an arrow, directed towards the end of the corridor. On the wall to the right, a white arrow points in the direction and at the far wall we see a red arrow, communicating that there is a right turn. Figure 73 (right), we see similar lines on the floor, but here they are orange, but still serve the same idea, to keep the player within them. Additionally, we see green arrows, similar to the neighboring figure's yellow line by the positioning and purpose, navigating the player.



Figure 73: Multiple navigational aids.

Despite the absence of strict color language in navigation, there are still traditionally used colors to convey navigation: red for closed doors and green for open doors (Figure 74).



Figure 74: Red light for closed doors and green light for opened doors

An intriguing instance of color usage involves the combination of the yellow color and an in-game object, a ladder, for navigation. In the game it is impossible to interact with ladders to climb them, but they are smartly placed in places where the player has to go up. However, ladders are never alone to guide the player. In Figure 75 on the left, we see the ladder supported with

arrows on the walls pointing upwards. In Figure 75 on the right, the ladder leads to the vent, where we can see currency in the vent that drags the player.



Figure 75: Ladder and arrows indicating direction (left), ladder and the vent (right).

This colorful array of signs provides a dynamic and vibrant guide through the rhythm-infused world, setting a clear path for players to follow.

Hi-Fi Rush brings forth **emotions** through its intriguing narrative and dynamic gameplay. The game's protagonist and his vibrant companions inject a distinctive energy into the game, establishing an emotional bond with the players. This connection is further enhanced by the game's innovative fusion of character-action and rhythm elements, creating a thrilling and fresh gameplay experience that keeps the players on their toes. The game masterfully weaves rhythm and action together, transforming each enemy defeated, each arena navigated, and each boss battle into a rhythmic triumph, generating a sense of accomplishment and exhilaration. This unique blend of action, rhythm, lights, colors, and beats goes beyond the conventional boundaries of game design, eliciting an array of emotions and crafting a deeply engaging player experience.

In *Hi-Fi Rush* **progression** is not marked by color. During the playthrough, players visit different game locations, but they go back and forth between locations. During one level, players can visit office buildings and the underground floors of the factory. Instead of a color-graded system reflecting advancement in the game's storyline or world, progression is primarily conveyed through changes in the rhythm and intensity of the game's soundtrack and enemies' quantity and power. The game's level progression and the growth of Chai's musical prowess form the primary indicators of the player's journey through this rhythm-action adventure.

After delving into the ways *Hi-Fi Rush* uses color as an informational layer in other categories, it is now time to consider how this game utilizes color as a **signifier**. We will start discussing the example that has a meaning for two categories, navigation and signifiers, Figure

76. When the player sees a dark orange circle with the magnet icon inside, they know that this icon signifies Chai's ability to get close to objects. At the same time, by using the ability, the player will travel from one point to another.



Figure 76: Orange magnet indicator

In Figure 77 the yellow clouds serve as distinct signifiers for various types of interaction. On the left, a yellow cloud adorned with an exclamation mark signals the player's ability to interact with a shop for purchasing upgrades. A yellow cloud with three dots in the middle indicates that interaction will initiate dialogue. Finally, a yellow cloud featuring a magnifying glass denotes the presence of a collectible item, specifically a journal entry. The yellow coloration makes these icons particularly noticeable against the game's background.



Figure 77: Yellow clouds signifying different types of interactions.

In the next Figure 78 we see breakable crates of 2 types: brown crate with white light signifies that it contains currency; green crate with green lights means that it has health points (HP) for the player.



Figure 78: Regular crates with currency and green crates with HP.

As we progress, examples of varied button types come into focus. In Figure 79 left, there is a button that is visually distinct by its red color, accompanied by the word “Push,” and is further emphasized with a glowing line running through it. Pressing this button triggers specific events in the game, such as the opening of a trapdoor. In contrast, Figure 79 right showcases a red button that bears a close resemblance but lacks the glowing element and the word “Push.” This subtle difference is critical as interaction with this second type of button engages players in a quick time event (QTE), wherein precise and timely button presses are required. These visual cues are designed to be intuitive, enabling players to understand the function of the buttons at a glance.

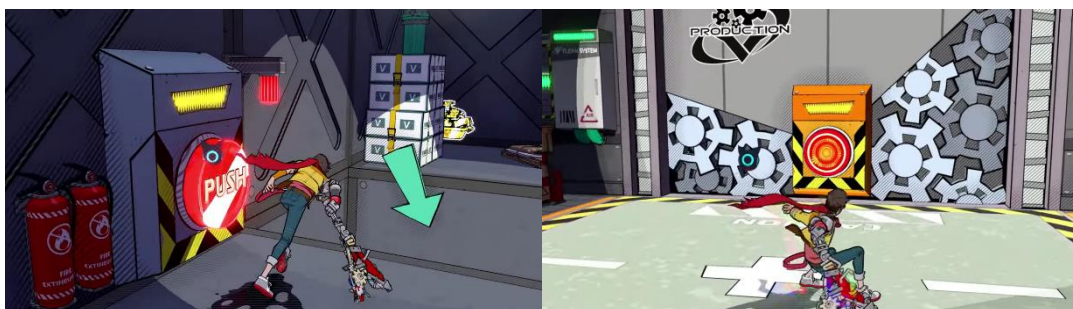


Figure 79: First type of buttons (left), second type of buttons (right).

Throughout the game, during certain traversal puzzles, players must rely on extrinsic knowledge to progress, specifically their understanding of traffic lights. In Figure 80, the platforms are extended out from the wall and have a green light above them, signaling that it is safe to proceed, thus serving as both a signifier and a navigation aid. In Figure 80, we observe yellow and red lights above the platforms. The red light is straightforward, functioning like a traffic light by indicating “Don't Walk”. The yellow light's meaning is context-dependent; if preceded by a green light, it signals that the platform will retract into the wall, whereas if it follows a red light, it tells the player to get ready as the platform will soon extend, turning the light green and allowing safe passage.

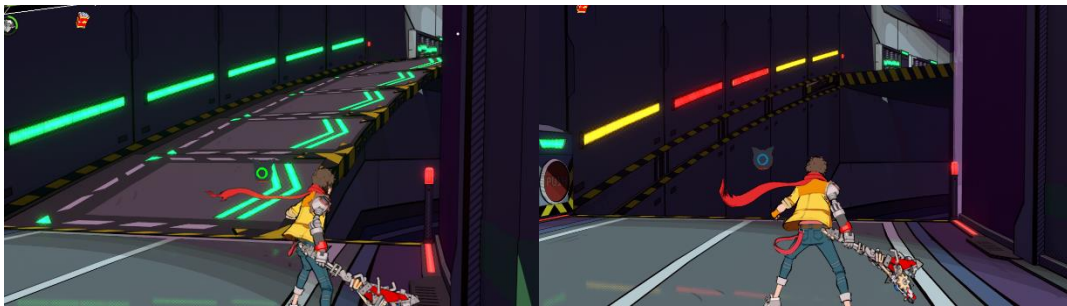


Figure 80: Extended platforms (left), hidden platforms (right)

Hi-Fi Rush includes a mechanic where Chai can summon companions to assist in combat and navigation. Figure 81 shows a cracked wall with a green circle. The green color is associated with one of Chai's companions, Macaron, and as the player approaches the wall, the green circle transforms into a portrait of Macaron with a prompt to summon him.



Figure 81: A cracked wall with a green circle (left), green circle transforms into a portrait of green companion (right).

Subsequent examples highlight two other companions, each associated with a distinct color and portrait. Figure 82 on the left, displays the blue color, linked to Peppermint, while Figure 82 on the right, showcases red, representing Korsica, who can interact with lava.



Figure 82: Blue companion's portrait (left), red companion's portrait (right).

Color also plays a role in combat, especially regarding companions. Certain enemies possess abilities that Chai cannot counter alone, necessitating the aid of his allies. For instance, Figure 83 on the left, features an enemy with a white and blue color scheme and a blue shield. To overcome this enemy, Chai must call on Peppermint to disable the shield. Similarly, in Figure 83 on the right, a white and green-colored enemy bears a pattern on its armor reminiscent of obstacles that Macaron can demolish, requiring the player to summon Macaron.



Figure 83: Enemy with a blue shield (left), enemy with the green elements (right).

Another combat-related application of color is to indicate enemies' attacks. Figure 84 on the left exhibits a green line on the ground, showing the enemy's aim. The line gradually narrows until it turns red, as displayed in Figure 84 on the right, at which point the enemy fires.



Figure 84: Enemy's line of aim (left), enemy's line of fire (right).

Similarly, area-of-effect (AOE) or directional attacks employ the same color coding. Figure 85 (left) depicts a green circle with a red interior. As the circle fills with red, the enemy prepares to strike. This mechanic also applies to directional attacks, as illustrated in Figure 85 (right).

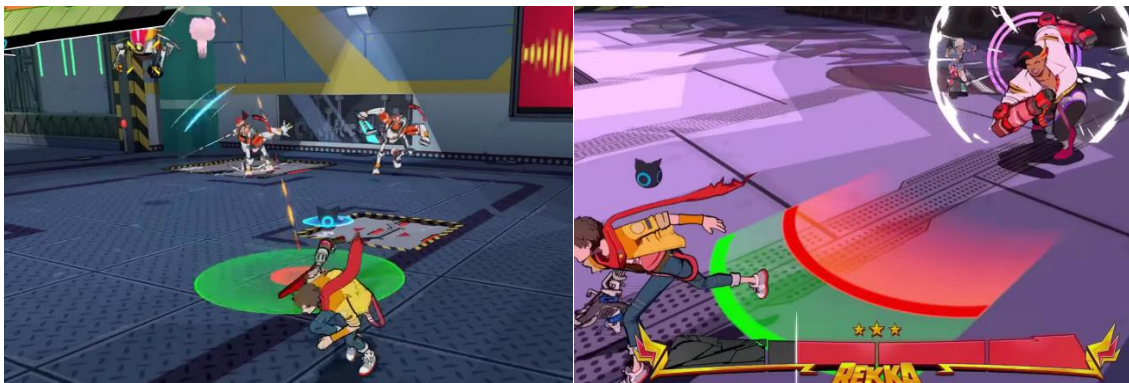


Figure 85: Area-of-effect signifier (left), directional attack (right).

Chai's ability to deal substantial damage in combat involves a timing-based mechanic. During the final hit of a combo, the player is presented with a green circle and a shrinking red circle, as seen in Figure 86. If the attack button is pressed while the circles overlap, Chai will deal significant damage, accompanied by audio-visual feedback. Otherwise, the damage will be moderate (Figure 86).



Figure 86: Time-based attack set up (left), time-based attack missed (right).

In terms of **identifiers**, *Hi-Fi Rush* shares similarities with *Hellblade: Senua's Sacrifice* and *Ghostrunner*. As with these titles, *Hi-Fi Rush* is a single-player game, and at first glance, it seems there is no need for differentiating friends from foes within levels. However, the game does feature companions and friendly non-player characters scattered throughout the game. These NPCs are non-hostile and can engage in dialogues with the player.

Figure 87 showcases all the companions encountered during the game. Each companion features a distinct color, such as Peppermint in blue on the left, Macaron in green in the center, and Korsica in red on the right. These colors help players recognize the relevant companion for different interactions.



Figure 87: Player's companions

Hi-Fi Rush contains various enemy types, as depicted in Figure 88. Though primarily white, they have distinct color palettes aiding players in identifying them and selecting the appropriate companion for combat. Other signs that help players identify them as foes are weapons and their hostile behavior.



Figure 88: Some examples of enemies

Friendly NPCs are typically fully colored. In Figure 89, they are blue, red, and yellow. A common identifier for non-hostile NPCs is a floating yellow cloud.



Figure 89: Friendly blue NPC (left), friendly red and yellow NPCs (right).

There is a special case where a couple of friendly NPCs have unique color palettes as an homage to *The Evil Within* (2014) series, also developed by Tango Gameworks. This character incorporates classic noir elements, such as introspective monologues and a long overcoat, representing a tribute to the police detective protagonist from *The Evil Within*.



Figure 90: Special case where a couple of friendly NPCs have unique color palettes.

In *Hi-Fi Rush*, color is adeptly employed across facets of the taxonomy. The navigation in *Hi-Fi Rush* uses color-coded cues to guide players through its diverse environments. There are instances where color has two meanings, for instance, not only signifying the use of Chai's ability but also directing players in traversing between points. Additionally, traffic light colors are cleverly integrated into traversal, drawing from players' extrinsic knowledge to influence navigation.

Moving on to signifiers, color in *Hi-Fi Rush* is instrumental in demarcating interactions and game mechanics. Colors are integral in differentiating between types of breakable crates and their contents. Yellow clouds, for example, indicate varying interactions, such as dialogues, purchases, or collectibles. Also, the use of red and green colors signals to the player about the impending danger of an incoming attack that needs to be avoided. Companions' colors help the player pick the necessary companion at a given moment. Lastly, color is employed in combat, indicating enemy attacks and highlighting Chai's ability to deal substantial damage through color-coded cues.

As for identifiers, *Hi-Fi Rush* demonstrates its effectiveness by using color to differentiate between companions and enemies. Companions are depicted in distinct colors, allowing players to recognize the corresponding abilities associated with each companion effortlessly. Furthermore, enemies, although predominantly white, have color palettes that help players identify them and relate them to the appropriate companion for combat. Friendly NPCs, typically fully colored, can also be identified by yellow floating clouds.

In conclusion, color in *Hi-Fi Rush* is more than a mere decorative element; it is a vital component that enriches the player's experience through intuitive navigation, clear signifiers, and identifiers while enhancing the game's vibrant aesthetics.

5. Discussion

In this discussion chapter, we revisit the research problem that underscores the lack of comprehensive literature on the role of color as an informational layer in video game design. While previous studies have shed light on visual aesthetics and the impact of color on player engagement and performance, they have not delved into the specific mechanisms through which color can guide players, signify critical objects or characters, and provide visual cues integral to gameplay mechanics. Our primary research question guiding this study is: how is color used as an informational layer in video game design? To address this question and fill the gap in existing literature, this work entailed a review of academic sources coupled with an analysis of video games. In this chapter, we will synthesize the findings from our analysis, evaluating how color serves as an informational layer in diverse facets of video game design.

Given the extent of our undertaking and the constraints of time, our analysis was directed exclusively towards action-oriented video games that were within our reach. While the limited scope could influence our findings, it is important to note that this study serves as a catalyst for future investigations in this domain.

To state our findings, let us quickly revisit our taxonomy, through which we analyzed the games: aesthetics, navigation, emotion, progression, signifiers, and identifiers. It became very clear from the first game that not all categories are present in all games, and that some of them do not have an informational layer to them.

5.1 Aesthetics and Emotion

We will begin by discussing the categories present in all of the analyzed games, but that do not possess an informational layer: **aesthetics and emotion**.

Aesthetics generally refers to the visual style and artistic elements of a game. This includes the use of colors, textures, character designs, and environments, and how these elements contribute to the game's overall visual appeal and atmosphere. Aesthetics in video games can be crucial in creating immersive experiences, setting the mood, and engaging players. Aesthetics often play a significant role in establishing the game's thematic tone and complementing the narrative and mechanics.

In *Hellblade: Senua's Sacrifice*, the haunting and desolate landscapes with darker, muted tones create an unsettling atmosphere that aligns with the game's nightmarish and mythological narrative elements. The use of vibrant colors in certain areas intensifies Senua's hallucinations and further accentuates the emotional depth of the game.

Ghostrunner takes a different approach, focusing on a cybernetic, dystopian setting. The neon lights and vivid colors against a dark background create an atmospheric contrast that brings the world to life. The meticulous visual design not only enhances the mood but also helps players navigate through different sections of the game world. Like *Hellblade*, *Ghostrunner's* aesthetics is finely tuned to its theme, in this case, a cyberpunk dystopia.

On the other hand, *Hi-Fi Rush* surprises with its aesthetics by deviating from the traditional grim environments typically associated with post-apocalyptic games. Instead, it boasts a vibrant and colorful world. The use of a rich color palette, along with cel-shaded visuals and an energetic soundtrack, creates a lively environment that is both playful and engaging.

This choice of aesthetics sets *Hi-Fi Rush* apart by creating a more lighthearted and visually captivating experience in contrast to the often somber atmospheres of post-apocalyptic settings.

From this analysis, we can say that the aesthetics in each game is carefully curated to create visual appeal and complement the themes and narratives. It helps in setting the mood and tone for the player's experience, ensuring an engaging and immersive environment. The color choices, textures, and environmental design all work in tandem to create an artistic expression vital to each game's identity and impact.

Emotions refer to the psychological responses and feelings that a game elicits in the player. These include aspects such as fear, excitement, sadness, joy, and tension. Emotions in video games are often evoked through various elements such as the story, characters, aesthetics, music, and gameplay mechanics. The use of color, in particular, can be a powerful tool in influencing emotions. For example, dark and muted colors might be used to create a sense of dread or melancholy, while bright and vibrant colors can evoke happiness or energy. Emotional engagement is crucial in video games as it contributes to immersion, player investment, and the overall experience.

Hellblade: Senua's Sacrifice employs a combination of color and visual design to evoke emotions of gloom, fear, and uncertainty. The bleak and shadowy aesthetics of the underworld in *Hellblade* is intentionally designed to reflect the threatening nature of the realm of the dead. The feelings of dread and despair that this atmosphere imparts to the player are instrumental in connecting the player emotionally to the character of Senua and her journey through the underworld.

Ghostrunner, set in a post-apocalyptic future, generates emotions of desperation and urgency as the player navigates through the dark and grim Dharma Tower. The protagonist's situation, as a Ghostrunner with erased memories, trying to ascend the tower, adds an emotional depth. The visual design and narrative context combine to affect the player's emotions, creating a sense of tension and determination.

In contrast, *Hi-Fi Rush* employs a more vibrant and dynamic approach to evoke emotions. The energetic protagonist and his colorful companions create an emotional bond with the player, and the game's fusion of character-action and rhythm elements generates a thrilling experience. This, coupled with the lively visuals, lights, colors, and beats, makes every accomplishment in the game feel like a rhythmic triumph, evoking excitement, accomplishment, and joy.

In summary, emotions are an integral part of the gaming experience, and the use of colors, narrative, characters, and gameplay mechanics plays a pivotal role in evoking them. Each of these games demonstrates how thoughtfully combining various elements can lead to rich emotional engagements that are central to the player's immersion and investment in the game.

In our analysis, we have grouped aesthetics and emotions, acknowledging that while they are integral to the gaming experience, color within these categories does not serve an informational layer within the context of this study. Rather than conveying information, aesthetics and emotions work synergistically to enhance the visual appeal and evoke psychological responses in players. It is essential to recognize their significant contributions to the overall gaming experience, even though they do not directly communicate information in the way that other elements might.

5.2 Navigation and Signifiers

Next, we will examine the pair of categories that are present in all of the analyzed games and have an informational layer: **navigation** and **signifiers**.

Navigation in video games refers to how players move through and interact with the game environment. It encompasses various elements such as pathfinding, orientation, wayfinding, and spatial awareness. In the context of color, navigation often involves using color cues to guide or

signal players toward specific paths, objectives, or areas within the game. For instance, a game might use brighter colors to highlight interactive elements or pathways or use color-coded markers to indicate different types of locations or objects. Effective navigation design helps to create a more immersive and engaging gameplay experience, allowing players to move through the game world intuitively and focus on the challenges and objectives presented.

In *Hellblade: Senua's Sacrifice*, color plays a significant role in navigation, guiding the player through the game's dark and mystical environments. The game utilizes subtle cues through the use of color contrast to draw the player's attention to paths, objects, or areas that are essential for progressing through the game. For instance, objects or paths essential for solving puzzles or moving forward often stand out with a different hue compared to the surrounding environment. This reliance on color to provide subtle hints allows players to navigate the game intuitively. By leveraging color in navigation, *Hellblade* enhances the player's immersion and engagement, making the navigation feel like an integral part of the storytelling and character development.

In *Ghostrunner*, color is integral to navigation by providing visual cues that guide the player through the fast-paced, parkour-style levels. The game features a neon-drenched cyberpunk setting, where vibrant colors highlight platforms, walls, and objects with which the player can interact. For instance, ledges and platforms that can be grappled or wall-run on are often highlighted with bright neon colors, contrasting sharply with the darker, industrial surroundings. This contrast serves as a visual guide for the player, helping them to quickly identify pathways and make split-second decisions, which is crucial in the high-speed gameplay of *Ghostrunner*. The smart use of color assists players in navigating through the game's intricate levels and contributes to the cyberpunk atmosphere and aesthetic of *Ghostrunner*.

In *Hi-Fi Rush*, color is central to navigation by furnishing players with discernible cues to guide them through the game's vibrant and eclectic environments. The game employs color-coded elements to intuitively direct the players' movements and interactions. For instance, dark orange circles featuring magnet icons have a dual purpose - they both signify Chai's ability and steer players in moving between points. Furthermore, arrows with varying colors act as clear indicators of the direction the player should take, while colored lines on the floor often demarcate paths or interaction zones. Ladders, however, are not climbable, are distinguished by distinct color, and are used to ease the recognition of the direction the players have to take. Moreover, the game integrates traffic light colors into platform movements, with green indicating it is safe to proceed, yellow as a caution, and red as a halt. This adept use of color in navigation ensures a seamless and engaging gameplay experience in *Hi-Fi Rush*, allowing players to effortlessly traverse through its lively world.

In summary, the role of color in navigation across the games *Hellblade: Senua's Sacrifice*, *Ghostrunner*, and *Hi-Fi Rush* is critical in guiding players through various environments and challenges. In *Hellblade*, color subtlety draws attention to essential paths and objects by contrasting hues, seamlessly integrating navigation within storytelling. In contrast, *Ghostrunner* employs vibrant neon colors to create a more conspicuous guidance system for the player in a fast-paced cyberpunk setting, ensuring players make rapid decisions during high-speed gameplay. *Hi-Fi Rush* takes a more symbolic approach by using color-coded elements to guide players through its vibrant world, making navigation intuitive. Each game employs a different approach, yet they all effectively use color as a tool for navigation, highlighting its significance in enhancing the player's engagement and immersion.

Signifiers in video games are visual or auditory cues that provide the player with information about the game's world and mechanics. They help guide player behavior by signifying possible or necessary actions in given contexts. Color is often used as a signifier in games, indicating various aspects. For example, a color change could signify that an object is interactive or that a character is in a particular state (like being invulnerable or poisoned). In this way, color-coded signifiers help players understand and navigate the game's systems and mechanics without explicit instructions, contributing to a more immersive and intuitive gameplay experience.

In *Hellblade: Senua's Sacrifice*, signifiers are employed to subtly guide the player's actions and decision-making within the game. One of the primary ways the game uses signifiers is through the use of color and lighting to highlight areas of interest or importance. For example, the runes the player must find to unlock doors are often signified by a particular pattern or glow that can be seen when the player is close. Additionally, environmental puzzles often involve aligning different elements to form patterns or symbols, and color is used to signify when elements are in the correct position. The voices accompanying Senua throughout her journey also act as auditory signifiers, providing hints and reacting to the player's actions. The use of visual signifiers in *Hellblade* is crucial in guiding players through the game's complex narrative and puzzles, contributing to an immersive and engaging experience.

In *Ghostrunner*, signifiers are employed to effectively communicate to the player the various actions and interactions possible within the game's fast-paced cyberpunk setting. The game uses color and visual indicators as signifiers to denote interactive objects and surfaces. For example, objects that can be grappled or surfaces suitable for wall-running are often highlighted with vibrant colors, with yellow being predominant. It is interesting to note that while yellow is frequently employed in navigation and acts as a signifier, there are times when the employment of yellow color might be deceptive and result in the player's death. This occasional ambiguity in the use of yellow as signifier can create unexpected challenges for the player. Enemy attacks are

also signified with distinct visual cues, such as glowing weapons, enabling players to anticipate and counter them effectively. The incorporation of these signifiers, despite the occasional misdirection, is vital for maintaining the rapid tempo of the gameplay and ensuring a smooth and immersive experience in *Ghostrunner*.

In *Hi-Fi Rush*, signifiers are employed astutely through color to demarcate interactions, abilities, and game mechanics. The game features breakable crates, with different colors corresponding to various types of loot and rewards. Additionally, yellow clouds signify different types of interactions, such as engaging in dialogues, making purchases, or obtaining collectibles. In combat, colors serve as cues for both the player's and enemies' abilities. For instance, the interplay between green and red colors indicates the opportune moment for using Chai's ability or the need to avoid an enemy's attack. The color of the companions is also utilized as a signifier, aiding players in picking the appropriate companion for a given situation based on the color-coded hints. This effective use of color as signifiers in *Hi-Fi Rush* provides an essential layer of information to the player, making interactions and decision-making intuitive and engaging.

In summary, signifiers in *Hellblade: Senia's Sacrifice*, *Ghostrunner*, and *Hi-Fi Rush* are pivotal in guiding players through their respective environments and challenges. *Hellblade* employs subtle visual signifiers such as color and lighting to highlight areas of interest and puzzle elements, which intertwine with the game's complex narrative. In *Ghostrunner*, vibrant colors, especially yellow, are primarily used as signifiers to denote interactive objects and surfaces, though yellow is sometimes used deceptively, adding an extra layer of challenge. *Hi-Fi Rush* uses color extensively to signify different interactions, abilities, and game mechanics, enabling intuitive decision-making. Across all three games, the thoughtful integration of signifiers enhances player engagement and immersion by providing crucial visual cues and information.

Navigation and signifiers are indispensable in creating a seamless and immersive gaming experience. Through the skillful use of color, these elements guide players through intricate environments, providing cues for interaction and pathways. In navigation, color is employed to highlight areas and objects that are crucial for navigating through the game. Similarly, signifiers use color to communicate actions and interactions, such as what objects to interact with, or when to execute specific actions. The proper implementation of color in navigation and signifiers enriches the game's visual language, making it more intuitive and engaging. These categories, therefore, play a pivotal role in communicating essential information and enhancing the player's experience.

5.3 Progression and Identifiers

Lastly, we will delve into the categories that possess an informational layer but were only found in some of the games: **progression** and **identifiers**.

In video games, **progression** refers to the forward movement or development within the game's environment, which can be marked by a player achieving specific goals, completing tasks, or unlocking new content. It is a way to measure and guide the player's advancement through the game. In many games, visual elements, including color, indicate progression. For instance, a change in the color palette might signal a transition into a new area or stage in the game. Certain colors could also be associated with gaining new abilities or reaching a new level. Progression helps in keeping the player motivated and engaged, as it offers a sense of accomplishment and opens up new challenges and experiences as the game advances.

In *Hellblade: Senua's Sacrifice*, progression is closely tied to the narrative and is manifested through Senua's journey into the depths of the underworld and her psyche. The game uses subtle visual elements to denote progression. As the player overcomes puzzles and defeats enemies, the environments around Senua change, reflecting both her mental state and advancement in her journey. The dark, oppressive atmospheres become increasingly twisted and fantastical as Senua delves further into her own mind and the Norse underworld. In addition, the game employs specific color changes to indicate the completion of challenges; for instance, blue boulders that signify challenges turn gray once the challenge is complete. This visual cue provides players with a sense of accomplishment and a clear indication of progression within the game. In *Hellblade*, progression is deeply interwoven with the narrative and the evolution of the game's environments.

In *Ghostrunner*, progression is represented through the player's ascent through the Dharma Tower, and this ascent is mirrored in the increasingly challenging level design and complexity of the game's cyberpunk environments. The use of color is instrumental in indicating progression; as the player ascends the tower, the colors transition from the darker, industrial shades at the base of the tower to more vibrant and elaborate neon hues at higher levels, reflecting the escalating stakes and challenges. Moreover, the player character's abilities and combat prowess evolve throughout the game. The ability to handle more complex scenarios and enemies, coupled with the visual transformation of the game's environments, provides the player with a sense of progression in *Ghostrunner*.

In contrast to the previous games analyzed, *Hi-Fi Rush* does not employ color to signify progression through either informative or aesthetic changes. In *Hellblade*, for instance, challenge boulders undergo a color change, and as the player delves deeper into Hel, colors progressively darken. Similarly, *Ghostrunner* adopts aesthetic progression through color changes as the player

ascends the tower. However, *Hi-Fi Rush* does not incorporate such elements. Essentially, *Hi-Fi Rush* refrains from using color to mark progression in the game. This distinction is further highlighted by the fact that locations in *Hi-Fi Rush* change frequently, even within a single level, making its approach to color and progression unique compared to the other games in this analysis.

In the analysis of progression in the games *Hellblade: Senua's Sacrifice*, *Ghostrunner*, and *Hi-Fi Rush*, there is a distinct diversity in the utilization of color to signify progression. *Hellblade* integrates both aesthetic elements and informational layers through color to mark progression. The aesthetic progression is demonstrated by the visual evolution of the environments as the player advances through the narrative, while informative progression is showcased by specific color changes, a unique example such as blue boulders turning gray upon completing challenges. This dual layer of progression in *Hellblade* adds depth to the player's experience.

On the other hand, *Ghostrunner* uses color primarily for aesthetic progression. As players ascend the Dharma Tower, the color palette transitions to reflect the increasing challenges and complexities of the environments. However, unlike *Hellblade*, *Ghostrunner* does not employ color in an informative manner to signify progression.

Hi-Fi Rush diverges from *Hellblade* and *Ghostrunner* by not using color to signify progression. The environments in *Hi-Fi Rush* change rapidly but without a color-coded system to indicate the player's progression.

This analysis highlights the varying design languages and approaches to progression in these games. *Hellblade* employs a more comprehensive utilization of color, integrating both aesthetic and informative aspects, while *Ghostrunner* uses color for aesthetic progression, and *Hi-Fi Rush* does not associate color with progression at all. This illustrates the diversity in game design and how color can be employed differently to contribute to the player's sense of progression or be left unassociated.

Identifiers in video games refer to visual elements that help players distinguish between different characters, objects, or areas within the game world. Color is often utilized as an identifier, making it easier for players to recognize and differentiate between various elements at a glance. For example, teams in multiplayer games might be distinguished by different colors, or specific types of items might consistently have a certain color coding (e.g., health potions being red). Identifiers are essential for providing players with the information they need to make decisions and act in the game. By using color as an identifier, games facilitate smoother gameplay and help players engage with the game world more effectively.

In *Hellblade: Senua's Sacrifice*, identifiers as a category are not prominently featured conventionally. As a single-player game focused on Senua's solitary journey through a hostile and mystical world, there is no need for identifiers to distinguish between allies, enemies, or factions.

The game's environment and entities are inherently antagonistic, and the distinction between friend and foe is clear-cut, with trust being vested solely in the protagonist, Senua. The absence of traditional identifiers in *Hellblade* reflects the game's narrative focus on isolation and the personal, internal struggles of the character, where the world itself is a singular, overarching adversary. In this context, the lack of identifiers serves to streamline the player's experience and immerse them more deeply in Senua's solitary struggle.

In *Ghostrunner*, the category of identifiers is similarly not emphasized in the traditional sense. Being a single-player game set in a hostile cyberpunk world, the player does not have allies and solely encounters enemies. As such, there is no need for color-based identifiers to distinguish between friends and foes. The game's environment is uniformly antagonistic, and this absence of traditional identifiers aligns with the game's narrative, which centers around navigating through a treacherous and unfriendly world. In *Ghostrunner*, the lack of identifiers underlines the singular focus of the player's objectives and the relentless nature of the challenges they face, immersing them in a world where their sole focus is on survival and overcoming obstacles.

In *Hi-Fi Rush*, color is a crucial instrument in identifying various characters and elements within the game. Companions met during the player's journey are distinctively color-coded, aiding in quick recognition and association with their respective abilities. For example, Peppermint wears a blue outfit, Macaron has green inserts, and Korsica is adorned in red. Similarly, enemies, though mainly white, incorporate certain colors in their designs, helping players to link them with the appropriate companion to counter them in combat. Additionally, friendly NPCs are typically fully colored and can be spotted with the presence of a yellow floating cloud. This clever use of color as identifiers in *Hi-Fi Rush* facilitates an intuitive understanding of the characters and elements in the game, allowing for more seamless and engaging gameplay.

In the discussion of identifiers in *Hellblade: Senua's Sacrifice*, *Ghostrunner*, and *Hi-Fi Rush*, it is evident that the use of color as identifiers vary depending on the narrative and game mechanics. In *Hellblade* and *Ghostrunner*, both single-player games set in inherently hostile worlds, the traditional use of color as identifiers to differentiate between allies and enemies is absent. This absence of identifiers reflects the themes of isolation and struggle in *Hellblade*, and the relentless survival and navigation challenges in *Ghostrunner*. The lack of identifiers in these games is, in fact, indicative of their narrative focus and serves to immerse players in the characters' solitary journeys against a singular, antagonistic environment. In contrast, *Hi-Fi Rush* employs color effectively as identifiers, particularly for NPCs. Companions and enemies have distinct color coding, aiding immediate recognition and association with specific abilities or characteristics. This utilization of color streamlines gameplay and assists players in making quick decisions during combat and interactions. The presence of identifiers in *Hi-Fi Rush* demonstrates

how color can serve as a functional tool in games that feature varied interactions and engagements with characters, in stark contrast to the more solitary and hostile settings of *Hellblade* and *Ghostrunner*.

In the analysis, progression and identifiers were grouped into categories with an informational layer but were only found to be present in some of the analyzed games. While both categories convey information to the player, their presence and implementation varied across the games. Progression, with its emphasis on tracking the advancement through the game, and identifiers, focusing on distinguishing between game elements such as characters and factions, serve critical roles in gameplay. However, not every game necessarily employs these categories, as their relevance and application are closely tied to the game's narrative structure and mechanics. Grouping progression and identifiers acknowledges their informational roles while also recognizing that their usage is contingent on the specific design and storytelling elements of each game.

5.4 Summary of Findings

Going into this research, there was a focused determination to uncover the aspects of color in video games that possess an informational layer, essentially examining how color can communicate information to the player without using words. This method of conveying information is particularly effective, as it seamlessly integrates into the gameplay, ensuring that players remain immersed and engaged without interruptions.

Through literature review, we found that there are many ways how color is used in video games. Some of the categories were minor, some shared a lot of similarities. We iterated on the existing categories, reviewed and combined them, so in the end, we came up with the final taxonomy which included: aesthetics, navigation, emotions, progression, signifiers, and identifiers.

Upon reflecting on the findings, it is clear that the categories of aesthetics and emotions, while integral to the gaming experience, do not serve as direct conduits for information. They are, however, indispensable in setting the ambiance and evoking emotional responses, which contribute immensely to the overall gaming experience.

Significantly, navigation and signifiers emerged as universal categories in all the analyzed games. This highlights their critical importance in game design. Employing color within these categories facilitates seamless and intuitive navigation, and acts as a non-verbal guide for players, enhancing engagement and immersion.

Progression and identifiers, on the other hand, demonstrated potential as categories that can carry an informational layer. Nonetheless, in this study, these categories were each present in only one game – *Hellblade: Senua's Sacrifice* for progression and *Hi-Fi Rush* for identifiers. This finding underscores that while these categories have the potential to be instrumental in conveying information through color, their utilization might be more context-sensitive and dependent on the specific themes and mechanics of the game in question.

In essence, color in video games is not merely an aesthetic choice but a multi-dimensional tool that can serve diverse functions ranging from setting the mood to guiding players through the game. It is incumbent upon game developers to consider the various ways in which color can be employed to communicate information, facilitate navigation, and enhance the immersive qualities of a game. Recognizing and leveraging the inherent potential of color as an informational and experiential medium can be pivotal in creating engaging, seamless, and rich gaming experiences.

Conclusion

This research undertook the task to explore how color is used as an informational layer in video game design. Using a careful blend of literature review and game analysis, the study revealed an understanding about the varied roles that color holds in video game design.

We commenced our literature review by delving into the fundamental aspects of color, progressing towards color theory. This included an exploration of color perception, psychology, and applications. We then shifted our focus to the realm of video games, tracing their historical evolution and the technological advancements that enriched color diversity. Additionally, we assessed the social and business dimensions of video games in relation to color. The final segment of our literature review was devoted to video game design, which furnished invaluable insights into game creation.

Before embarking on our analysis, it was crucial to define the term “informational layer”. To do this, we explored analogous concepts in various domains and integrated our understanding of color, video games, and video game design to articulate what constitutes an informational layer.

We established a taxonomy, a set of categories that served as both a framework and an analytical tool for systematically examining the multifaceted roles of color as an informational layer within video games. This taxonomy, developed through a meticulous literature analysis, comprises six integral components: aesthetics, navigation, emotion, progression, signifiers, and identifiers. It is significant because it provides game designers with a structured approach for understanding and utilizing color effectively in their creations. With this taxonomy in hand, we proceeded to put it to the test through an analysis of video games.

We began the game analysis by evaluating three diverse games within the action video game genre. The variation in these games enabled us to observe applications of all the categories identified in our taxonomy. Notably, the categories of aesthetics, navigation, emotion, and signifiers were present in each of the games analyzed. Although the progression and identifiers categories were observed in only one game each, it was crucial as it verified the validity of our taxonomy and established a foundation for future research.

Building upon these observations, the findings of this study carry significant implications for video game design. The deployment of color as an informational layer does not only bolster visual aesthetics, but also enhances guidance and intuitiveness in the gaming environment. This is achieved through the skillful utilization of color to emphasize critical objects or characters, thereby cultivating an immersive gameplay.

Moreover, grasping the multifaceted roles of color arms game designers with the necessary insight to make well-informed choices. Such insight proves invaluable during the design process, igniting potential for innovation and heightened engagement in games.

Ultimately, this study reveals that color in video games is not simply an artistic element but rather a versatile tool with an abundance of functions, including establishing ambiance and facilitating player navigation. Game developers are, therefore, urged to explore the multifarious applications of color in communicating information and augmenting the gameplay. Through strategic and discerning use of color, designers have the potential to forge more captivating, intuitive, and fulfilling gaming experiences.

However, this study is not without limitations. One of the key limitations is the scope of the games analyzed. The analysis was constrained to three games within the action video game genre. While these games were varied, they do not represent the entirety of video games available, and other genres might exhibit different uses and roles of color.

Additionally, cultural differences in color perception might initially influence how players interpret colors within a game. Although it is true that players may adapt to the color conventions within a specific game as they engage with it, their initial interpretations and associations with colors might still be influenced by their cultural backgrounds. For instance, in some cultures, the color red might be associated with luck, while in others it might be associated with danger. These initial associations could potentially affect how quickly and intuitively players understand the informational cues conveyed through colors when they first start playing the game. While it is plausible that these cultural associations may become less relevant as players become more accustomed to the game's internal logic and conventions, it is still a noteworthy consideration, particularly when designing games for a global audience.

Moreover, one of the limitations of this study is that it primarily focused on design aspects, without incorporating the players' perspectives. This leaves a gap in understanding how the design choices, particularly in terms of color as an informational layer, are actually perceived and experienced by the players. The player's interpretation and reactions to color choices could be an essential aspect of validating the effectiveness of design principles.

This study lays the groundwork for additional inquiries in this field. Building on these results, prospective research could encompass a wider array of games, examining the occurrence and use of the defined categories across a broader spectrum of game genres such as strategies, simulators or role-playing games (RPG) and a larger number of games. Future works might focus further on the action genre, as it is very popular and wide, even shooters can be included into this category. Additionally, it might be interesting to explore multiplayer games, as they use a lot of different ways to utilize color to deliver information to the players.

Furthermore, an essential direction for future research would be to involve data gathering from players to understand how they interpret and react to the use of color in video games. This could include surveys or interviews to analyze how players engage with and are influenced by color during gameplay. Understanding the player's perspective would provide invaluable insights into the practical implications of color choices and could contribute significantly to the development of more effective design strategies.

Such comprehensive exploration, encompassing both a wider variety of game genres and the player's perspective, could yield further understanding of color's flexible and adaptable role in game design, and provide valuable insights for game developers to innovate and enrich the player experience.

In conclusion, color in video game design is an indispensable and potent tool, extending far beyond aesthetics. This study not only highlights the multifaceted roles of color as an informational layer, but also offers a structured taxonomy that game designers can utilize to

harness the full potential of color in their creations. By guiding players through environments, indicating critical elements, and enhancing immersive experiences, color significantly contributes to the enrichment of gameplay. Furthermore, this study sets a foundation for continued exploration and research. In summary, this research aims to strengthen the field of video game design and pave the way for further studies on the diverse roles and possibilities of color in video games.

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