Mai Huynh Thi Nguyen

Fundamentals of 2D Game Art

KAMK • University
of Applied Sciences

Abstract

Author: Mai Huynh Thi Nguyen

Title of the Publication: Fundamentals of 2D Game Art
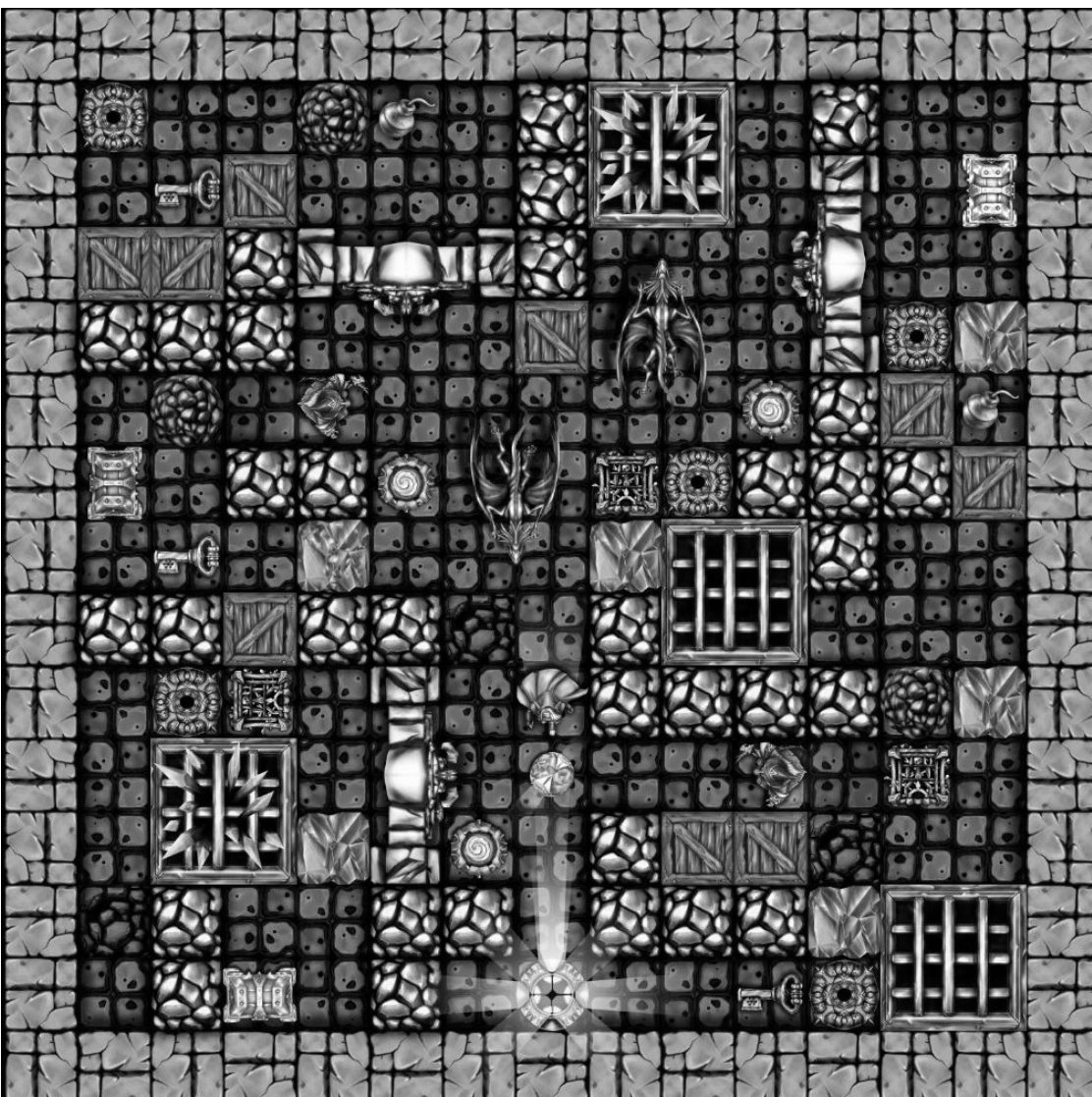
Degree Title: Bachelor of Business Administration, Business Information Technology

Keywords: game, graphics, visual aesthetic, 2D game graphics

As an interactive and entertainment medium for countless people from different age groups and backgrounds, the game industry is becoming more and more vivid as its annual revenue grows higher and higher. On the other hand, the game developing and distributing process has become convenient and accessible over the decades thanks to technological advancement. Thereby, besides big companies, Indie companies or individual developers can still compete and flourish.

With that being said, game development is a time-consuming and challenging process for a small team with little experience or formal training in a professional environment. By choosing to develop 2D games, unskilled developers can mitigate the initial obstacles of limited experience and resources. Furthermore, the development process often encounters numerous trials of errors that lead to project abandonment or a complete overhaul.

Knowing the challenge of finding guidance for young artists on what to do in the early stages of game development, the purpose of this thesis is to provide important background information for young 2D artists to solidify their knowledge and skills in such a way that they can confidently follow their passions.

Furthermore, the thesis attempts to investigate the core foundation of video game aesthetics in the development process through an artist's perspective. This thesis applies the secondary research method to study the foundation of the such as basic terminology concepts, need-to-know principles, and standard manufacturing processes that will be explained in turn. Through practicing the principles mentioned in this thesis, the author hopes young artists can find enjoyment and passion in game development supported by creating effective and effortless production processes.

Forward

I am grateful for all the wonderful experiences I had at KUAS with the people I have met, studied, and worked with. I would like to take this opportunity to express my deep gratitude to Tommi Helin, an enthusiastic instructor of my art classes. Special mention to my thesis supervisor Joonas Muhonen, for sharing the expertise, valuable guidance, and encouragement. I would also like to thank my friends and family who have been on my side during this thesis process.

All the best to everyone.

Table of Contents

List of Symbols

Asset   Pieces used in building a finished game.

2D   Two-Dimensional

2.5D   2.5-Dimension or three-quarter view

Sprite   A single graphic image that is incorporated into a larger scene

1   Introduction

According to Newzoo (2021), the impact of the 2021 COVID-19 outbreak, the value of the video games market is forecasted to be 175.8 billion U.S dollars with a slight decrease of 1.1% year over year. However, the outlook of the global games market in recent years is generally positive and its revenue is predicted to exceed 200 billion U.S dollars by 2023. (Wijman, 2021)

With ever-evolving technology, the games industry comes to life like never before as new games are released every day and promising remakes come every year. Notably, more and more people are joining the indie world and many indie games are flourishing. Passionate indie game developers working as an individual or in a small group of amateurs include Designer, Programmer, Artist, Sound Designer, Project Manager, Tester, Producer, Writer (Kantilaftis, 2014) without the financial and technical support (Mozolevskaya, 2021). However, this is a dream development team that can hardly cover all departments at the early stage of the establishment. There will be many challenges for an Indie development team or small game company to face the pressure of time, budget, and even loss of motivation when inexperienced. Whether as an artist or any part of the team, all members play an equally important role in making the game work. The lack of specialized knowledge, not being trained by experienced people can lead to delay in the production schedule as well as put immense pressure on the whole team. Because of these things, artists should prepare a solid background knowledge to make the game-making process smoother and more enjoyable.

This thesis seeks to answer the following questions: Why are 2D games still popular for development? What role does art play in the game? What are the fundamentals of art in the game and how are they applied? The thesis's topic focuses on the visual art aspects of 2D games studied from the perspective of a game artist who used to work in an Indie game company. This thesis aims to become a manual for any artist who works at small indie development teams or game companies wishing to strengthen their 2D fundamentals. The thesis is divided into 4 main parts. The first one gives a glance at 2D games to answer why 2D is still popular in development today and provide insight into the most common perspective angles in 2D. The second part presents the role of visual arts in enhancing the player's experience in the game. The third part covers all the vital aspects of 2D art from the simplest terms to the larger aspects such as the theory, principles, tricks, and standard workflow to produce 2D games assets. Then after providing a solid

foundation, the author also shows the process, used to apply theory into a level mockup that was inspired by flat games for the fourth part.

2   A glance of 2D game

This chapter will go through the key features and advantages of 2D games, which have contributed to 2D being chosen for today's game development. In addition, the whole picture of projections in the game will be mentioned briefly or in detail depending on their popularity.

2.1   Why 2D are still popular today?

First of all, it's easier to get familiar with the terms 2D and 2D games. 2D stands for two-dimensional and is generally associated with flat shapes and objects that being on one plane of existence, where an object can only have movements along the horizontal X-axis and the vertical Y-axis in the two-dimensional plane. While the Z-axis defines depth as considered null. (PlamzDooM, 2021) Next, 2D games are also called Platform games which refer to limited scrolling movement with only two axes of motion on the 2D plane. Typically, they are side-scrolling or vertical scrolling. A side-scrolling platformer in which the player is limited to moving left and right as well as up and down by running, jumping, shooting, or power gathering action on a platform, a classic example is Super Mario Bros. In these "flat" games, every "flat object" called a "sprite" has its own X and Y coordinates that accurately represent its position in the 2D plane (Stegner, 2D Games vs. 3D Games: What Are the Differences?, 2020). Besides, the whole game environment assets, characters are rendered in 2D. Although it looks simpler than the 3D model, a 2D game has a way of conveying attraction in its own vivid way through mechanics, animation sequences, and cut scenes (Manan, 2019) (2D Game Art Styles: The Ultimate Guide, n.d.).
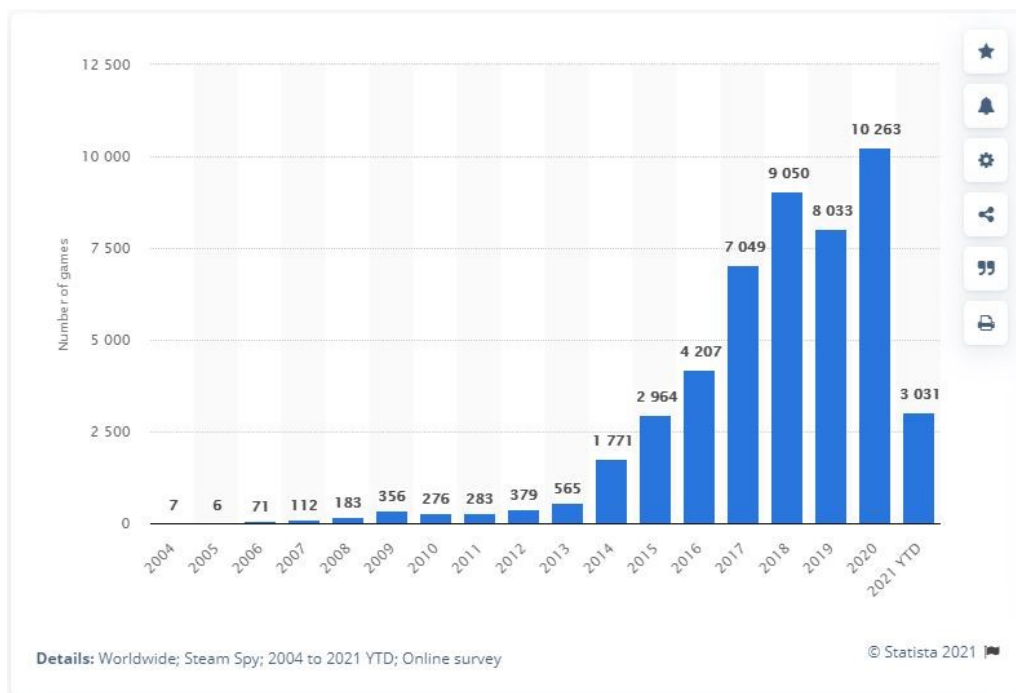
Figure 1. Number of games released on Steam worldwide from 2004 to 2021 (Clement, 2021)

Almost all video games fall into the 2D or 3D graphical style, but how do make a wise choice? According to Video Game Industry Statistics, Trends and Data In 2021, the game industry is growing at an amazing pace with a whopping 159.3 billion dollars in 2020 alone (WePC, n.d.). It is a real challenge for game developers to come up with innovations, as well as creative ideas, release new games every day, for example, 10263 games released on Steam 2020 (Clement, 2021) (Figure 1). At the early stages of game development, one of the common considerations would be 2D or 3D games. It is difficult to accurately represent the benefits and burdens of building a 2D game because not all games are the same. 2D games continue to hit the market and show no sign of stopping. It wouldn't be surprising that two-dimensional games in the early years of video games were incredibly primitive with 2D graphics, but the real reason came from the technical limitations of the hardware, which prevented the easily create three-dimensional graphics. But before video games evolve to using actual visual graphics, and 3D game development had grown drastically overwhelming in today's circle of professional, 2D games had enough time to become the norm for gamers. Besides, the rise of indie development and digital distribution services such as Steam, Xbox Live Arcade, PlayStation Network, and WiiWare has brought the 2D game design back into the spotlight by impressive games such as Braid, Limbo, and Shadow Complex. This renaissance has influenced the design of high-profile games that mix 2D gameplay with 3D sensibilities such as New Super Mario Bros, Bionic Commando Rearmed, Street Fighter IV and Mortal Kombat. (PlamzDooM, 2021)

2.1.1 Development process

2D games are simpler than 3D counterparts when comparing between them by 5 aspects, which include movement, control, environment, camera, and goal. First, in 2D games, the object's movements are linear. This means there is a starting point and an ending point in each of its movements with different locations within the computer screen border. It leads control aspect in 2D games are quite easy and simple in 2 dimensions, with few possible movements and interactions with other objects in-game. The novice may figure out how it works much easier than the 3D game. There will likely be more complex control options that players need a little practice to get used to playing 3D games. Next, 2D assets are flat. Therefore, artists do not focus as much on the game's environment as the rich 3D visual assets. For the camera, it is greatly simplified, most of which are looked straight at the game from the side or top, or somewhere between. Finally, the goal of a 2D game is normally just as straightforward as the direction, since the controls do not have many complicated options, the mechanisms are also easy. (2D VS 3D games: Differences, benefits and cost, n.d.)

1. Mini-Game Cost: $3k – $10k

Even a simple mini-game like Sudoku or Pac-man will cost somewhere around 3k-10k for a single platform. If you want advanced features and multiple platforms, it can cost up to 20k.

2. 3D Game Cost: $30k – $60k

Games like 3D shooting and Tennis Clash, which come with excellent graphics, can cost around 30k-60k for a single platform. The price can rise up to 80k for advanced features and multiple platforms.

3. Mid-Level Game Cost: $60k – $100k

Mid-level games like Angry Birds and Cut the Rope can cost around 60k-100k for a single platform. For advanced features and multiple platforms, the price can rise up to 120k.

4. High-End Game Cost: $150k – $400k

Games like PUBG, Call of Duty: Mobile can cost around $150k to $200k for a single android or ios platform. The price can rise up to $400k for multiple platforms and advanced features.

5. AAA Game Cost: $300k – $500k

AAA Games like GTA and FIFA are among the costliest games. The development cost for such games starts from $300k. The price also increases **up to $1M** depends on the functionality, features, and story.

6. Real Money Game Cost: $10k – $100k

Real money games like real money Ludo, 8 ball pool, Rummy, Carrom can cost around $10k to $50k for a single platform. The cost can go up to $100k for advanced features and multiple platforms.

Figure 2. List of the types of games and their estimated development cost (Calculate the Cost of Mobile Game Development – Step by Step Guide 2021, n.d.)

According to Appshunts.com (2D vs 3D Games: Differences, Benefits and Cost), both 2D and 3D games are suitable for respective certain games with their respective niche and do not overrule each other. However, the basic difference between flat objects and depth objects from 2D and 3D respectively leads to some other influences in the gameplay like movement, environment, controls, and goal. Basically, simple and straightforward controls bring 2D games more audience, even the beginners with no gaming experience. Next, the development of 2D games takes less time and on the whole, it is much cheaper than 3D in developing (Figure 2). The same goes for polishing and updates later on. Besides, easy instruction by flat graphics with clean visuals from simple user interface help players get acquainted quickly. Another reason is the cost of 2D games. There are many factors to name the exact price of developing a game. It depends on the engine, the complexity of mechanics used, the level of graphics, the presence of a soundtrack, and many other things. Last but not least, hiring an in-house developer team, or outsource game development to a remote team can also add up to the cost. As an example, Flappy Bird just costs $300 to

develop, while Candy Crush games are estimated at about $100,000 with an in-house team. Generally, 2D game development requires a smaller skill set than 3D game development. Therefore, it can solve issues both in the gameplay aspect as well as in the budget, but only if it is decided early. Thus, independent game studios that do not have large teams would resort to using 2D games widely because they are more profitable. Basically, they take less time and resources to develop so there is more money to be made. In detail, 2D will be easier to program because elements such as cameras, controls, are significantly less complex. For graphical requirements, artists have spent a sufficient amount of time on graphics with certain styles such as pixel, vector, and so forth. They also have much control over the graphics in 2D games compared to the 3D environment, which is more predictable through conveying information easily. In addition, production timing for the assets of the sprite is usually faster to make than a 3D model since there are unlikely to be as many issues with shaders. However, it does not mean that simple, clean graphics would not be less attractive than fully detailed drawings. (2D VS 3D games: Differences, benefits and cost, n.d.) Visual art will be presented in detail in chapter 4 of the thesis.

In short, both 2D and 3D games have respective advantages and disadvantages, they still have their own space and own foothold in the industry (2D VS 3D games: Differences, benefits and cost, n.d.). Moreover, game development involves weighing up the cost to make versus marketability. Although 3D games can typically charge a higher price, it does not always cover the development cost. It needs much manpower and finances throughout the production and later for the polishing and marketing phase. Therefore, the right choice to develop a game may come after the question how the game looks like. It depends on the goals that include the story, mechanics, art style, and design features.

2.2   Perspective 2D game

Amateurs frequently consider representing three-dimensional objects on a two-dimensional plane. Unity mentions typical perspectives used for the 2D games which include Top-down, Side-on, Isometric, and 2.5D (Game perspectives for 2D games, 2021). However, the whole picture of the graphical projections is quite wide, including two branches, the Linear and the Curvilinear projections (Jan, Game developer's guide to graphical projections, Part 1: Introduction, 2017). In each branch, there are different types of perspectives (Figure 3). Consequently, the scope of this chapter will just become familiar with popular perspectives in Linear graphical projection without counting on Curvilinear projection in detail.
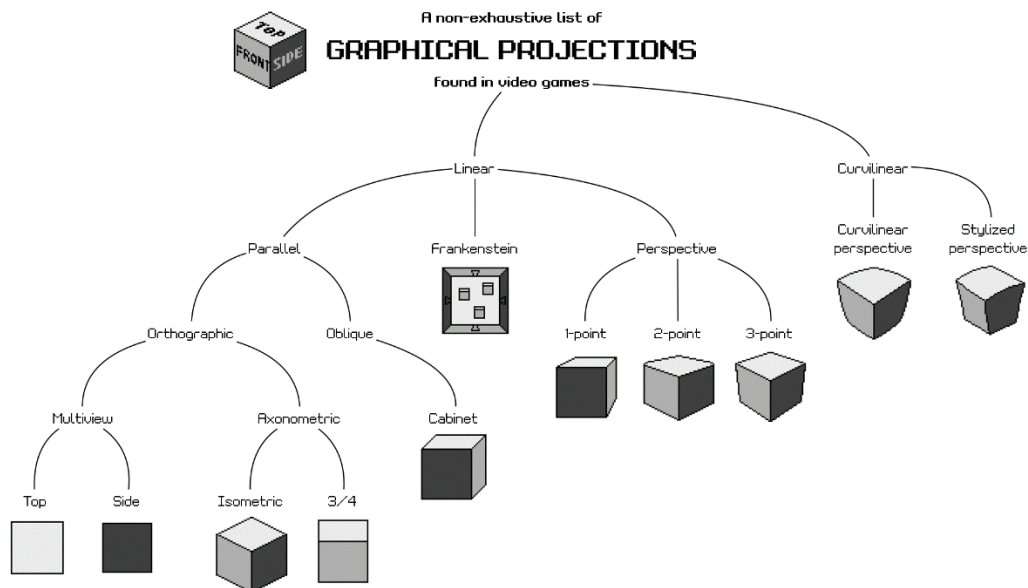
Figure 3. Graphical projections (Jan, Game developer's guide to graphical projections, Part 1: Introduction, 2017)

Briefly, in Linear projections, 3D straight lines can be converted into 2D; these 2D counterparts are always straight. While some straight lines will become curved in Curvilinear projection, like seeing the scene through a lens or over-exaggerating the image from the artist's intentions to make objects look more humorous. (Jan, Game developer's guide to graphical projections, Part 1: Introduction, 2017) Figure 4 illustrates Linear projections with Justice League Task Force, Sunsoft, 1995 (left) and Curvilinear projections with Michael Jordan: Chaos in the Windy City, Electronic Arts, 1994 (right)

Figure 4. Linear projections (Left) and Curvilinear projections (Right) (Jan, Game developer's guide to graphical projections, Part 1: Introduction, 2017)

In terms of detail, Linear projections are usually divided into parallel and perspective (Figure 5). In parallel projections, all 2D lines converted from 3D parallel counterparts are also parallel and the perspective looks further away in terms of distance. While in perspective projections, parallel lines in 3D are not always parallel but can instead go towards one or more vanishing points and implies a horizon line. Without going into much detail, it includes 1-point perspective, 2-point perspective, and 3-point perspective. This allows for deeper and more immersive perspective projection as if the observer is right there. The prominent advantage of parallel projection is that everything moving within them remains the same in size, no matter where they move. Thus, this reduces the workload for the artist by drawing each object at one size. In contrast to the parallel perspective, the artist has to spend time redrawing characters over and over again because objects in perspective projection become smaller with the move further away. This is also considered a waste of computer memory. (Jan, Game developer's guide to graphical projections, Part 1: Introduction, 2017) Next, the different perspectives in Parallel Perspective that are more commonly used in 2D games will be presented through the following subsections respectively.

Figure 5. Parallel projection (Left) with game Light Crusader, Treasure, 1995) and Perspective projection (Right) with game Simon the Sorcerer, Adventure Soft, 1993 (Jan, Game developer's guide to graphical projections, Part 1: Introduction, 2017)

2.2.1   Oblique

The projection also utilizes parallel rays and strives to create an illusion of 3D by using some sort of distortion to show depth (Figure 6) (Jan, Game developer's guide to graphical projections, Part 1: Introduction, 2017). One face of the projected object is presented parallel to the projective plane and the lines are drawn at an angle other than ninety degrees. This results in completely arbitrary scaling of dimensions and angle proportions and looks more awkward. (Larochelle, 2013,

pp. 35-39) For example, a sphere projected obliquely will appear distorted as an oval. Due to this "stretching out" effect, the oblique projection is not generally used for games (Koncewicz, 2009). However, Cabinet projection is a subtype of Oblique projection which has been used popularly and successfully in video games in unique appearance by a fairly easy ruleset. One side of a cube is drawn as it would be seen straight from the front, and the other sides are extended from it, usually at an angle of 45 degrees. The lengths of these sides are cut in half to help simulate a sense of dept. Figure 6 illustrates Oblique (Left) and Cabinet (Right).

Figure 6. Oblique and Cabinet projection (Jan, Game developer's guide to graphical projections, Part 1: Introduction, 2017)

Cavalier and Military perspectives are also the forms in Oblique projection, but not as commonly used (Figure 7).

Figure 7. Zombies Ate My Neighbors, LucasArts, 1993 (Left) and Indiana Jones and the Temple of Doom, Atari Games, 1985 (Right) (Jan, Game developer's guide to graphical projections, Part 1: Introduction, 2017)

2.2.2   Orthographic

The camera in the Orthographic projection can be blocked to three views such as side view, top-down view, and third-person view, also known as bird-eye view, where the camera moves over the player's character head, and it does not have a vanishing point. The Orthographic projection divides the screen into small squares called tiles and then arrange them in level editor effortlessly (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017). Since the map coordinates of Orthographic projection match with the coordinates of the screen and sprites, they can be easily manipulated. In addition, the Orthographic projections further break down into Multiview projections and Axonometric projections (Jan, Game developer's guide to graphical projections, Part 1: Introduction, 2017).

To Multiview projection, it is pretty prevalent in 2D games, including Side-scrolling, so-called Parallax scrolling, and Top-down, especially since so many of them rely on blocky tiles. All in-game objects described with 2 coordinates of x and y without the third dimension make the 3D world simplified in this projection. (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017) For example, boxes, spheres, cylinders, cones become rectangles, circles or rectangles, triangles respectively, depending on which side the player sees. It is typically simulated in platforming games to Side-scrolling, showing a scene as viewed through the player's eyes. This type of viewpoint frequently uses the Parallax effect, which provides a sense of illusion of depth. They often require some degree of transparency between front layers and back layers. Parallax effect will be presented in detail in section 4.4.2 of the thesis. From Top-down view, it fails to fully display four sides of a box by its height into the y-axis and depth into the z-axis occupy the same space (Koncewicz, 2009). Example for Side-scrolling and Top-down view in Figure 8.
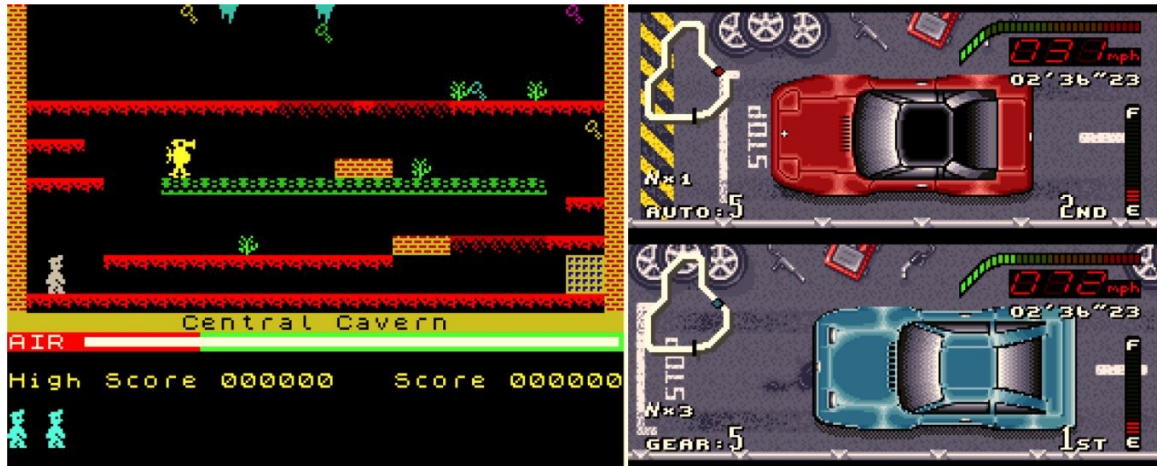
Figure 8. Side-scrolling and Top-down view (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017)

Axonometric projection, the so-called 2.5 Dimension, or also known as the three-quarter view (Game perspectives for 2D games, 2021), is a technique that tries to show all three dimensions of an object. It is an illusory projection; it presents an unrealistic issue like the depth and elevation can blend together. In addition, the division of the sum of all three angles forms the axis of the projected object, categorized into specific terms: Isometric, Dimetric, and Trimetric projections. In Isometric projection, the three axes are represented at the same scale, and the angle between each axis is 120 degrees (Koncewicz, 2009). For example, all three faces of the cube have the same surface area and are identical in size for all sides (Figure 9). (Koncewicz, 2009) In developing a 2D game, the isometric view is the hardest to work on owing to its 45-degree rotation in a triangle. The rotation transmutes the isometric coordinates from previously tied to the screen coordinates into new coordinates. Consequently, in order to handle the models, developers have to convert isometric coordinates carefully and accordingly. (Khalid, 2020)
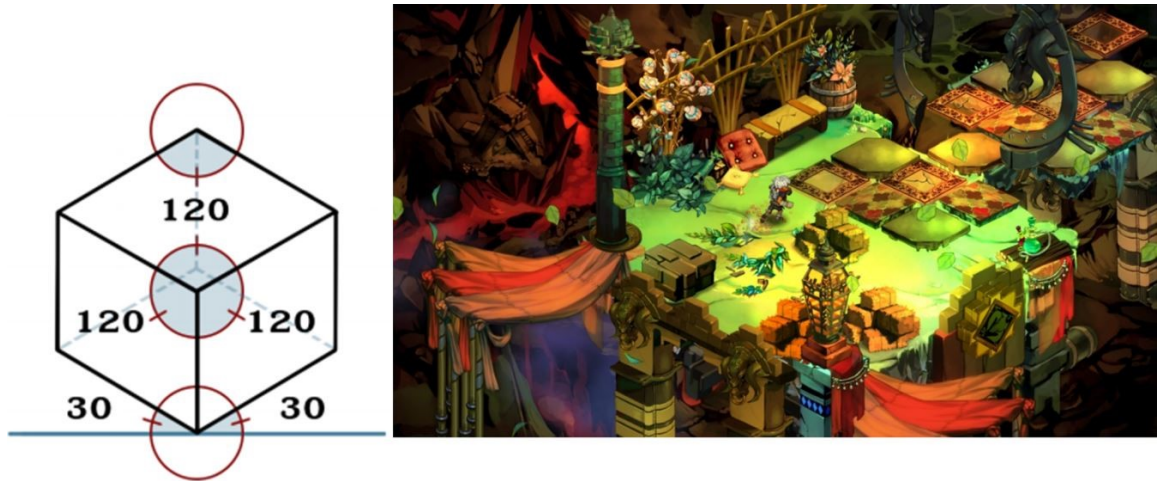
Figure 9. Isometric projection (Oravakangas, 2015)

In the Dimetric projection, two of the axes are at the same scale and have an identical angle with any value (Figure 10) (Koncewicz, 2009). Besides, Dimetric gives depth to traditional orthographic. The trimetric projection is the typical instance of axonometric projection as shown in Figure 11.
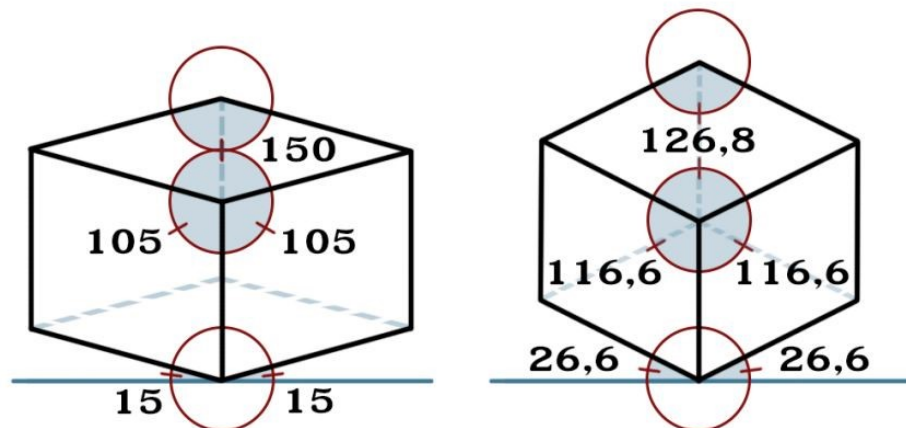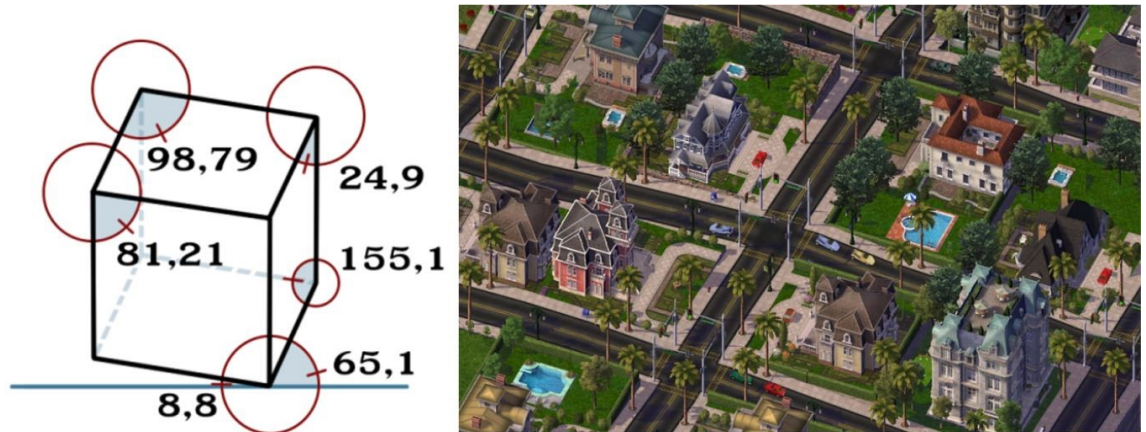

Figure 10. Dimetric projection (Oravakangas, 2015)

Figure 11. Trimetric projection, SimCity 4 Deluxe screenshot (Oravakangas, 2015). (Electronic Arts Inc. 2011)

In addition, In the 2D games, there are mainly two types of perspective First-person perspective and Third-person perspective. The First-person game is the graphical perspective rendered from the viewpoint of the player's character, which means the player sees exactly what their character sees. However, they cannot see much more of their character than their character's hands, weapons such as guns, explosives, fire, etc., and space they are interacting with e.g. cockpit, the front seat of the vehicle (Stegner, First-Person Games vs. Third-Person Games: What Are the Differences?, 2020). Because of this, to get a full glimpse of what's in the game world going on, players have no choice but to roleplay and move the entire perspective of their character. Meanwhile, third-person game refers to a game where player views their character as an observer instead of controlling the game from their view directly. Typically, the Third-person view gives players almost perfect information regarding their characters, be it the interactions with in-game environments and events or the views on their characters' appearances and aesthetics. Because of this, the Third-person game can more show the character's personality than the First-person perspective. (Stegner, First-Person Games vs. Third-Person Games: What Are the Differences?, 2020) Further Third-person perspective categorizes into two kinds of views which are used in different level editors to construct graphic user interface for games visually i.e. Orthographic projection and Axonometric projection (Khalid, 2020). Example for First-person perspective and Third-person perspective in Figure 12.

Figure 12. First-person perspective and Third-person perspective in game Stalker: Shadow of Chernobyl (Anderson, 2019) and Assassin's Creed IV: Black Flag (Williams, 2013)

There are many ways to offset each perspective's individual weaknesses and to support their strengths, but game designers need to be aware of those strengths and weaknesses. Briefly comparison between Orthographic and Axonometric shows in Table 1.

	ORTHOGRAPHIC	AXONOMETRIC
ADVANTAGES	Easy to make tile Easy to composite	Sort of easy to tile Some 3-D movement
DISADVANTAGES	Movement is 2D Game feel flat	Harder to composite Objects may be hidden Lot of work for artist

Table 1. Comparison between Orthographic and Axonometric

3   Role of visual art

Before diving into the essentials of 2D art, this chapter will take a quick look at the definition of aesthetics and its importance in building a game's experience. To explore the role of aesthetics, this chapter will cover the conceptual framework in which it is one of the other four vital components that make up a game.

3.1   Game Aesthetics

The word "aesthetics" in philosophy refers to the nature of beauty in the creation and appreciation that is based on perceptual and sensation experiences (Levinson, 2009). Video games are a kind of art emotional response in player (Hunicke, LeBlanc, & Zubek, 2004, p. 3). Although the game's story and constructs of the rules are factors players must follow and be bound by, their experience is completely personalized based on their choices for in-game actions.

Aesthetics of games are not mutually excluded from other art forms such as 2D illustration, 3D modeling sculptures, dynamic music, narrative structure, illustration. Ultimately, the result is a unique product presented by three distinct voices, i.e. the creator, the game, and the player (Melissinos, 2015) (Niedenthal, 2009, p. 2). Visual aesthetics in video games deal with the audio-visual and visual components presented in the game, such as music and sound effects, animation, visual effects, user interface, and more (Niedenthal, 2009, p. 2). Those are tools that connect players with the game world, where they can immerse themselves if the game is well designed.
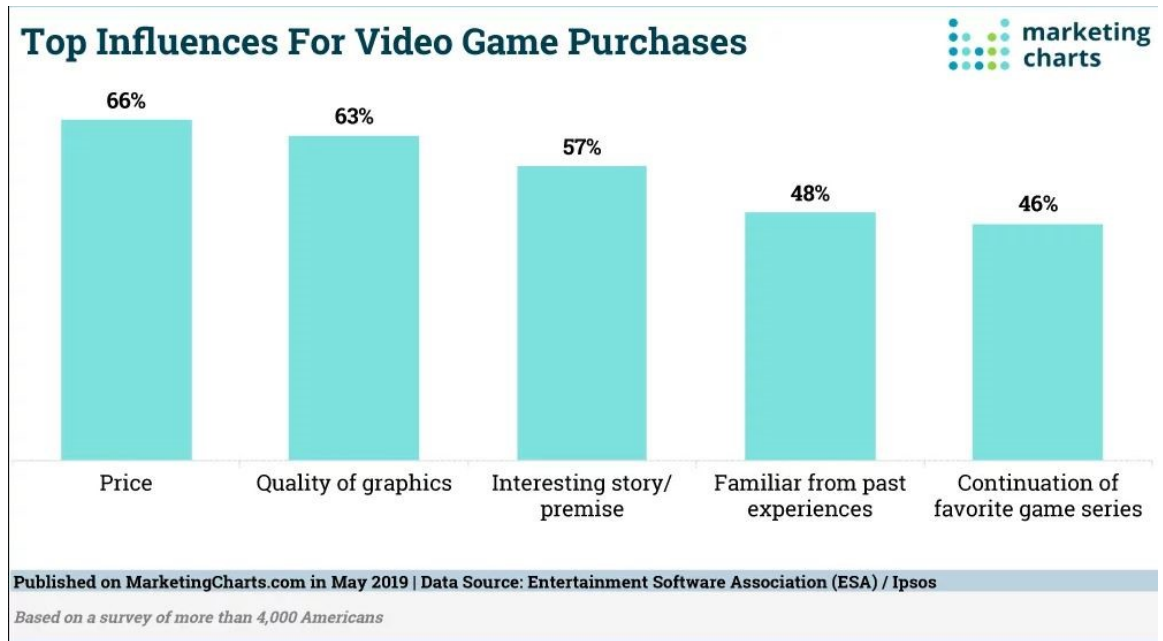
Figure 13. Top Influences for Video Game Purchases in May 2019, Based on a survey of more than 4,000 Americans (2019 Essential Facts About the Computer and Video Game Industry, 2019)

The data collected on the effects on game purchase decisions from the entertainment software association ESA in 2019 is the latest to date. Although the percentage impact of graphics quality in 2019 decreased compared to 2018 and 2017 before, it was not significant because it ranked second in the top five. Specifically, 67% and 66% for 2017 and 2018, and 63% of US players in May 2019 said that graphics quality is one of the most significant influencing factors on their purchase (Figure 13), but the graphics they refer to can be interpreted as the visual aesthetics of the game.

3.2   Elemental Tetrad

According to The Art of Game Design, Schell introduced a so-called Elemental Tetrad about the relationship between four components that form a game, illustrated (Figure 14) are technology, mechanics, aesthetics, and story (Schell, 2019, p. 51).
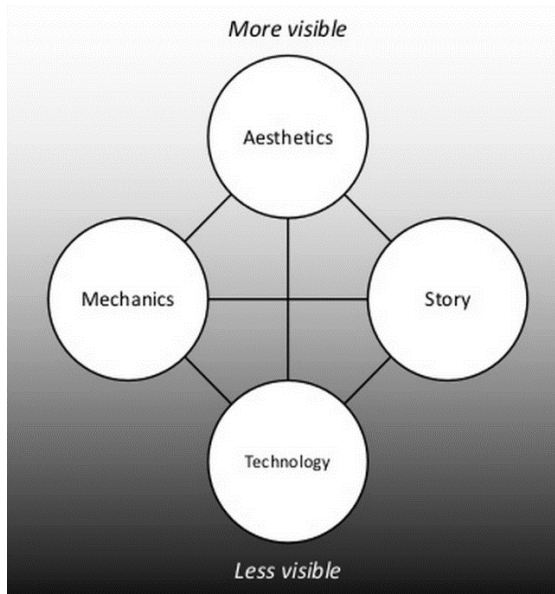
Figure 14. Elemental Tetrad (The Elemental Tetrad of Games, 2015)

Aesthetics is the third quadrant of the elemental tetrad, a core part that should be considered when building the entire experience of a game. First, the aesthetics is the first factor that catches the player's eye to decide whether to experience the rest of the game's elements i.e. mechanics, story, and technique. Next, the aesthetics helps to enhance the endogenous value of the game if the game world is strong enough to impress with magnificent graphics. Furthermore, the fact that the game is filled with beautiful works will be the reward that players always expect and want to spend time to experience more. In addition, not every game does well for all four elements of technology, mechanics, aesthetics, and story, so the look of the game can compensate the game's imperfections (Schell, 2019, p. 385). Although art or game graphics are not presented as separate components they can be understood as part of the aesthetic element.

In addition, various and often subjective perceptions of videogames are based on different stimuli and experiences of perceivers, thus leading to multiple aesthetic expressions in video games. However, the correlation between success and art quality may not be direct as not all high-grossing games possess stunning graphics. On the contrary, not all good-looking games are sure to return the investment to developers.

4   Fundamentals of 2D Game Art

This chapter will go through the important aspects related to 2D art that should be kept in mind during asset production, which are presented in separate sections in the following order: Style and Graphic types, Color, Shape, Environment, Workflow, and Tools.

4.1   Style and Graphic types

The gaming experience is dictated by mostly a combination of gameplay, game mechanics, and amazing graphic, which all feedback each other toward the success of the game (Masuch & Röber, 2005, p. 3). Thus, especially choosing a graphic style in graphic design is an important part of the game development process. Since the graphics are the first thing that reaches the players, they tend to gravitate towards graphically eye-catching and impressive games. The graphics of the first 2D games were very rudimentary with only simple shapes in poor detail due to the limited graphics capabilities of the software and hardware. However, as the technology improved, a wide range of 2D styles appeared with unique looks today that are implemented by diverse game engines, computer programs that create virtual environments for developing video games conveniently. Most notable platforms such as Unity, Godot, GameMaker Studio 2, Corona, RPG Maker, Ink, and so forth. This section will cover the three main groups of art styles in 2D games, Minimalist, Pixel, and Illustrative, which are also classified as common in Unity (Art styles for 2D games, 2021). In addition, monitors consist of individual square-shaped dots, also so-called pixel, which contains color information. This thesis will mention two main ways to present graphics on computers, especially the main vector and raster properties in section 4.1.2.

4.1.1   Style

Minimalist style group is quite popular in the mobile game (Figure 15). It emphasizes the flat and simple aspects of game assets i.e. objects, enemies, characters, background, and other content without depth and volume (2D Game Art Styles: The Ultimate Guide, n.d.). Its own unique look is completely distinct from other styles in presenting the flat colors, clean lines, and high readability, which not including any other nature of realism like shadows, cel-shaded titles. Albeit with flat color, the minimalist style group often has bright colors and the transitions between the colors

are sharp and contrasting. In this group, geometric art and vector art are typical examples. Geometric asset in-game consists entirely of primitive geometric shapes, usually, go along with contrasting with a dark background (Jeckson, 2020). Some great samples are tiles like Asteroids, Pong, Geometry Wars, Super Meat boy. Vector one offers a unique graphical style with bright colors and crisp shapes relied on mathematical algorithms for polygons, dots, and lines along with storing the color data. Albeit it does not depict colors as subtly as the realistic art style, it is preferred for its outstanding feature of smaller file size, higher quality, and resolution when enlarging or reducing the size compared to pixel-based files. (2D Game Art Styles: The Ultimate Guide, n.d.)Some notable examples of vector game art are The Banner Saga, and Ghost Trick: Phantom Detective, Steamworlds Heist, Red Alarm, Flat Kingdom, Kentucky Route Zero. In addition, the main properties of vector graphics are closely mentioned in the next section 4.1.2.

Figure 15. Minimalist style games: Pong (Parker & King, 2008), Steamworlds Heist (Espineli, 2016), Super Meat boy (Reeves, Super Meat Boy Forever Review – Hardcore Hurdling, 2021) (Left to Right)

Pixel art, so-called Pixelated graphic (Art styles for 2D games, 2021) describes raster or bitmap graphics. Which is widely known to be originated from early video games and arcades that are limited by the primitive hardware (Tanner, 2010). For example, Space Invaders (1978), Pac-Man (1980), or games of the 8-bit or 16-bit generation, e.g. The Legend of Zelda, Final Fantasy VI, Mega Man. Pixel art is composed numerous of individual square-shaped pixels are combined to form a single object in-game (Figure 16).

Figure 16. Pixelated games: Owlboy, Killer Queen Black (Ahmed, 2021)

The important thing is that the placement of each pixel that shows up on the screen is control by the artist's deliberate control (Benjaminsson, 2019). Besides, a common characteristic in pixel art in older video game graphics is the tight restraining on size and overall color count in the image, since the computer's limited ability in outputting a limited number of colors at once. However, the use of a limited color palette with consideration increases the overall neatness and cleanliness of the image instead of using a large number of colors without much difference in value. (Tanner, 2010) Interestingly, despite its considerable age, this style remains popular even to present on handheld and mobile devices with low-resolution screens. Even though high-resolution displays are standard today, 2D pixel art is still preferred by some studios or Indie game developers for various reasons. First, it emulates and triggers the warm feelings of nostalgia of classic games (2D Game Art Styles: The Ultimate Guide, n.d.). Second, its style functions splendidly for dozens of game genres that operating on minuscule screen sizes. In addition, the amount of work and work-flow of building game Pixel assets are simpler and faster than other styles as the output is still, small sized images. Lastly, that the developers consider the pixel art style to be visually appealing and timeless. (Silber, 2015, pp. 4-8) Examples of modern 2D Pixel Art games (Figure 17) as Fez, To the Moon, Hotline Miami.

Figure 17. Modern 2D Pixel Art games: Fez (Welsh, 2015), To the Moon (Reeves, To The Moon - New Moon, Same Cycle, 2020), Hotline Miami (Bramwell, 2015) (Left to Right)

The illustrative group consists of Cartoon, Stylized, and Realistic art styles whose main aim is to create and represent images with all the truthful aspects of the images to provide an authentic gaming experience. These styles attempt to depict game objects as more real-looking by adding shadows, detailed textures, though still two-dimensional images (Jeckson, 2020). Some games are so well made in conveying the depth of mood of the character as well as the story with only a limited color palette. Limbo, Badlands, Inside, One Upon Light are notable examples of Mono-chromatic art style. In this style graphics, backgrounds, other objects are all one hue as it is often intentionally used to emphasize a certain atmosphere or emotion, often mysterious or gloomy. However, a range of shades and tints of these colors are also used to distinguish between differ-ent objects. Limbo is a prime example of how a story can be told with silhouette visuals, black and

white are the only dominant color used to, besides all other objects in the game are distinguished by various shades of gray (Figure 18). Equally popular in 2D games is the Stylized style, which simplifies unnecessary visual information in favor of exaggerating a person's or an object's most prominent features (Egenfeldt-Nielsen, Smith, & Tosca, 2019). Basically, this style combination of some essential features of realistic graphics and a little Flat graphic to make visual messages becomes clearer. Figure 18 illustrates Limbo (Monochromatic style) and Flipping Death (Stylized style)

Figure 18. Monochromatic style in Limbo (2D Game Art Styles: The Ultimate Guide, n.d.) and Stylized style in Flipping Death (Art styles for 2D games, 2021)

4.1.2   Graphic types

Raster graphics, also known as bitmaps graphics, describe the image as an array of color values one after the other into pixel grids. Besides, each pixel consists of one or more bits that depend on the level of detail in the image, and the number of bits stored in each pixel is known as pixel depth. (Hosch, 2019) The Figure 19 gives more information about the number of bits that represent each pixel, along with the corresponding number of colors it can display on the monitor. For black and white images, only 2 bits per pixel are required, while the highest level of an image called true color goes up to 24 bits, to display 16 million colors, indistinguishable with the naked eye. (The Arithmetic of Color Depth, n.d.)

Name	Bits per pixel	Formula	Number of colors
Black and white	1	21	2
Windows display	4	24	16
Gray scale	8	28	256
256 color	8	28	256
High color	16	216	65 thousand
True color	24	224	16 million

Figure 19. Arithmetic of color depth (The Arithmetic of Color Depth, n.d.)

Thus, the more colors displayed at each point, the more natural, and sharper the displayed image is. Image quality in the raster graphics is determined by the size and the number of pixels per inch (PPI). In other words, pixel density helps determine the clarity of the image (What's the Difference Between Raster and Vector?, n.d.). For example, the quality of an image will be lost, most commonly blurred, blocky, or pixelated if it is enlarged. Because the pixel size becomes larger or image editing software tries to deal by adding nearest-neighbor color pixels for missing pixels (Ignatchenko, 2016). Nevertheless, highlights of the raster are offering a lot more editability in details with multi-colored visuals, especially color gradients, shadow, and shading, which is ideal for creating digital painting and photo editing such as posters, magazines, etc. Raster graphics can be created and edited in Adobe Photoshop, Krita, and so forth. (What's the Difference Between Raster and Vector?, n.d.) Popular raster file formats include .jpeg, .png, .gif, .bmp, or .tiff, in which .jpeg and .png are two of the most popular formats for game development. Jpeg format is lossy in quality. Whereas, .png is lossless and supports transparency. (Ignatchenko, 2016)

Because the computer will automatically recalculate the image when the vector image is enlarged, the nature of vector graphics instead defines color areas, lines, curves, and shapes based on mathematical equations, which are infinitely scalable without losing any detail. However, vector graphics do not display small, natural nuances without requiring extreme detailing. Common vector file types are .svg, eps, .ai, or .dxf. Adobe Illustrator, Corel Draw, Gravit Designer, and so forth, are commonly used for creating vector graphics. (What's the Difference Between Raster and Vector?, n.d.)

Both the vector and raster graphics have their downsides. Typically, in graphic design, vector graphics are widely used with printable media like logos, illustrations, engravings, signage, and embroidery because of their versatility in the scalable size. However, when it comes to photographs and shaded graphics that require complex color blends, such as in painting, the raster

graphic is the preferred format. The detailed images in raster graphic files result in large file sizes than vector graphic files, although file size can be managed through data compression. (What's the Difference Between Raster and Vector?, n.d.) In most 2D games, bitmap images or so-called raster graphics are more common than vector graphics. The computer must rasterize that image by calculating the pixels in the image to display an image. There is not much calculation the computer must do with raster graphics; they are faster to render on-screen since their nature is already rasterized. Meanwhile, vector graphics need to be processed in real-time, which can get really heavy for the processor when there are several shapes and lines to calculate. To create a crisp and sharp look as vector graphics, graphics software like Adobe Illustrator and Photoshop allows the rasterization of a vector file, meaning that the created file is in the form of a bitmap (What's the Difference Between Raster and Vector?, n.d.).

4.2   Color

In color terminologies, there are three main terms for the elements of color that need to be known first, namely Hue, Saturation, and Value. Hue refers to the color itself; Primary, Secondary, Tertiary colors are considered hues. In Saturation, the so-called Tone is the amount of pure gray mixed with a color that results in a much duller intensity. (Beachpainting, n.d.) Artists should remember that the result of this combination can become over-dulled if too much gray is mixed. Next, Value, or Lightness, specifies the lightness or darkness of a color by adding "black", "white", and "gray" values into a hue (Pav, 2021). Lower values will result in darker colors and higher values correspond to brighter ones. Moreover, there are other terminologies such as Tint and Shade. Tint that refers to a mixture of pure color and white that is paler than the original color, also known as Pastel colors, whereas Shade is a hue or mixture of pure color with black (Beachpainting, n.d.). Next, the Color ramps term is a specific range of colors that work well together, arranged according to brightness. A good color ramp should apply the hue-shifting technique, in other words, the transition that makes the base color is not only lighter or darker but also shifts the hue. This technique makes the art design to be more distinguished specifically, the highlighted areas will look more prominent while shadows will be much deeper. The term Palette is also often mentioned. It often contains multiple color ramps, a color ramp itself is however considered a palette. (Schlitter, 2018) The illustrations of color terminologies as shown in Figure 20.
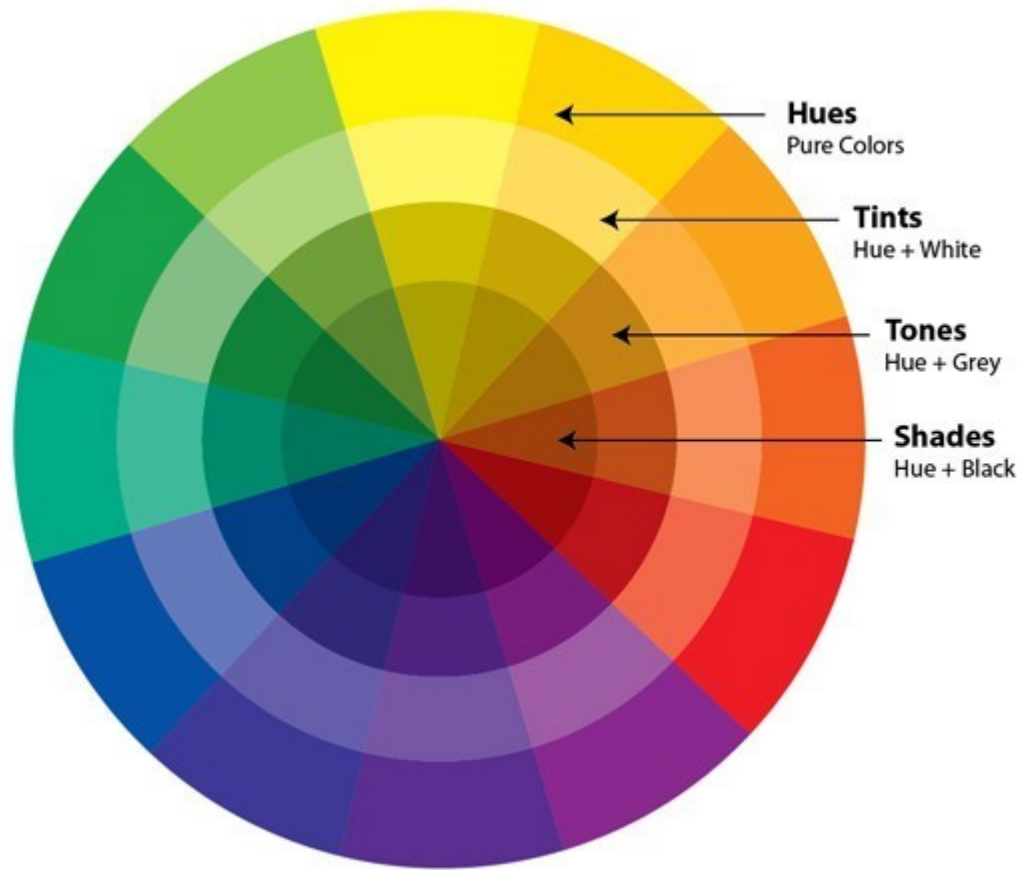
Figure 20. Color terminologies (Beachpainting, n.d.)

4.2.1   Color theory

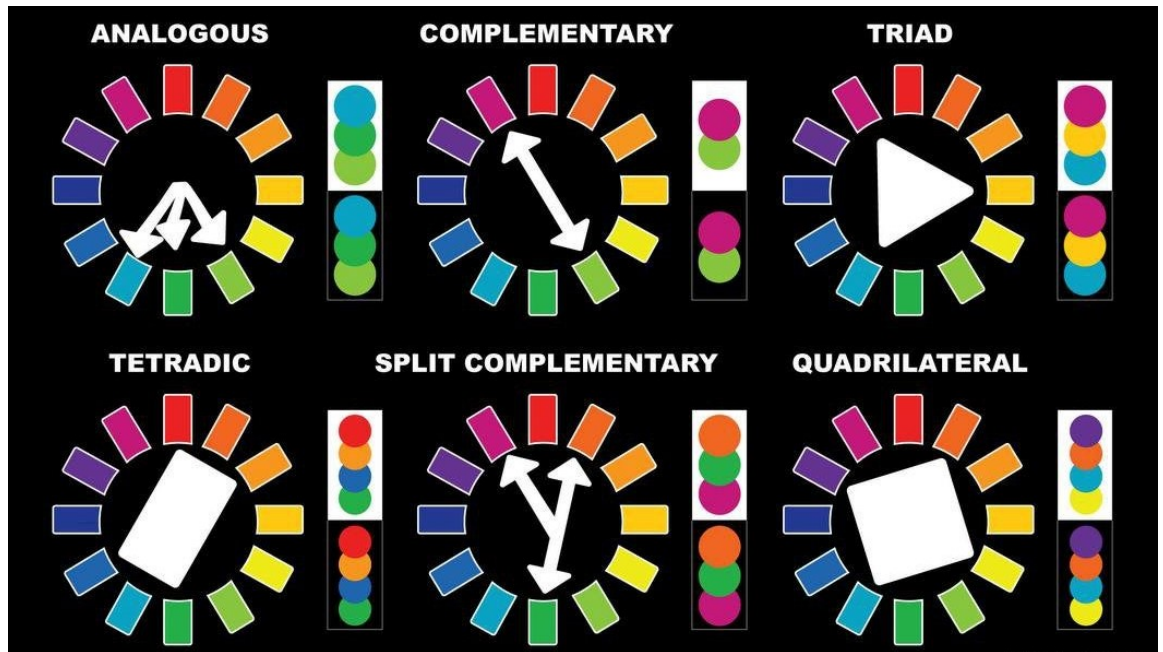Figure 21. Color theory (Wilson, 2010)

Figure 22. Color schemes (Wilson, 2010)

The color theory, primary rules and guidelines, are applied in the use of color to create an aesthetically pleasing image or evoke a particular emotion. Besides, the color wheel created by Sir Isaac Newton in 1666 will be better at understanding and choosing colors. Based on combinations from primary colors, the color wheel can be categorized into three main types of color, namely primary colors, secondary colors, and intermediate colors. Particularly, primary colors are basic colors such as yellow, red, and blue, and secondary colors are created by mixing two primary colors to result in orange, green, and purple. Intermediate colors are created by mixing both primary and secondary colors (Figure 21). (Soegaard, 2020) Then, the designer would fine-tune their choice to get maximum harmony for aesthetic appeal as well as better user experience by three main color schemes. There are monochromatic, analogous, and complementary colors. The main difference between them is color scheming from other positions on the color wheel. Whereas, the monochromatic scheme is color created from different tints by adding white or black to the original color. In addition, there are slit-complementary, triadic, tetradic, and square scheme whose color positions combine as illustrated in Figure 22. (Soegaard, 2020) Examples for Complementary color, Analogous color, Monochromatic color are illustrated in Figure 23.

Figure 23. Examples for Complementary color, Analogous color, Monochromatic color (Pav, 2021)

4.2.2   Color Psychology

To color Psychology in-game, the color itself has many different message nuances that have been studied from the historical context and the depth of culture, no matter how it is designed. The artist can unleash the power of color when using it properly. It will describe how compelling the world of game is and subtly direct how characters interact in the game with a purpose (Stewart, 2017). As the result, the color will form the game tone color, such as certain warmth, coolness, or neutrality. In principle, yellow, orange, red on the haft of the color wheel on are considered warm colors while the remaining colors on the opposite half of the wheel, including green, blue, and purple, are considered cold colors (Pav, 2021). Gamasutra.com also summarizes the key messages conveyed in each color that the artist can use as an advantage in the use of color (Figure 24).

Figure 24. A brief overview of color messages (Stewart, 2017)

Equally important, color psychology is also influenced by different cultures. When it comes to culture, it can be divided into two basic segments: Western culture and Eastern culture. In some Eastern cultures like China, red is considered a lucky and successful color while it symbolizes danger in Western culture, even a symbol of death in Nigeria. (The Psychology of Color for Game Development, 2018) According to Jennifer Kyrnin at About.com, the way cultures think about color is not the same and these differences are shown in Figure 25.

Yellow
Eastern: Proof against evil, for the dead, sacred, imperial
Western: Hope, hazards, coward, weakness, taxis

Green
Eastern: Eternity, family, health, prosperity, peach
Western: Spring, new birth, go, money, Saint Patrick's Day, Christmas (with Red)

Blue
Eastern: Wealth, self-cultivation
Western: Depression, sadness, conservative, corporate, "something blue" bridal traditional

Purple
Eastern: Wealth
Western: Royalty

White
Eastern: Funerals, helpful people, children, marriage, mourning, peace, travel
Western: Brides, angels, good guys, hospitals, doctors, peace (white dove)

Black
Eastern: Career, evil, knowledge, mourning, penance
Western: Funerals, death, Halloween (with Orange), bad guys, rebellion

Red
Eastern: Worn by brides, happiness and prosperity
Western: Excitement, danger, love, passion, stop, Christmas (with Green), Valentine's Day

Pink
Eastern: Marriage
Western: Love, babies (especially female babies), Valentine's Day

Gold
Eastern: Wealth, strength
Western: Wealth

Figure 25. Eastern and Western cultures think of color (The Psychology of Color for Game Development, 2018)

4.2.3 Role of color in-game

The function of color in-game plays a vital role in support for the artist, game designer, and marketer to make the game successful, but the main goal is to make it easier to recognize objects in the game as the similarity between the game world and the real world. According to Color in games: An in-depth look at one of game design's most useful tools at Gamasutra.com, color relates to emotion, branding and fashion, visual hierarchy, progression, mechanics, and signifiers, and identifiers. (Tulleken, 2015)

For the emotional aspect, color creates an emotional framework for the player's activities. Where transition of color within the same scene represents a distinct mood or affects the impact of feeling. In addition, it facilitates the emotional state of the player to be formed and developed according to the storyline (Tulleken, 2015) (Anhut, Color Theory For Game Design 1 of 4 – Fundamentals, 2014). In the Silent Hill Series (Figure 26), the clever color scheme by colors creates a dirty, gloomy feel that evokes an unpleasant feeling in the player about an atmosphere of danger and decay with the survival horror genre.

Figure 26. Color scheme in Silent Hill Series (Anhut, Color Theory For Game Design 1 of 4 – Fundamentals, 2014)

To the branding function, color plays an important role in the branding and recognition of the game [42], for example, the purply blue from Super Mario Bros (Figure 27), the hot pink of Hotline Miami (Figure 28). Besides, color can also convey the target audience that the game is aimed at, e.g. bright colors are often applied to casual games, while core games use more nuanced colors. Also, the choice of colors in the games is influenced by the fashion of the time (Tulleken, 2015). For example, many games in 2012 look more homogenous and monochromatic with blues and browns or oranges as the dominant colors, and some games also lean towards using desaturation and tinting palettes to achieve realism.

Figure 27. Color Branding in Super Mario Bros (Tulleken, 2015)

Figure 28. Color Branding in Hotline Miami (Tulleken, 2015)

Next is the visual hierarchy function where color can help navigating the player's focus what is important to interact with within the game, instead of leaving them in the middle of a jumble of objects. More specifically, the elements of the game scene form a visual system, which is hierarchical in priority as follows: first the player, followed by the enemy, the interactive object, and finally the background elements. Furthermore, Value, Saturation, and Hue can all be used to distinguish important elements. (Tulleken, 2015) Examples are shown in Figure 29.

Figure 29. Visual hierarchy focus with Value, Saturation, and Hue (Left to Right) (Tulleken, 2015)

Next, color sets the tone and atmosphere of the world which can help the player feel the progression of the game through the change in time and space (Tulleken, 2015). A prominent example from Journey in Figure 30 by Matt Nava shows how color communicates with players through the evolution of the environments, subsequently, provides players with clues for better understanding and prediction of game events. Colder and darker environments evoke hidden threats compared to lighter and warmer counterparts.

Figure 30. Progression by color in Journey (Tulleken, 2015)

Next is mechanics, some games that exploit color for mechanics and rules, which are often puzzle games that challenge color memory and color scheming ability (Tulleken, 2015). Huedoku and Blendoku are games that have the same idea of asking players to arrange swatches in gradient order in a grid or crossword-style grid. More examples for the relationship between color and mechanics such as Exit Palette, Hue, Brandseen. Followed by identifiers and signifiers, in-game colors are used to identify different elements along with alert the player to the elements' properties. To signifiers, color is often used to communicate an element's properties as a part of terrain or an item about whether or not the player can interact with them and how they can be used. (Tulleken, 2015) (Figure 31)

Figure 31. In Pirates of the Caribbean Online, different potion ingredients are categorized by different colors depending on what they are made from (Tulleken, 2015)

4.2.4   Glyphs and neutral

More about identifiers, specific to glyph and neutral, the color can hint to the players about an object's factions whether it is good or evil (DVNC, n.d.). Normally, when players see red, they may start thinking about enemies, danger, while blue may be associated with teammates or relaxation. Thus, it's essential to get a small inside into how to use glyphs and neutral for color layouts before planning to color characters, environments, and props. Frist, color identifiers (glyphs) are used to group and separate game elements, such as in-game characters, and areas by color. It should be easy to label by primary and secondary colors and need to be mutually exclusive from other identifiers, meanwhile, all remaining colors are referred to as neutral. In color layout, neutrals are used for the color canvas, and glyphs are used to make the color objects stand out. (Anhut, Color Theory For Game Design 2 of 4 – Glyphs And Neutrals, 2014). Figure 32 illustrates using color canvas and color objects.

Figure 32. Color identifier (Glyphs) and Color object (Neutral) are used in Limbo (Anhut, Color Theory For Game Design 1 of 4 – Fundamentals, 2014)

Commonly, the marking object can be established by 2 color identifiers, 3 or more color identifiers depending on the set of rules or mechanics of the game. The most effective two-color identifier to mark two factions in a competitive game requires clear color communication that is chosen as opposed to each other as possible, frequently preferred colors such as red versus blue, red versus green, blue versus orange (Figure 33). (Anhut, Color Theory For Game Design 2 of 4 – Glyphs And Neutrals, 2014)
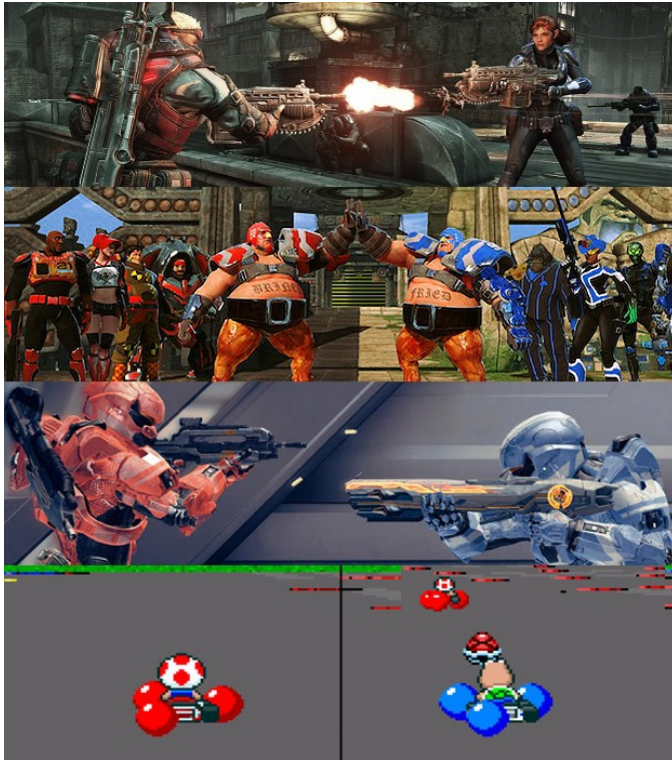
Figure 33. Games with either 2 players or 2 teams (Anhut, Color Theory For Game Design 2 of 4 – Glyphs And Neutrals, 2014)

They have to ensure the contrast between cold and warm as well as primary and secondary counterpart very well. In the case of a game with more than two color identifiers to represent characters, GUI elements, and other objects, color selection becomes more complex and often follows a certain priority. The three recognizable colors like red, blue, and yellow are usually used for 3 color identifiers, then the secondary colors such as green, orange, and finally purple are applied to the four, five, and six color identifiers respectively. Additional glyphs such as gray, turquoise, white and black will be used after the above six colors are used up. (Anhut, Color Theory For Game Design 2 of 4 – Glyphs And Neutrals, 2014). Figure 34 from New Super Mario Bros Wii illustrates for 4 color identifiers.

Figure 34. Color identifiers New Super Mario Bros Wii (Anhut, Color Theory For Game Design 2 of 4 – Glyphs And Neutrals, 2014)

However, a few cases don't show exactly in this order of priority mentioned above. For example (Figure 35), with 4 characters in Turtle design, they do not show four-color identifiers with red, blue, yellow, and green as the green skin and yellow chest plates are eliminated from the glyph group. They actually are downgraded to neutrals in-stead of a glyph. Hence, this forces the use of the next two colors orange and purple to replace skipping green and yellow. Briefly, glyphs need to be exclusive to the objects they represent, i.e. there should be no color matching of character traits. (Anhut, Color Theory For Game Design 2 of 4 – Glyphs And Neutrals, 2014)

Figure 35. Color identifiers in Turtles in Time (Anhut, Color Theory For Game Design 2 of 4 – Glyphs And Neutrals, 2014)

4.2.5   60-30-10 rule

Color combinations can enhance the aesthetic appeal and user experience or vice versa if not used properly. Working with a limited but carefully selected palette can help artists control and develop assets efficiently (Pav, 2021). The game world will look more coherent and pleasant. On the contrary, if there are too many randomly selected colors, the game's visuals can look chaotic, even confusing the player's eyes. Therefore, color should be chosen carefully at the start of the design process by thoroughly understanding color theory as well as color schemes.

The 60-30-10 rule can be applied to help color fulfill its role. This rule may be seen as a visual and easy-to-apply color organize solution that helps balance the design when using too many colors. The basis of 60-30-10 rule is to choose a primary color, a secondary color, and an accent color at 60%, 30%, and 10% of its area in the same design respectively (Figure 36).
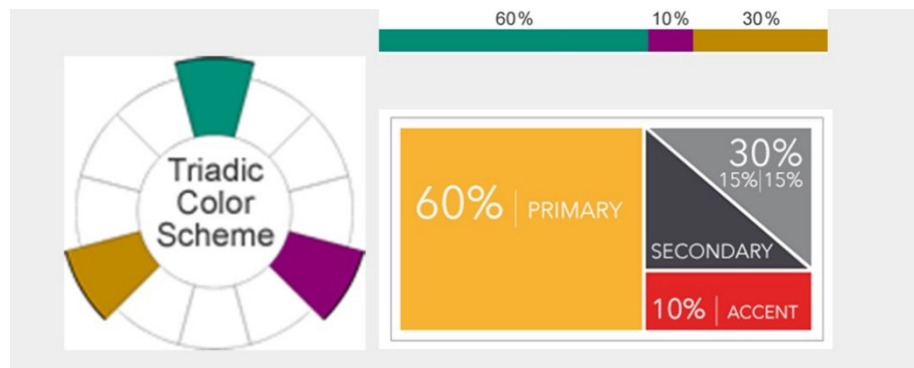
Figure 36. The 60-30-10 rule (How many colors should you use in your designs?, n.d.) (The 60-30-10 rule, n.d.)

In-game design, this proportion corresponds to 60% for environments, backgrounds, non-interactive objects; 30% for interactive objects; and 10% for characters. For example, start with the 3-color scheme used in a game, then decide on the proportions to use for each color. If the design has more than 3 colors e.g. 4 or 5, select only primary or secondary colors to split, resist splitting accent color. Then add a lighter or darker shade of that color as long as keeping the color split within its designated percentage. (The 60-30-10 rule, n.d.) For example, if the primary color is selected to be split to add a lighter hue, the 60% result will change to a 40% original color plus a 20% lighter hue.

4.3   Shape

This section will go through the important aspects related to shape, which are presented in separate paragraphs in the following order: basic elements of composition; dynamic composition; character shapes; character development; and the relationship between character and environment shape.

4.3.1   Elements of composition and dynamic composition

Before inspecting the effective composition in-game, it is necessary to take a quick glance at the basic elements of composition of an art product including in form of lines, shapes, and volumes along with their psychological effects. No matter how simple or complex a work of art is, it always starts with the simplest shapes that are considered the root of visual design (Mehrafrooz, n.d.).

When it comes to shapes, they are consistently associated with their corresponding aesthetic concepts throughout art history based on players' personal experience and perception from real-life to visually assess the general characteristics of objects (Solarski, The Aesthetics of Game Art and Game Design, 2013). Each of the basic lines and shapes conveys a different set of feelings and attributes to the viewer. Curved lines and circular shapes or spherical volumes are considered the friendliest as they have no sharp or dangerous corners. They represent energy, youth, innocence, femininity. While square-like shapes related to the straight vertical and horizontal lines, or cubes that convey strength, maturity, balance, stability, confidence, stubbornness. Whereas, triangles relate to diagonals and angular lines or pyramids are the most dynamic in all shapes that communicate the most aggression, masculinity, force. (Solarski, The Aesthetics of Game Art and Game Design, 2013)
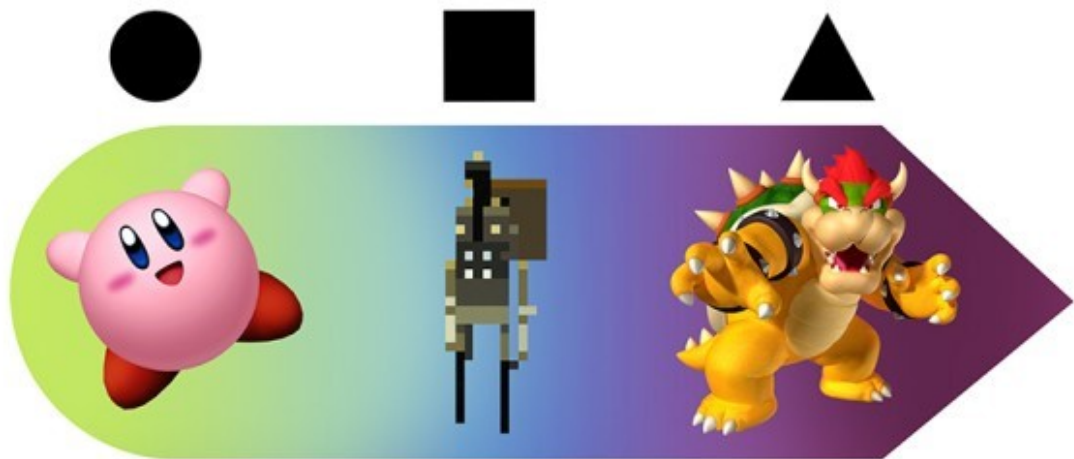
Figure 37. Psychological associations with primary shapes (Solarski, The Aesthetics of Game Art and Game Design, 2013)

Composition is the act of purposefully combining basic elements, including lines, shapes, and volumes, to form a whole (Solarski, The Aesthetics of Game Art and Game Design, 2013). Taking advantage of the principle of design correctly which encompasses Scale, Proportion, Repetition, Contrast, Balance, Emphasis, Hierarchy, and Harmony, will result in a simple yet strong composition. A simple visual composition gives more room to the main theme and the game's atmosphere reinforces and enhances the player's emotional experience, rather than placing them in the visual noise (Solarski, The Aesthetics of Game Art and Game Design, 2013) (Lovato, 2015). As players need to be guided through a narrative designed to understand the mechanics and messages conveyed instead of getting confused with too many directions. In other words, strong composition directs the players' eyes to follow a designer's purposeful invisible path through events one by

one at each given point in a level. Hence, the layout with a clear objective called dynamic composition consists of five elements, such as character shape, character animation, environment shape, pathway, and player gestures (Figure 38) (Solarski, The Aesthetics of Game Art and Game Design, 2013).

Figure 38. Dynamic composition (Solarski, The Aesthetics of Game Art and Game Design, 2013)

The path in dynamic composition should be a coherent hierarchy among various elements that are based on the weight. However, factors such as contrast, size, luminosity, and object's position on the layout canvas assign a certain visual weight to each asset. In particular, objects that are big, bright, colorful, and must contrast with their surroundings, have a high weight, and are eye-catching (Lovato, 2015). Briefly, dynamic composition stresses its importance in how the visual of the game world is viewed and experienced by the player which is essentially shifting from design concept to interactive experiences. Thus, it should be the top consideration for developers in shaping their video game emotional experience.

4.3.2   Character shapes and character development

The character's personality in-game is answered through visual art, in which the silhouettes contribute greatly to defining who is the protagonist or antagonists, friend or enemy, and so on. Most

importantly, the silhouette of characters emphasizes the distinction in the main shape rather than minor details to make their shapes easier to follow, thus mitigate the cofunction (Solarski, Drawing Basics and Video Game Art, 2012, p. 180). Besides, the stylized game allows more creativity to stylize and exaggerate the character's dominant character through shape and proportion. Usually, circular concepts depict protagonists, likable characters, or superheroes who are dependable to elicit feelings of safety, whereas bad guys or villains need to display a sense of peril and always put events in motion rather than in a passive state. It is for these reasons that triangular concepts fit antagonists perfectly. Figure 39 illustrates characters' shapes that represent different personalities.

Figure 39. Silhouettes of some of the characters in Megamind (Ekström, 2013)

Although visual stereotypes exist in all elements of art by sharing a similar visual vocabulary about a real-life experience as the examples above, artists can employ these common conceptions that already exist to create an interesting character design. By subtle combinations between visual elements together in a proper way, the character will become memorable and leaves a greater impression on the audience. Toy Story 3 (2010) produced by Pixar Animation Studios, is a great example of using visual elements to communicate the character's personality (Figure 40). The design main antagonist, Lotso, has a friendly and lovable appearance by using primary shapes like circles, while his primary color is purple, often reserved for evil characters. The contraction highlights his cunning and twisted personality in later revelation. Besides, the shape of a single character itself has the ability to reveal personality through the visual. However, this visual communication becomes more powerful and interesting by placing the characters in relation to each other in terms of proportions, size, and body shape (Bancroft, 2006, p. 132). For example, a small character placed next to a large character will make them appear larger and smaller. Also note that when creating opposing characters, or a team, it is important that they work well together.

Figure 40. The main antagonist Lotso - from Toy Story 3 (Ekström, 2013)

Next is character development in the course of the game. By relying on the user interface or character's costume change, the players can know the maturity of the character's strength and ability (Solarski, The Aesthetics of Game Art and Game Design, 2013). Corresponding to the left and right screenshot of Figure 41 from Zelda: Ocarina of Time (1998), shows Link's progression at early his quest and after many boss battles. The interface on the left has fewer hearts and Link is equipped with only one sword while the right one clearly shows Link's power with more hearts, weapons, and gadgets.

Figure 41. Character Development - Zelda Ocarina of Time (1998), Nintendo (Solarski, The Aesthetics of Game Art and Game Design, 2013)

However, especially in narrative games, the character's emotional progression from start to finish is always changing through in-game events rather than the same state. Therefore, in addition to the interface and costume change, the physical posture can be considered the most powerful

visual element to express the inner feelings of the character. Thus, by treating the character in a video game like a real person, the developers skillfully crafted a multi-dimensional, nuanced and above all an interesting character. (Solarski, The Aesthetics of Game Art and Game Design, 2013) Journey (2012) is a successful game in using physical gestures to express the character's emotions that showed in Figure 42. The character's weakened physical state during the journey is shown through the character's upright and free-jumping posture at the beginning of the game, then shifting to heavy steps and always toward the storm.

Figure 42. Character Development, Journey (2012), thatgamecompany (Solarski, The Aesthetics of Game Art and Game Design, 2013)

4.3.3 Character and environment

The relationship between character and environment is based on the character's shape and animation; players can respond emotionally to characters. However, the narrative only emerges when placing the character and environment in a certain scene (Solarski, The Aesthetics of Game Art and Game Design, 2013). In dynamic composition, the environment such as secondary characters and enemies or so-called character's surroundings plays a key role as it occupies most of the visual frame. In other words, environment objects are the narrative obstacles that either has a harmonious or dissonance relation with the playable characters.

The shared similarities in visual design between characters and surroundings offer a sense of safety to players or danger when they are placed in the opposite environment (Solarski, The Aesthetics of Game Art and Game Design, 2013). Figure 43 represents a composition of character and environment shape respectively with purple and green to refer to the concept of harmony and dissonance. Although the primary shapes give a different aesthetic sensation, the matching shapes of characters and environments can exhibit a sense of harmony in the art style. In contrast, the contrast in the shape of the character and environment gives a sense of dissonance. (Solarski,

The Aesthetics of Game Art and Game Design, 2013) For example, a circular or triangular character appears to be threatened when placed in an edgy or rounded environment respectively. The character and environment relationship can change dynamically throughout the game to create different emotional progression for the player. Journey is a good example where triangles are used and echoed in the shape of the character and throughout the landscape to achieve harmony.
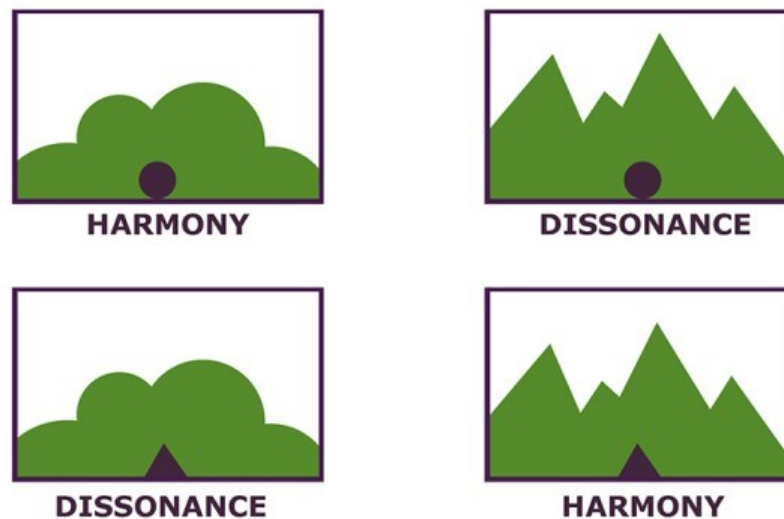
Figure 43. Character Shape Versus Environment Shape (Solarski, The Aesthetics of Game Art and Game Design, 2013)

4.4   Environment

This section will describe the important aspects related to environment, which are presented in separate paragraphs in the following order: space, illusion of depth; then are mentioned effective tricks of creating the illusion of depth to compensate the limits of 2D assets and locked camera.

4.4.1   Space and Illusion of depth

Basically, space is split into 3 parts, foreground, middle ground, background, to depict the different distances of the subject in a work of art. Any image that adds depth and dimension will capture the audience's eyes even more because their gaze is paused to see how the various elements work within the context of the frame. In simple terms, in a scene, the foreground is the part at

the bottom that is closest to the camera and the viewer. In contrast, the background is farthest away from the camera and the viewer, usually making it the part that is nearest to the horizon. By default, what falls somewhere in between the foreground and the background is called the middle ground. (Gupta, n.d.) Depending on where the object is in a scene, its size and detail will vary. Subjects in the foreground often look large with a lot of detail, while subjects in the background will be small, with little or no detail. In the middle ground, objects are usually medium in size and have less detail.

Albeit the 2D games are purely flat images that have discarded the third dimension, developers still attempt to represent them as 3D worlds as possible. Excluding abstract games, the artist communicates depth in multiple ways towards the illusion of space which implies that the scene is three-dimensional with varied lighting and shadow effects. Some effective approaches that can help games achieve that include Parallax, overlap, atmospheric perspective, lighting, shadow, size, and detail.

4.4.2   Parallax

Parallax scrolling (Figure 44) is a technique commonly used in 2D computer graphics that evolved from the multiplane camera technique used in traditional animation since the 1930s (Moos, 2019). It was considered a great leap forward towards real perspective for video games in the early 1980s even though all of the assets are still 2D planes. The way to create an illusion of depth in a 2D scene is to move background layers past the camera more slowly than the foreground layers. Besides, this technique applies the layout method that is supported by multiple background layers with different distances, which can be scrolled independently in the horizontal and vertical directions. Layers can be placed in front of a layer containing objects that the player interacts with to obscure some of the actions of the game or distract the player. Layers that are closer to the camera will move faster and vice versa. (Parallax Scrolling, n.d.)
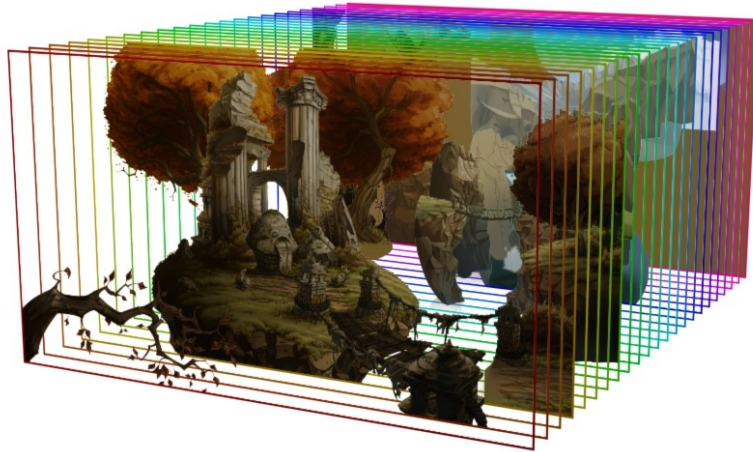
Figure 44. A side view of the layers used for parallax scrolling in The Whispered World (Aalto, 2020, p. 10)

The overlap is understood as the placement of graphical elements, such as sprites, in front of other objects and obstruct the view of objects behind them (Fussell, n.d.). The fact that each 2D element has length and width but no depth tends to flatten the design, while a 3D object, always carries a certain volume helps to create the illusion of the third dimension. So, the principle outcomes of overlapping shapes in a composition are to make the shapes either dominant or subordinate along with creating depth. In the game, the placement of some scenery in front or behind the character's movement plane is necessary to express the relative positions for the clarification. This contracts to the confusion shown in Figure 45 due to the lack of overlap. Basically, a general rule of thumb of overlap is to push two objects closer together and try to avoid ambiguous compositions such as making two objects touch each other. (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017) The visual result looks particularly flat since they are just touching each other in 3D.
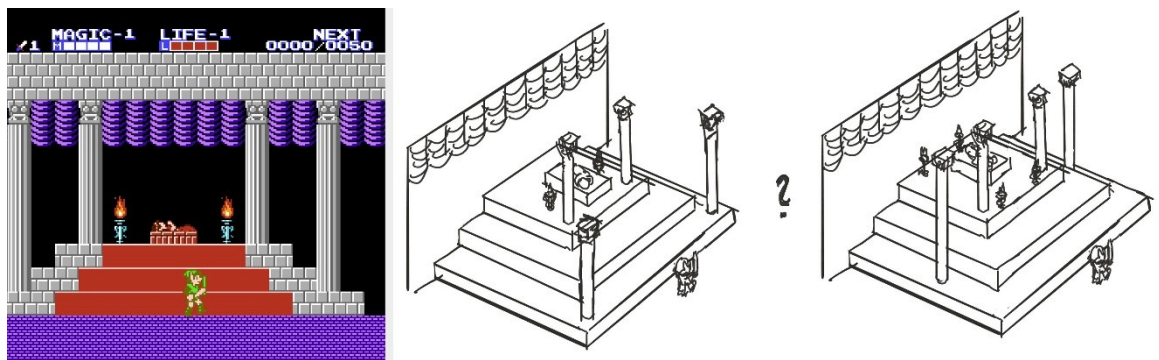
Figure 45. Game scene Zelda II: The Adventure of Link, Nintendo, 1987, without overlap (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017)

4.4.3   Atmospheric perspective

Atmospheric or aerial perspective is a common technique used in landscapes and video games by distinguishing the background from the foreground to communicate depth that makes the scenes easier to read. In fact, numerous objects are always obscured by the surrounding atmosphere including air, light, and scattering particles such as water, smoke, dust, pollution, etc. which causes distant objects to have blurred details, loss of contrast, and shifted in color (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017) (Stevens, 2008). The more distance there is between the viewer and the object, the more the view is affected. In more detail, the colors of objects close to the viewer will be more vibrant, saturated, while objects in the background have less saturation and lean towards blues or match the sky colors, for example like red at sunset. When it comes to loss of saturation, that means colors will become dull or neutral instead of rich or bright. Besides, the contrast between the light and dark areas of the object decreases as it moves further away from the viewer (Stevens, 2008). Figure 46 from Super Mario World 2: Yoshi's Island is a great example. The background of hills and clouds is rendered in soothing pastel tones that contrast sharply with the platform where the characters interact.

Figure 46. Atmospheric Perspective Super Mario World 2, Yoshi's Island (Stevens, 2008)

4.4.4 Light - Size - Contrast - Detail

Lighting is the next technique that light sources fade through their reach, distant objects appear to be darker. Depending on the position relative to the light source, the object receives varying intensity at different distances, inversely with the square of the distance (Figure 47) (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017). In 2D games, good contrast between the foreground and background gives a better illusion of depth. Figure 48 from Super Castlevania IV, Konami, 1991, example for bright foreground and dark background, while the aesthetic in modern games is the opposite, from Frogatto & Friends, Frogatto Team, 2012, the background is brighter than the subjects that are close to the camera.
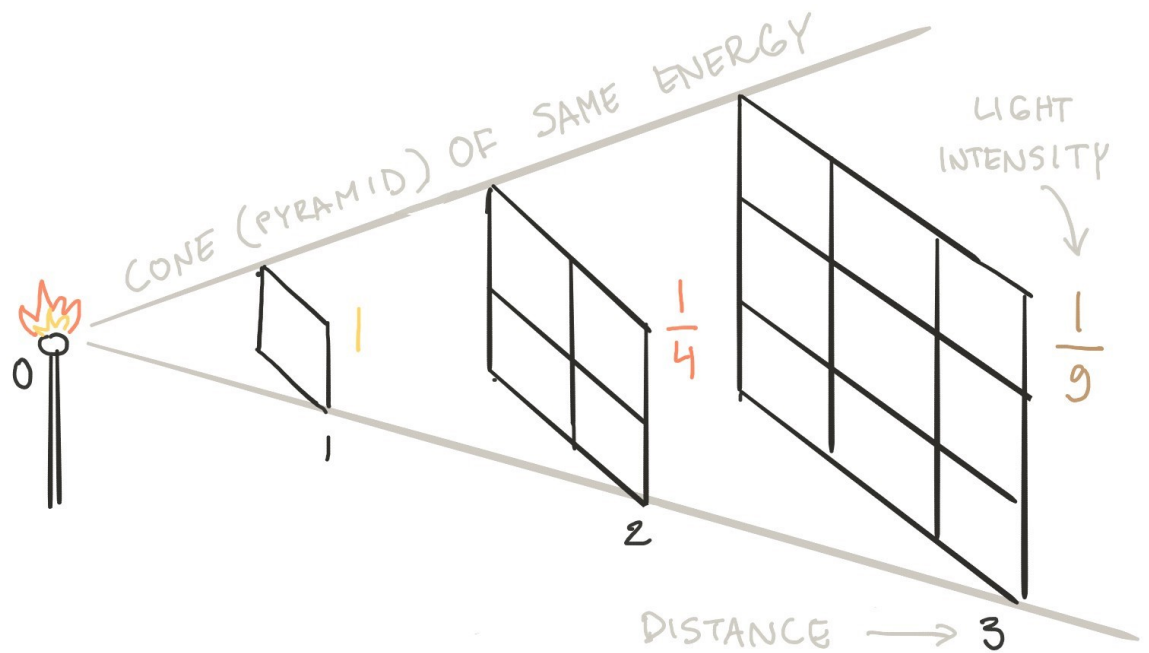
Figure 47. Light sources and intensity (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017)

Figure 48. Contrast between the foreground and background gives a better illusion of depth (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017)

In addition, the technique of blackening the inner parts of the architecture is also favored as the Figure 49 when completely removing the light through them or gradually reducing the light below the platform like Dead Cells, Motion Twin, 2017. It creates a very pleasing lighting setup with clear prominent characters (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017).

Figure 49. Technique of blackening the inner parts of the architecture and reducing the light below platform (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017)

The shadow trick also implies the depth of the object when receiving the light source, where the shadow's size implies how far the object is from the surface receiving the shadow. Besides, the shadow can approximate the shape as the object casting it if its volume is not taken into account or it is very thin. In contrast, the shadow shape needs to be represented with volume as a real 3D object (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017).

The size technique is used to draw objects in the background to a smaller size to create a sense of depth. Although this is not proper for Multiview projections as the scale of the objects should be uniform regardless of the distance. In a game scene, larger objects appear to be closer to the player and vice versa, corresponding to how the eyes see objects in the real world (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017). Figure 50 from the Mad TV game, Rainbow Arts, 1991, illustrates the buildings in the far background that are much smaller than the main tower, where the player interacts.

Figure 50. The Size technique, The Mad TV game, Rainbow Arts, 1991 (Jan, Game developer's guide to graphical projections, Part 2: Multiview, 2017)

In the environment, the contrast between the dark and light areas decreases as objects are far away, the same applies to the level of detail, the farther the objects are from the camera, the less detail is displayed and vice versa. The object's importance to the gameplay also affects the level of detail, which means that the most important objects will get the most detail with thick outlines and sharp edges. In contrast, less important objects, farther in the distance of the non-interactive background are favored last, with thinner outlines, softer edges, and blur (Ran, 2021). In fact, the viewer's eyes are limited in perceiving distant details, which is partly due to a large amount of light affects the objects reducing theirs display clarification. Furthermore, the viewer's eyes can only focus on one object at a time while the surrounding objects will be blurred to avoid distraction. Besides understanding the natural effects of the eye, removing unnecessary details to focus on elements such as composition, silhouette, color saturation, etc. background will be easier to read.

4.5   Workflow and Tool

Every game world has a large number of objects that themselves have a story to communicate with the player, whether more or less. Research, concept, and then final design are the key phases of creating a complete design whether it's for a single object or a vast environment. (Solarski, Sponsored Feature: Drawing Basics and Video Game Art: Character Design, 2012) In each phase, there are small stages arranged in an order to work towards a common goal. It should be noted that presenting work between different team members is extremely important for feedback as not everyone can think alike.
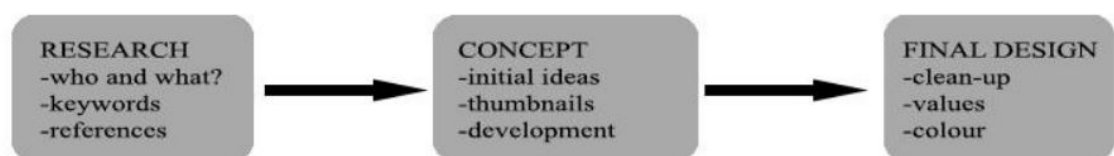
Figure 51. Workflow (Ekström, 2013)

4.5.1   Research

The research phase includes brainstorming and moodboard. During the research phase, it is essential to get acquainted with who and what the object or character is, and how it will be developed before embarking on a design (Mattesi, 2008, p. 96). The approach of making questions around characteristics such as gender, age, mood, strengths, weaknesses, and so on is most effective for getting a summary of desired object's emotional experience. Appropriate keywords will be assigned to the character or object in the form of nouns and adjectives, but adjectives will be preferred. Compared to nouns, artists can easily and effectively describe and convey emotions by using adjectives (Solarski, Drawing Basics and Video Game Art, 2012, p. 190). These selected keywords are then used by the development team to build a high concept and serve to find references.

Moodboard (Figure 52) is simply a composition of images that inspire the development team to envision the mood, color scheme, and future appearance the game is about, which can include concept art or screenshots from existing games. Mood boards can be created for the whole game, or specific areas, characters, or props by using the powerful image search from Google or any other available search engine with given keywords or phrases. (Wolstenholme, 2018) All ideas are then put together into a visual document that the development team can refer to throughout game development.
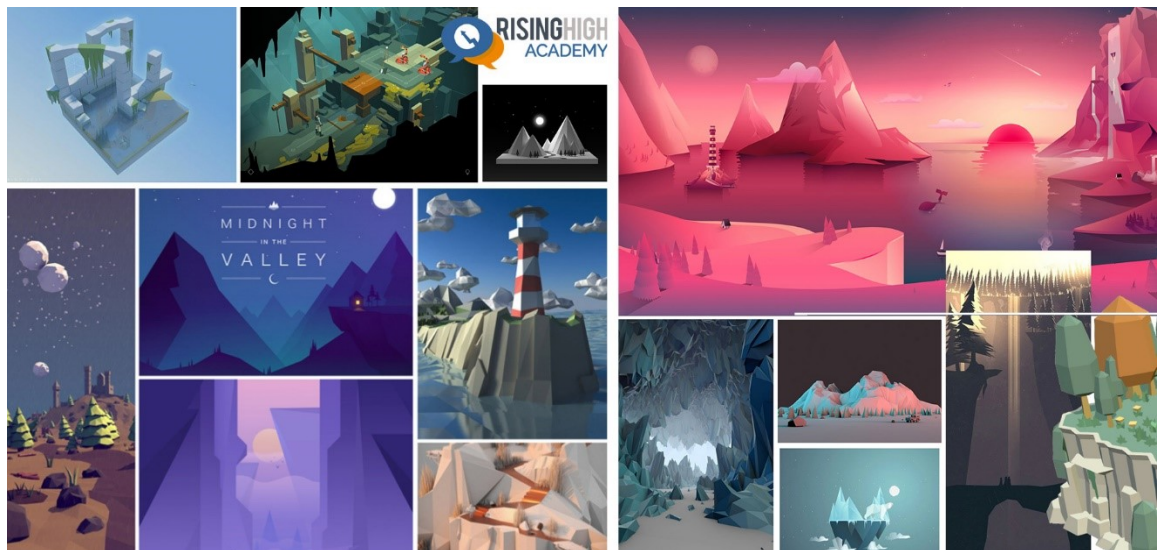
Figure 52. Example for Moodboard (Wolstenholme, 2018)

4.5.2   Concept

The concept phase includes initial ideas, thumbnails, and thumbnail development.

The initial ideas come up from expanding the visual vocabulary after reflecting on the collected references (Introduction To Thumbnailing And Quick Sketching, n.d.). From the materials available, the artist gets an overview of the style and makes appropriate choices about which primary shapes represent each object. Ideas on paper are then explored and developed by thumbnails.
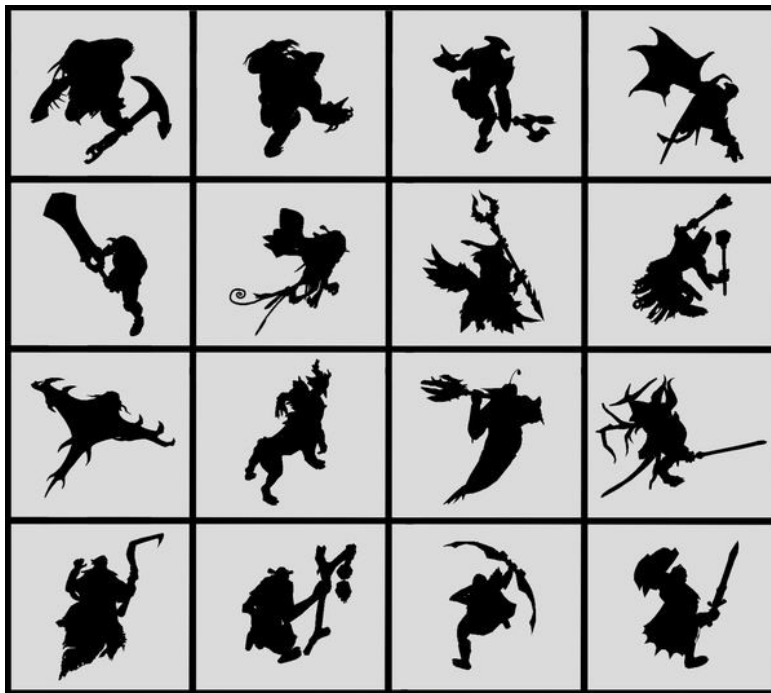
Figure 53. Silhouette Dota 2 Workshop, Character Art Guide (Dota 2 Workshop - Character Art Guide, 2012)

Thumbnails, also known as Silhouettes, are small images that are simply filled in with one color, usually black, with no details in them. Artists work with thumbnails in the first processes when visually designing their artwork using a mix and match of primitive shapes and previous research. Since each of the basic shapes, circles, squares, and triangles conveys certain emotions, the artist should consider which shapes best suit the high concept. In addition, silhouettes are seen as an effective way to see the general form, proportions, and scale of an object. (Kennedy, 2013, p. 36) The prominent purpose of the silhouette is to get the general shape language of the thumbnail object which saves a lot of time and effort without any fine-tuning or polishing at this stage. On the other hand, with its small size and focus on quantity over quality, the first silhouette version allowed new versions to be quickly iterated and mutated into unique variations (Figure 53). This

forces artists to think about what they are creating and allows the freedom to explore many compositions before getting serious with any idea, especially without worrying about technique (Introduction To Thumbnailing And Quick Sketching, n.d.). The process of developing silhouettes for other objects and environments should be implemented concurrently to provide a visual overview as well as a basis for effective comparison (Solarski, Sponsored Feature: Drawing Basics and Video Game Art: Character Design, 2012).

When enough silhouettes are explored or time is running out, the team eliminates ideas that do not need further iterating and focuses on ideas worth pursuing, in which potential ones can be combined. The more options presented, the closer to the best solution. This step focuses on pushing the design and should exaggerate important areas to highlight the features of an object, especially at the contacting points in the silhouette. (Solarski, Sponsored Feature: Drawing Basics and Video Game Art: Character Design, 2012) A well-designed silhouette has a readable shape and reinforces characteristic aspects of a character, such as their strength, demeanor or speed, and more. In addition, by using negative and empty space between the shapes, the silhouette looks clear and distinguishable from the rest of the objects (Lovato, 2015).

4.5.3   Final design

The final design includes clean-up, values, and color stage.

After the thumbnail development stage complete, the clean-up phase will follow by adding full details. It is important to note that added details should be consistent with the design and not change the approved silhouette (Solarski, Drawing Basics and Video Game Art, 2012).

"Value" is understood as the range of lightness and darkness within an object on a scale of white to black that is considered even more important than color (Scott, 2017). As it not only helps to create focal points but also creates the illusion of depth to the object.

Figure 54. Value Gradient (Left) and Value Patterning (Right) (Dota 2 Workshop - Character Art Guide, 2012)

The first application of value takes the form of a value gradient. Object or character is applied by the range of value, which goes from the darkest at the feet to the lightest at the head of a character. Following the value gradient, value patterning is the process of separating the design into unique pieces, e.g. head, arms, weapon, armor, and so forth. Afterward, the artists alter their values to increase contrast between objects, as long as the upper parts is higher than the lower counterparts. Also, note that white and black should not be used absolutely because both do not react well to lighting. Generally, both of these stages are used to direct the viewer's eye to the important parts of the design, and then to the less important parts. This is because the eye is instinctively drawn to areas of high contrast and light rather than low contrast and darkness. (Dota 2 Workshop - Character Art Guide, 2012). Figure 54 illustrates Value Gradient and Value Patterning.

An effective approach to the color stage is to prioritize choosing the primary color that best represents the object or character. The secondary and tertiary colors are then selected by using color schemes such as complementary, split complementary, analogous, or triadic color schemes (Figure 55). New colors can be added while painting the texture but need to keep the overall color harmony; by blending primary, secondary and tertiary colors with grayscale values. In addition, saturation is equally important to note if used too much or applied in the wrong place. Basically, the intensity of the color i.e. saturation also attracts the eye, so saturation level should be less towards the lower part and gradually increased towards the top of the object or character. In addition, applying high saturation to large areas will overwhelm the eyes and distract the viewer, it is preferable to apply to small areas to re-enforce visual interest sense. Besides, balancing

detailed areas in a design is also considered a way to give the eye a rest. However, detailed areas should make up a small percentage of the whole and should only be concentrated in important areas. Large areas with less detail will make the design easier to read, but avoid using too small details because it will cause visual noise. Finally, putting all artworks in a context makes it easier to objectively assess overall harmony. (Dota 2 Workshop - Character Art Guide, 2012)

Figure 55. Coloring stage (Dota 2 Workshop - Character Art Guide, 2012)

Some online tools for creating interesting color palettes can refer to. Adobe Color and Galactic are color scheme generators with a visual interface displayed by a familiar color wheel with which users can easily experiment with different color schemes (Color Wheel, n.d.) (Mudcube, n.d.). In addition, Adobe also supports extracting colors and gradients from an image as well as having accessibility tools like Color Blind safe and Contrast checker. Colormind is also a color scheme generator that can extract color palettes from images, websites, aimed at finding beautiful palettes (Colormind, n.d.). The interface is displayed simply by a color ramp instead of a color wheel. Lospec provides online tools for people creating pixel art and other restrictive digital art (PALETTE LIST, n.d.).

5   Mockup – Creating a level mockup for a flat game style

This chapter is a practical part of creating a mockup level that is inspired by existing games. The expected impressive mockup is a combination of applying the theoretical knowledge presented in the previous chapters with the creativity of the author as an artist.

5.1   Research and analysis

When starting a project in a development team, the first thing to consider is to plan ahead and consider current resources and skills by research and analysis. This seems to be becoming more and more important as the gaming industry is developing rapidly by a huge amount of game releases every day on Steam. Hence coming up with an interesting enough design within the allotted time will benefit the production process allowing the game to be completed.

The primary criterion of the thesis mockup is to choose what is currently considered popular, thereby continuing to develop in its own way. Simple and highly viable options are given top priority to produce the least amount of assets but are effective for a basic level.

5.1.1   Genre

Nowadays, various games cannot be described by the board archetypes such as Action or Strategy but by the sub-genres such as Metroidvania or Match 3. Consequently, the gaming genre assortment can overwhelm most gamers. According to 10 Trending Gaming Genres in 2021, Puzzle and Arcades genres are in the top ten mobile game genres with 56.5% for Puzzle games and 55.08% for Arcades (Baalu, 2020). In terms of detail, Platformers aka Arcade genre is extremely popular with indie studios and gamers because of covering a huge variety of 2D side-scrollers games in the earliest of 2D games. With this genre, players require running and jumping between platforms while avoiding in-game objects and the adverse effects of gravity through challenging levels (Pavlovic, 2020). However, Parallax technique requires numerous assets for background layers to create the illusion of depth for the Platformers. As the result, the production process will take more time. Meanwhile, when it comes to mobile and tablet gaming, the Puzzle genres have the highest revenues in the game market. In puzzle games, players are required to solve mini-maps,

which are presented as puzzles that can involve memory, the exercise of logic, pattern matching, reaction time, and so forth. Besides, Puzzle has its own charm when it is built into a conventional narrative adventure and set logically. Therefore, I aim to find game titles related to the Puzzle genre.

5.1.2   Inspirational games

For the game analysis, author went through a lot of puzzle games. Out of those games I chose two that expertly showcase some of the traits that would be very beneficial for this mockup to analyze. These games are Acno's Energizer and Square Maze. They represent the same flat and minimalist graphic style and the gameplay is not much different. But both have differences regarding what author wants the thesis mockup to look like.

Acno's Energizer (Figure 56) is one of the most addictive internet popular web games developed by Uselab and published on flash portal Miniclip in 2000. Player maneuvers Acno, a small yellow sphere, that moves around a room with the goal of getting one or more red orbs into the portal to move on to the next level. One cool thing is that Acno's Energizer has a level editor that allows the player to customize the levels. Where the typical level's playfield limits the size to 16 x 10, only the Steel Wall surrounding the perimeter cannot be erased. The objects in the editor are all the same 1-slot size.

Figure 56. Acno's Energizer game (Acno's Energizer/Level editor, 2013)

Square Maze (Figure 57) is a beautiful and minimal puzzle game developed by Gladio Games in 2019. Players will role-play a black dot and find the right moves to escape the maze.
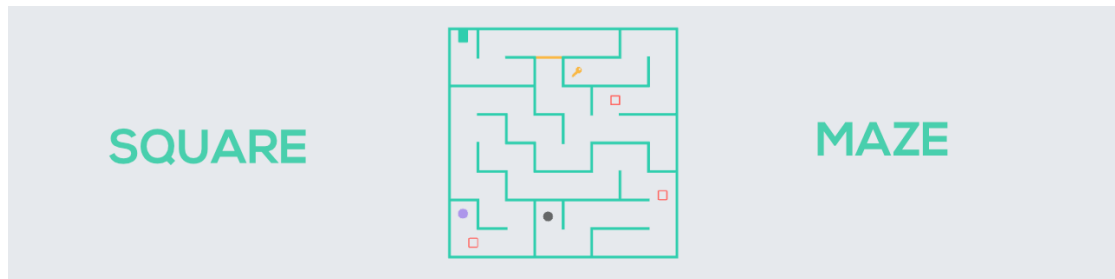
Figure 57. Square maze game (BEAUTIFUL AND SIMPLE SQUARE MAZE, n.d.)

5.1.3   Game analysis

The analysis aims to find an efficient workflow approach with minimal assets but still aiming for a beautiful game. Below are some of the differences between Acno's Energizer and Square Maze that the author has found especially useful for the production process and polishing later. Moreover, the author has drawn two highlights as a direction for the mockup to follow. The first is to use a top-down perspective to limit the number of assets for the animation at a later stage. The second is that the assets are designed as tiles to be more efficient in level creation.

Although both were developed quite a long time apart, both have a minimalist style. Flat and simple game asset are emphasized without showing too much depth and volume. The graphics are simple enough for players to focus on solving challenging puzzles from easy to very difficult level. Besides, the amount of assets of both games is quite small, including character, non-interactive objects, interactive objects, and enemies, but enough to create an attractive game. The player's goal in both games is to find the right path and act at the perfect time to avoid the obstacles to get out of the maze.

For author, Acno's energizer was an obvious starting point for analysis and inspiration for creating assets with tiles. To simplify production and make efficient use of computer memory, in-game objects are used iteratively rather than creating completely different versions. Tilemap is known as a popular technique in 2D game development for building game worlds or level editors by repeating regularly shaped tiles. Square-based tilemaps are popular and easy to implement than rectangular-based tilemaps (Tiles and tilemaps overview, 2021). Besides, Square tiles allow use for both Top-down and Side-view. This way level creation could be done easily and quickly by combining tiles. It is important to note that the patterns in each tile should be arranged in such a way as to create the most harmonious rhythm when all assets are placed side by side.

However, in Acno's Energizer's Side-view perspective, the main character's shape has been sim-
plified to a sphere, resulting in the amount of animation being also implied to be reduced to just
2. The character usually needs at least 3 animation sprites to represent the 4 movements for 4
directions, including right, left, up, and down. In contrast, applying a top-down perspective like
Square maze makes my production asset list simpler than ever. The object's animation for all 4
directions is the same, meaning that just making one animation is enough.

In addition, the top-down perspective does not have the advantage of showing personality traits
for characters or objects like Side-view. For example, in a top-down perspective, the character's
facial features are largely obscured by the costume and hair. Players can guess whether this is a
protagonist or a villain depend largely on the silhouette's appearance, costumes, accessories,
weapons, movements, and actions of the character in the game. It will be a huge challenge to
striving to create a unique silhouette that represents each character. But I saw this as an oppor-
tunity worth experimenting with what silhouette could do in a top-down perspective.

5.2   Proposed art style

From the beginning, author wanted to create a style that stood out which is different from the
existing flat style of Acno's Energizer and Square Maze. Therefore, the Realistic style is a good
choice because it features a faithful depiction of shadows, detailed textures for images.

2D games always strive to communicate depth in multiple ways which imply that the scene is
three-dimensional. For example, the Parallax technique applied to platform games or 2.5D games
that combine 3D and 2D all have the same purpose. These reasons that convinced author to
choose the Realistic style.

As mentioned earlier, the pure top-down perspective takes away some of the personalities and
traits of in-game characters and objects. For example, all the player can see is no more than the
top of the character's head or the top surface of an object 100% of the time. It would be better
to give the player a bit of information about the surrounding sides of the object so that they are
aware of what they are interacting with. To deal with this, when it comes to the ability to create
shapes, Stylized art is most notable for allowing proportions and shapes to be exaggerated in
infinite ways. Therefore, I decided to use it to communicate asset information to players more
effectively. In short, the mockup uses Stylized art to design silhouettes and Realistic styles to ren-
dering images with more depth at the beginning and end of the workflow.

5.3   Showcase process

Objects in Acno's Energizer			New Asset list
Name	**Image**	**Behavior**	
Acno		This is you	Adventurer
Energizer		Get all the balls in here to energize it. Then get in to finish the level.	Magical Energizer
Ball		Push these into the energizer to energize it	Magical Crystal
Rock		These can be pushed, which can also be used to kill baddies. Watch out-they can kill you too!	Boulder
Explosive Barrel		Barrels explode when they hit the ground	Explosive (bomb)
Dirt		Can be removed	
Brick Wall		Can be destroyed	
Steel Wall		Cannot be destroyed	Castle Stone Block Brick Wall
Bee		Simple enemy	Evil Wizard
Spider		Spiders are smarter about how they move. They follow Acno	Flying monster
Empty Space		Anything can be here	
Door		Locked until you find the key	Metallic Door
Key		The Key opens the door	Key
			Tile Icicle Hole in Floor Wooden Crate Metallic Chest Metallic Cage Spikemat Step-on Activator

Figure 58. Asset list

The asset list was created based on the original objects from Acno's Energizer along with personal ideas of additional obstacles, in order to make the level mockup look more varied and attractive. In addition, the main theme throughout the content list is medieval fantasy. In which, the overall atmosphere ought to maintain the fascinating, adventurous, magical, and captivating feeling of the environment.
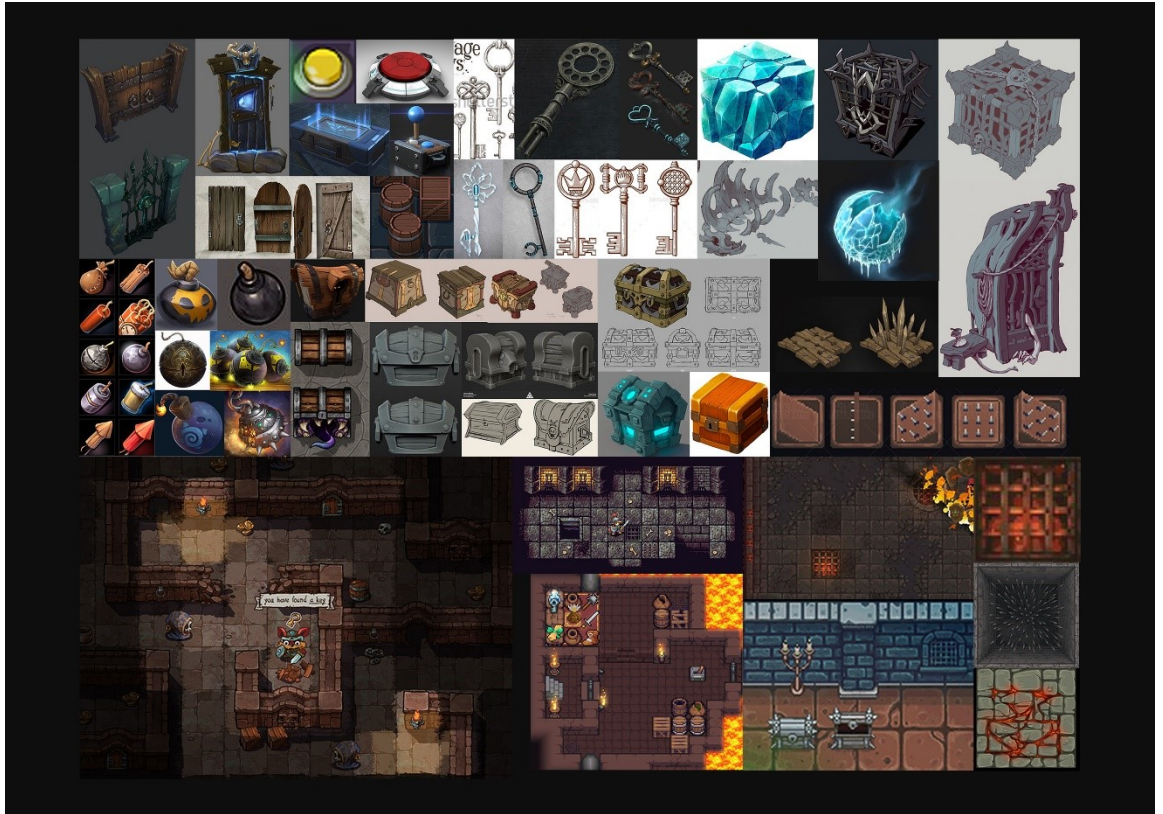
Figure 59. In-game Environment Moodboard
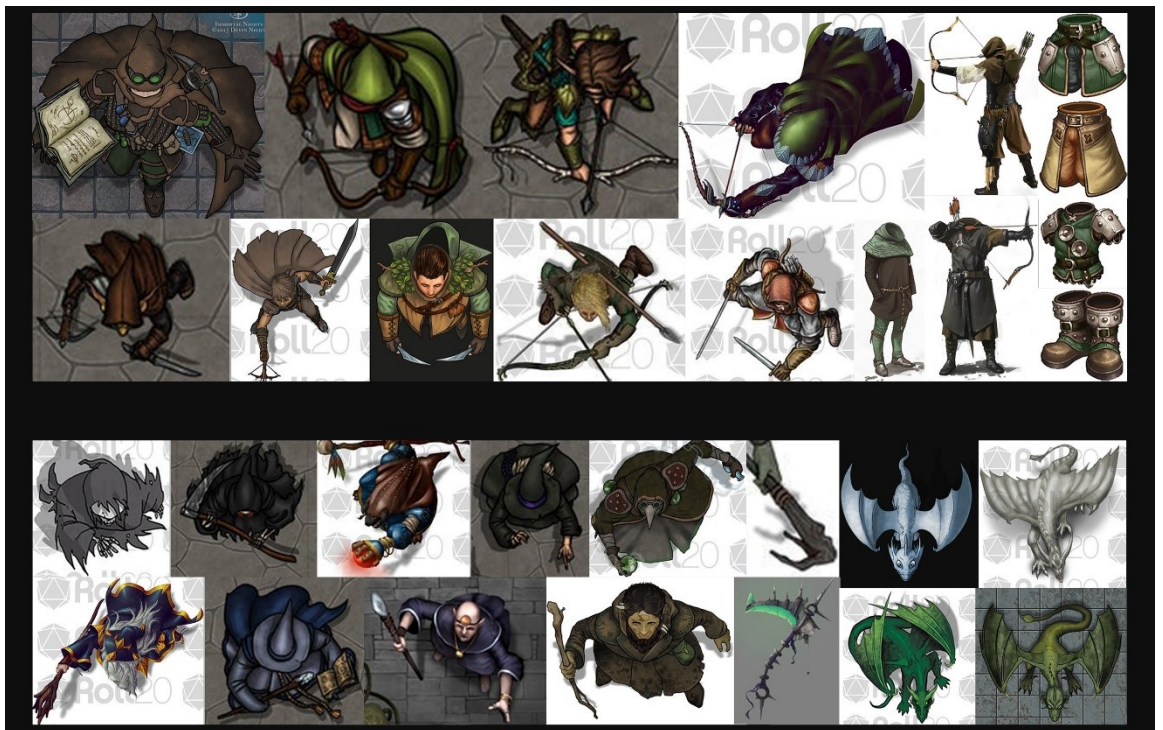
Figure 60. Adventurer, Evil Wizard, and Flying monster Moodboard
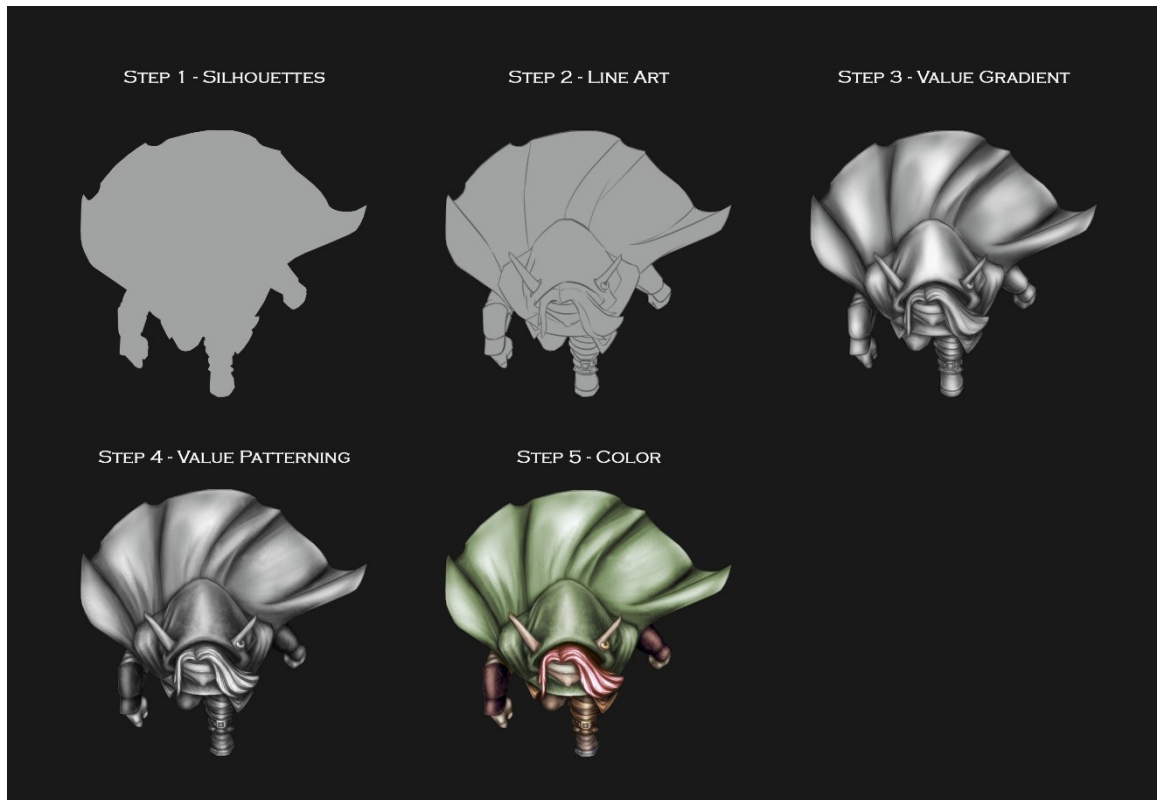
Figure 61. Rendering process for Adventurer

Figure 61 shows the five steps in the complete rendering of the Adventurer as well as other in-game assets. These include Silhouettes, Line Art, Value Gradient, Value Patterning, and Color steps. In step 1, the adventurer's silhouette is chosen from the most promising sketched silhouettes, which are acquired from previously researching the mood board. The main goal of this step is to find featured silhouettes that best represent each character to ensure clear distinction.

The personalities of in-game characters can be hinted at by employing the technique of the contrast between the silhouettes. For example, in this mockup, the silhouettes of the Evil Wizard and the Flying Monster are emphasized with angular shapes to display the sense of peril. Meanwhile, the Adventurer counterpart tends to have rounded shapes to elicit feelings of safety and reliability.

In step 2, details are added to the Silhouettes to identifying the characters such as the costumes of characters. The Evil Wizard is designed with a long, flowing robe with purple chosen as the main color. The sleeves are edged in golden medieval ornament patterns, while his hooked nose is partially revealed to create a mysterious yet obviously cunning aura. To further complement old-aged wisdom, his hair is deliberately designed to long with light colors. As for his mystique and magical power, accessories like a pointed hat and a magic wand with an animal skull are

included. Meanwhile, the adventurer is equipped with a cape, cloth hood, musketeer boots, warrior belt, and leather forearm protectors. The hood covers most of the face but only partially reveals the hair with the intention of showing the character's characteristic bravery and readiness to face any challenge.
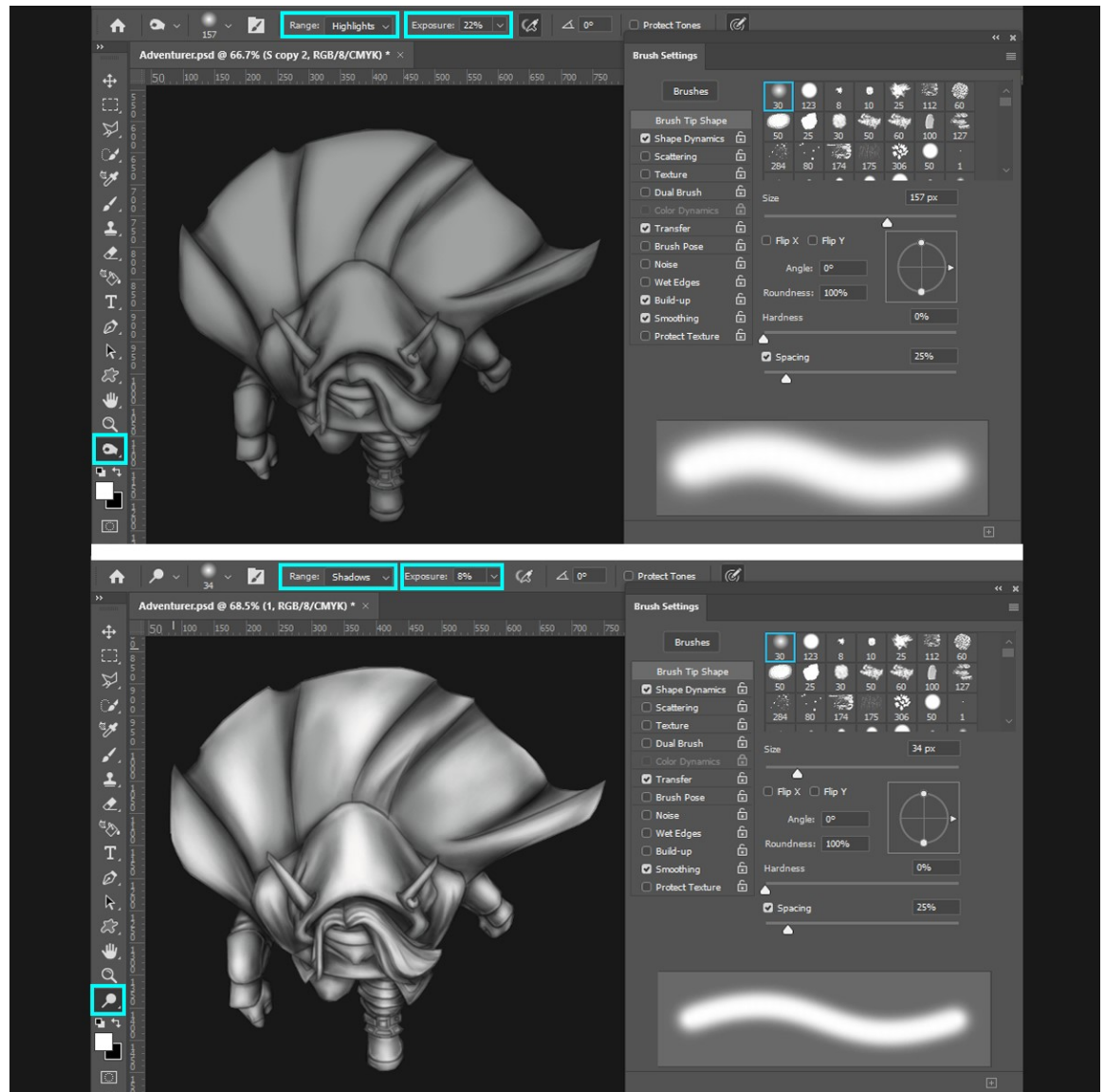
Figure 62. Using Burn tool and Dodge tool at value gradient stage

Step 3 aims to generate a gradient value through the Burn tool for the shadows between the points of contact between parts on an object, i.e. line art. Meanwhile, the Dodge tool is adopted to highlight areas that received the light source. First, artists need to determine which areas receive the most lighting and in contrast which areas receive the darkest shadows in an overall silhouette. From a top-down perspective, the brightest parts will be concentrated at the top of

the head and above the character's chest to attract attention. An efficient value gradient representation maximizes the depth of objects in the top-down perspective.

The next step is value patterning into a realistic style. First, the design is separated into different pieces by the Lasso tool in Photoshop based on grouping the parts with the same material together. For example, cloth hoods with cloaks, leather forearm protectors with musketeers' boots, hair, skin, and so forth. Afterward, adjustments are made for the Hue/Saturation values of the separated parts to reinforce the contrast between the objects. Following this step, deploying the appropriate brush sizes for the Burn tool or Brush tool to depict the characteristic texture for each part. For instance, there are differences in the appearance of shiny and virgin metal compare to damaged and rusty metal as well as between fabric and leather.
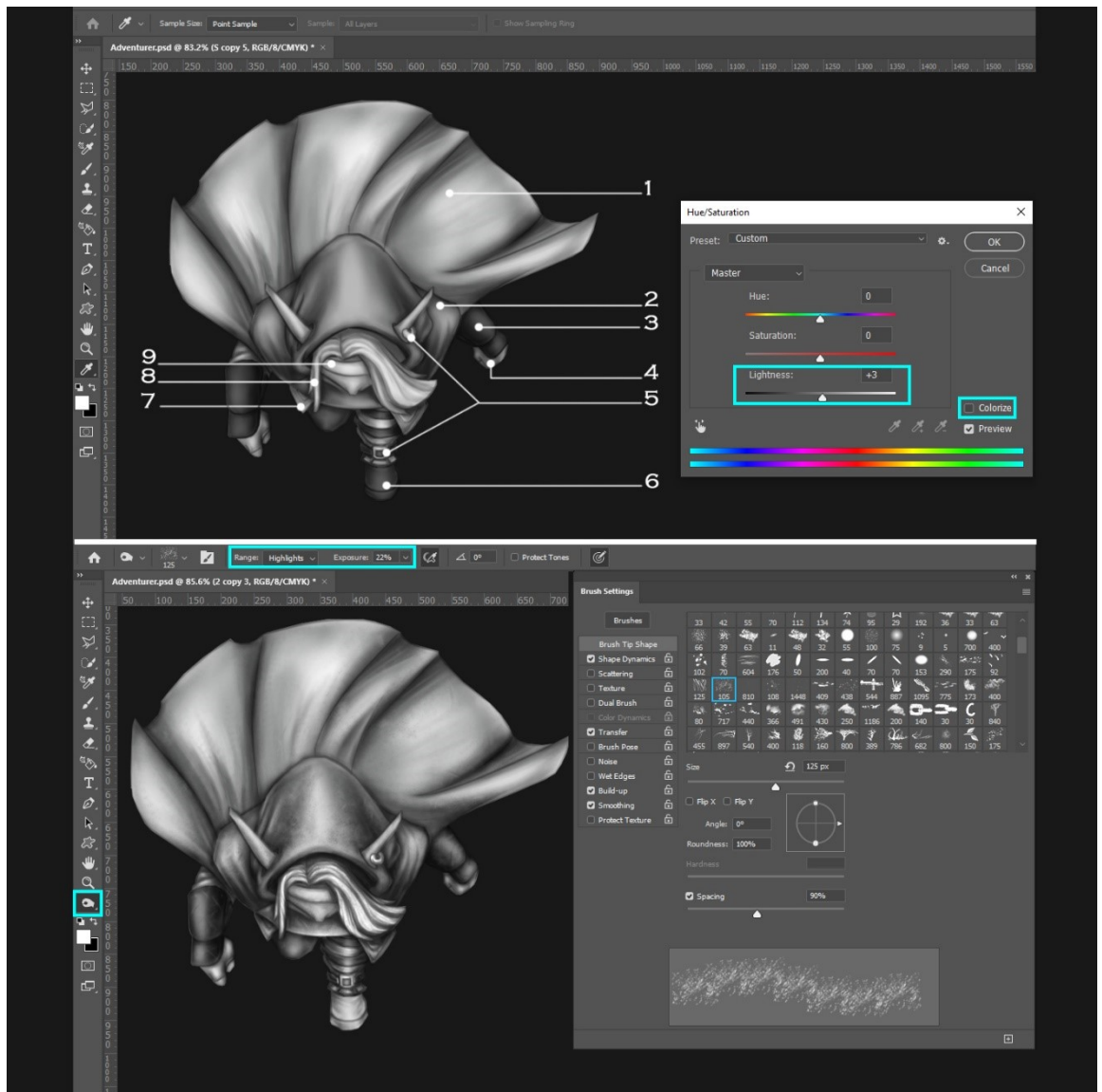
Figure 63. Using Hue/Saturation adjustment and Brush tool at Value Patterning stage

The last step is the color stage, in which the colors of the separate parts are chosen through Hue/Saturation adjustments. Color intensity i.e. saturation will attract attention. If applied over large areas, the asset can overwhelm and distract viewers. Therefore, an appropriate level of intensity is required to keep color harmony. Afterward, Color Balance adjustments are applied for blending.
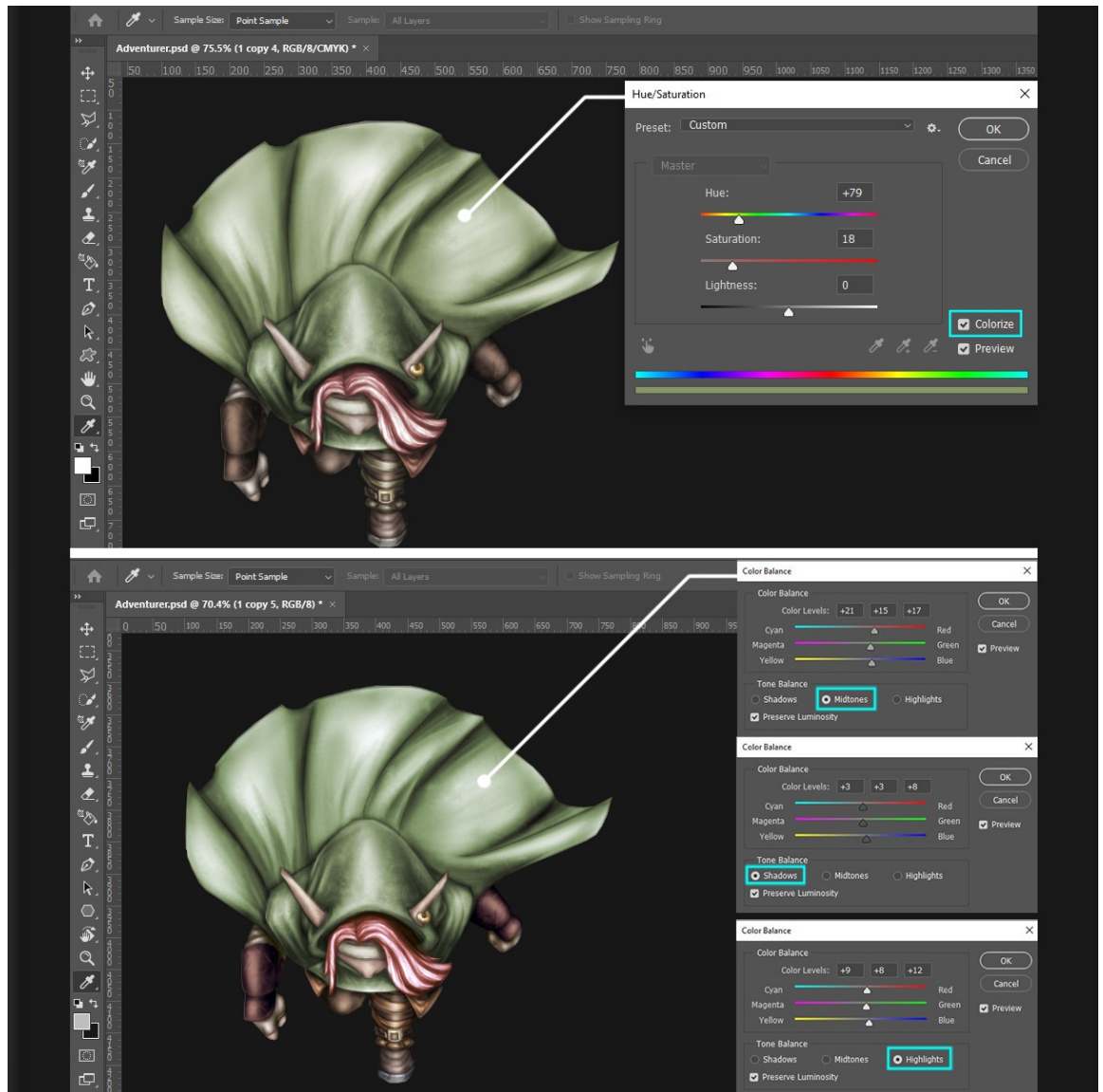
Figure 64. Using Hue/Saturation and Color Balance adjustment at Color stage

The same process is iterated for the Evil Wizard, the Flying Monster, and other environmental assets as shown in Figure 65 to Figure 69.

Step 1 - Silhouettes

Step 2 - Line Art

Step 3 - Value Gradient

Step 4 - Value Patterning

Step 5 - Color

Step 1 - Silhouettes

Step 2 - Line Art

Step 3 - Value Gradient
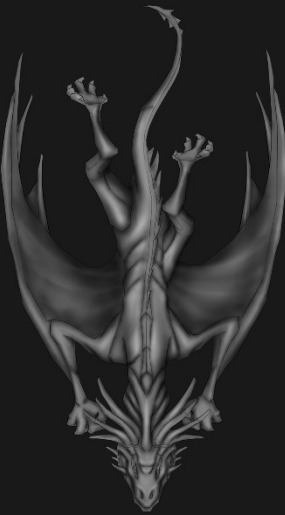
Step 4 - Value Patterning

Step 5 - Color

Figure 65. Rendering process for Evil Wizard and Flying monster

In pursue of the overall coherence, the design prioritizes the primary color that best represents each character. The secondary and tertiary colors are then selected by using color schemes that adopted the 60-30-10 rule. In the mockup, the analogous, quadrilateral, and split complementary scheme colors are applied to the Flying Monster, the Evil Wizard, and the Adventurer, respectively. The color identifier or primary color for Adventurer and Enemies should ensure the contrast between the protagonist and the antagonists that should be chosen as opposed to each other as possible on the color wheel. However, the chosen color should be considered the personalities of characters. For instance, the Red of the Flying Monster who is actively opposing the Green of the Adventurer, while the purple shows the evil and cunning of the Evil Wizard.

Figure 66. Color scheme for Adventurer and Enemies
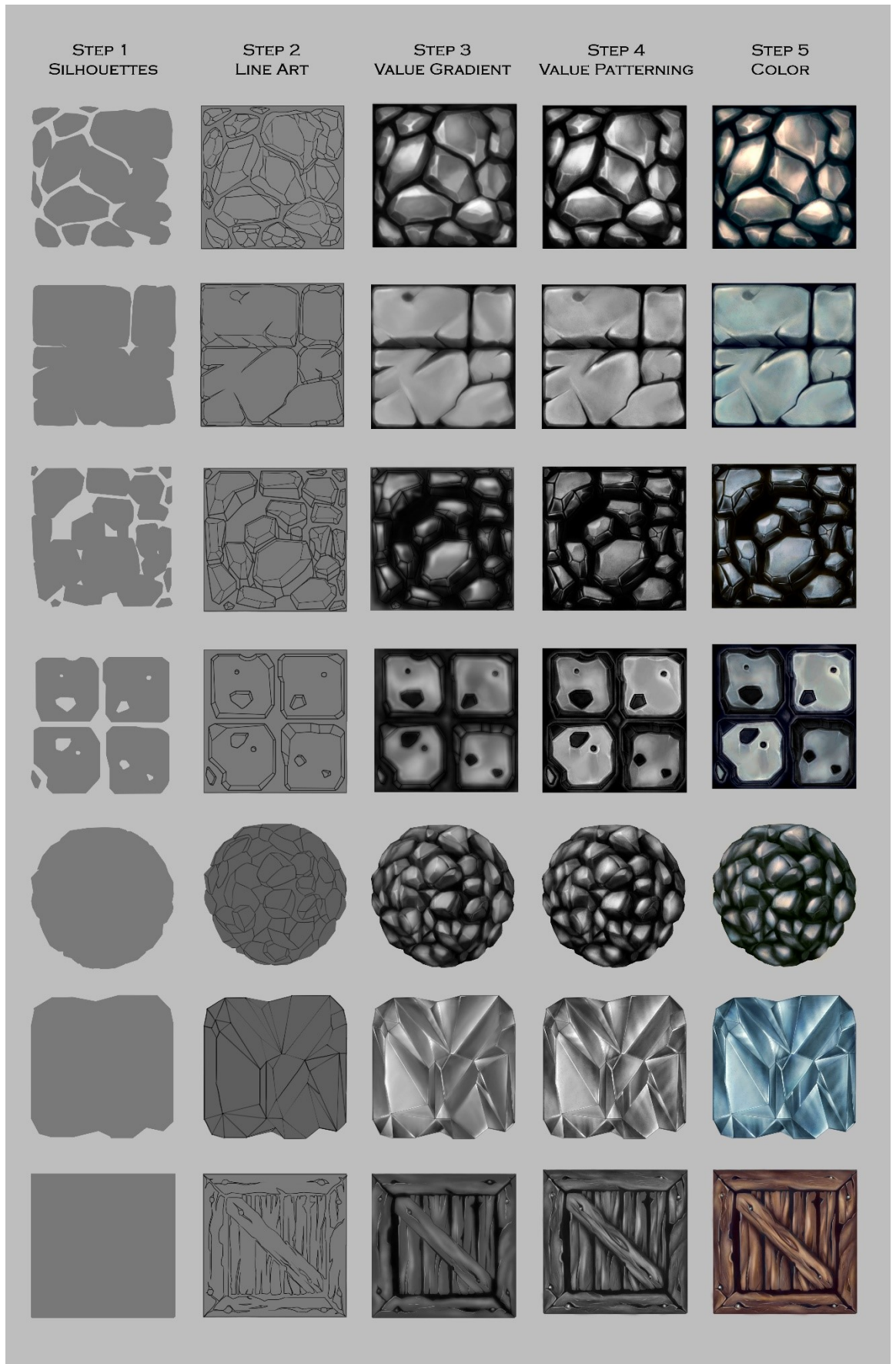
Figure 67. Rendering process for Environment Asset
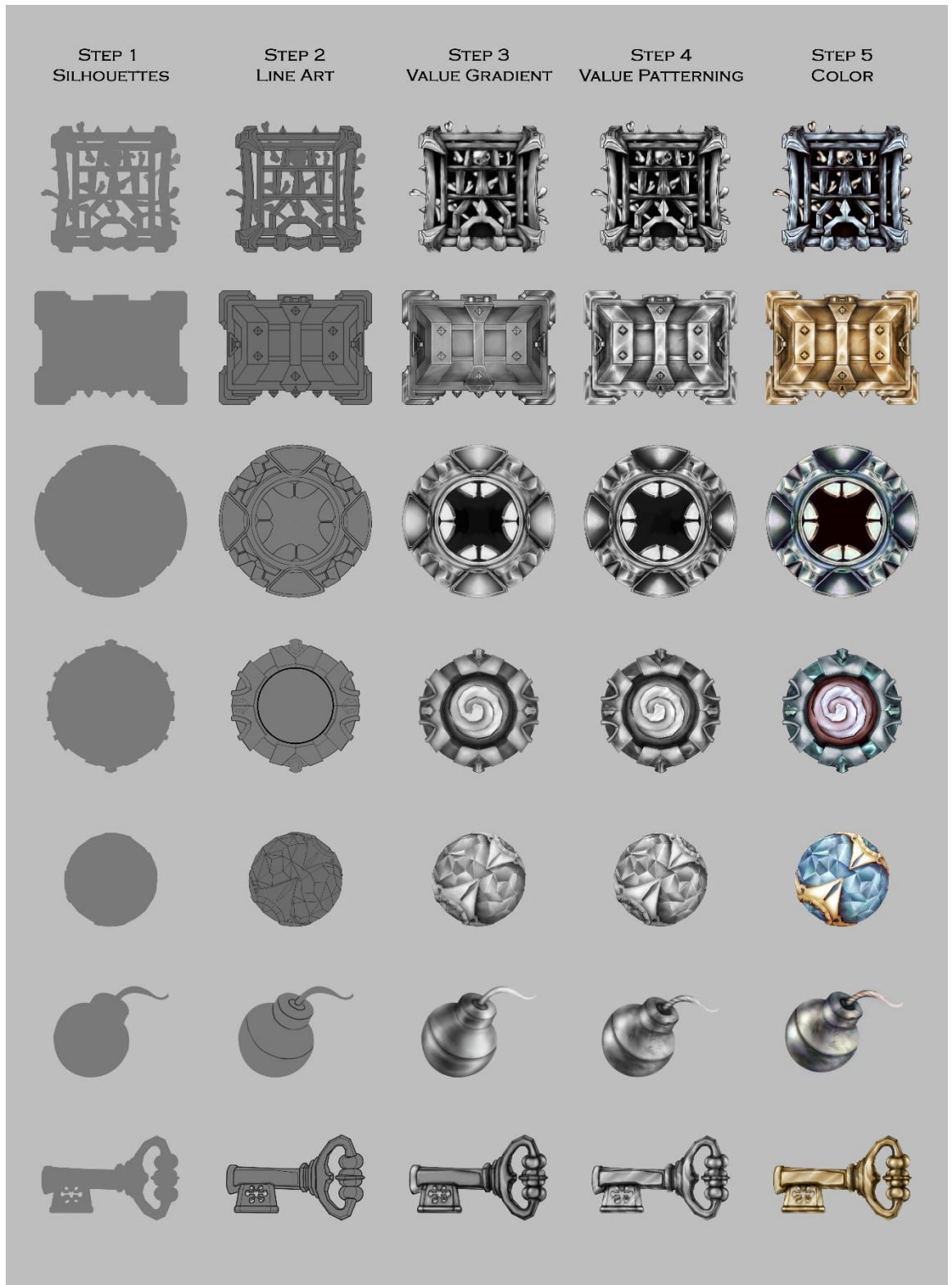
Figure 68. Rendering process for Environment Asset

STEP 1
SILHOUETTES
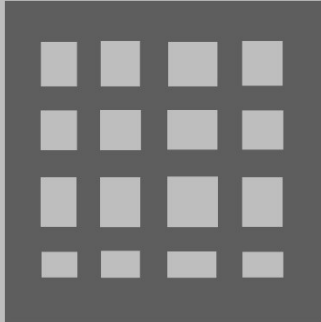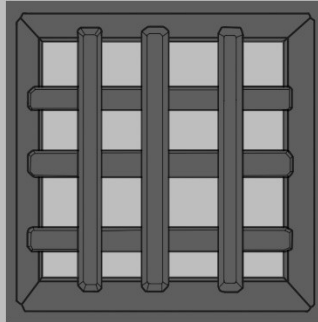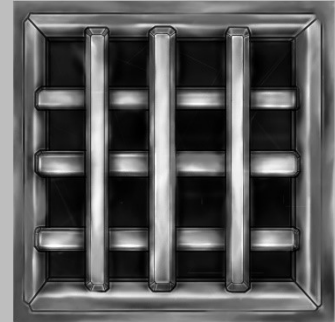
STEP 2
LINE ART

STEP 3
VALUE GRADIENT

STEP 4
VALUE PATTERNING
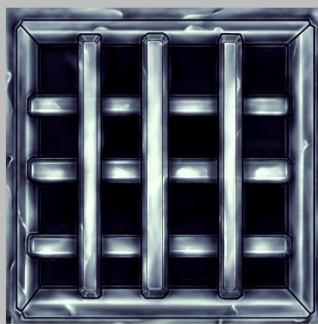
STEP 5
COLOR

STEP 1
SILHOUETTES

STEP 2
LINE ART
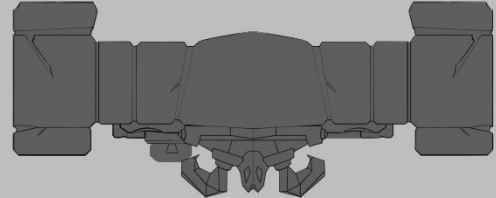
STEP 3
VALUE GRADIENT
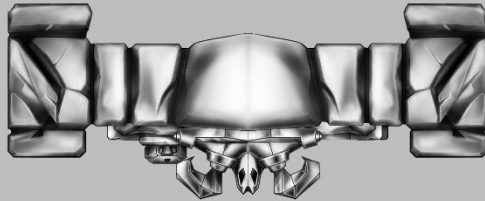
STEP 4
VALUE PATTERNING
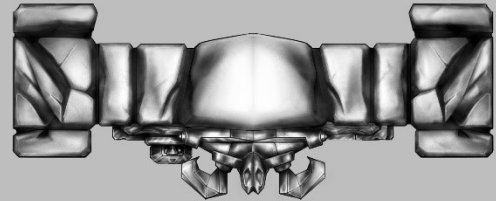
STEP 5
COLOR

Figure 69. Rendering process for Environment Asset
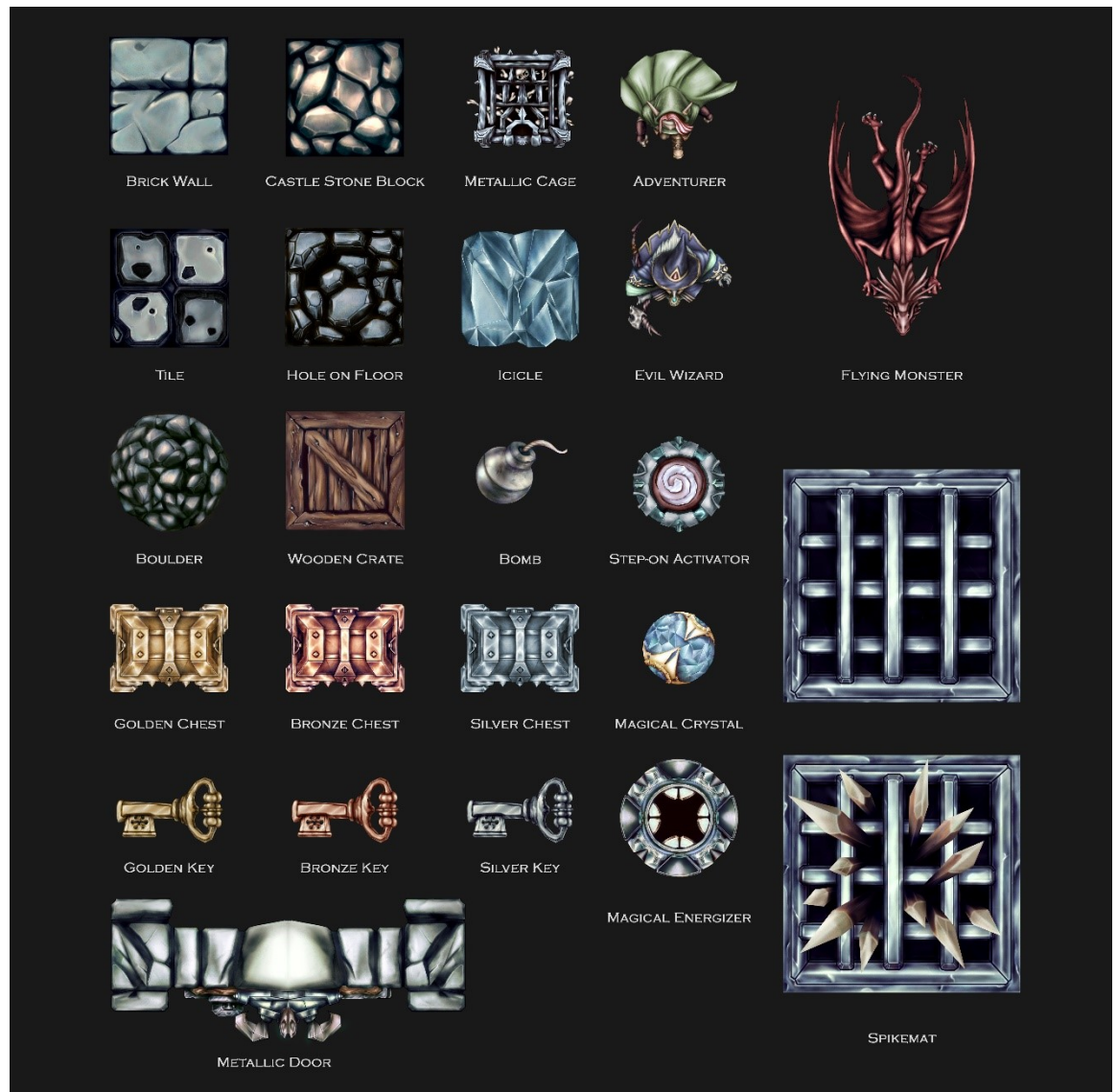
Figure 70. Final assets

Finally, putting all assets in a level mockup for easier objectively assess the overall harmony.
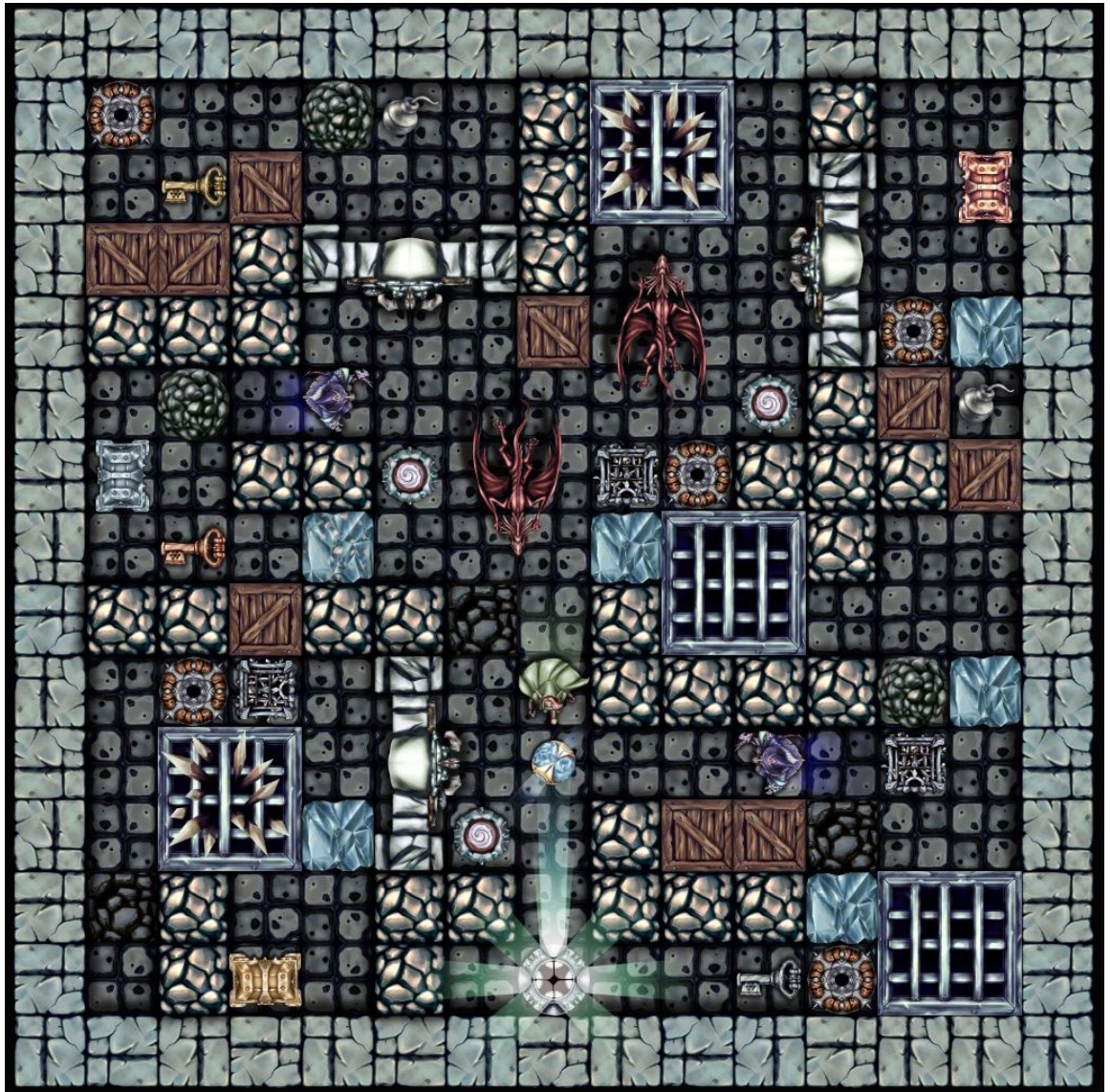
Figure 71. Final mockup

6   Conclusion

This thesis conducted the secondary research method to draw a theoretical basis for answers to the original research questions. First of all, the development potential of the game industry in the current context was indicated by the author with the latest data showing that the competition in this industry is quite intense. It is understandable to consider between 2D and 3D in the early stages to avoid unnecessary risks and costs later on. Although 3D and VR technologies are increasingly developed, 2D games still have a large audience due to simple and easy-to-understand controls. This thesis has presented significant advantages why 2D is still considered popular today based on aspects including movements, controls, environments, cameras, and goals that are easy to implement and less time-consuming. However, the right choice for developing a game still needs to be considered by other aspects including story, art style, mechanics, and other design features.

The thesis also points out that video games are an art form that combines art and technology and shares with many other art forms to elicit an emotional response from players. Additionally, the author mentions a conceptual framework used in a game design called elemental Tetrad which includes four components that make up a game: mechanics, aesthetics, stories, and technology. In particular, this relationship does not emphasize which outstanding factors deserve the most attention in the development process. This simply means that the quality of the aesthetics may not be the most important part, but it is a core part that needs to be considered when building the entire experience of a game. It is more relevant when developers choose the aesthetics as the first element to communicate with players so before they can experience the other elements. However, the author also mentions that the perception and reaction to different types of aesthetics are often subjective. Therefore, the correlation between a game's success and aesthetic quality may not be direct but should be considered as a whole of the four aforementioned factors.

In video games, the foundation of the visual arts can fulfill its role only if it is firmly understood in both theory and practice. In this thesis, the author has presented specific knowledge of the most important elements in the 2D art foundation, including style, graphic types, color, shape, and environment. By secondary research method, distinguishing terms, definitions, principles are collected and synthesized into the most useful information. Many important aspects that have not been mentioned in previous studies are also covered in this thesis. Those include cultural influences on color meanings, the relationship between silhouette and character personality, color

psychology, and standard workflow. In addition to the theoretical background, the thesis has introduced important tricks and rules that artists can consider applying in production to achieve efficiency in terms of time and quality. In particular, working with a limited but carefully selected palette can help artists effectively control and develop assets, while a color scheme with lots of colors often makes the design look too crowded. Conversely, too few colors can make the design look boring. Therefore, the suggestion of using three colors with the 60-30-10 rule that can make the game world look more coherent and pleasing has been presented in this thesis. In addition, in a 2D game, even though all assets are flat, the artist can still create the illusion of depth using tricks such as parallax, atmospheric perspective, lighting, size, contrast, details to enhance the game aesthetic experience. Starting with a basic theoretical foundation will be easy to apply, control, and quickly detect problems encountered in actual production stages.

This thesis has created a theoretical foundation sufficient to answer research questions about the 2D art background in games. The conclusion of this thesis is in the beginning of the process of honing professional skills to adapt to this creative and ever-changing industry. Younger artists with little experience can use this thesis as a guide to studying carefully the work they are pursuing. Since any challenge in the process is also a useful or valuable reason to review one's true knowledge. It is essential to be able to nurture future results.

In addition, this thesis can narrow the scope of research to examine deeper some of the details that have been presented for more focused and realistic results. Themes can be 2D asset production combined with in-engine execution or Visual effects, where artists have multiple playing fields to showcase their abilities. The thesis also encourages future researchers who can study the Visual effects, Animation platform in 2D games. From there, the picture of the 2D platform will be more accurate and meaningful.

References

(2019). *2019 Essential Facts About the Computer and Video Game Industry.* The Entertainment Software Association (ESA). Retrieved June 7, 2021, from Entertainment software: https://www.theesa.com/wp-content/uploads/2019/05/2019-Essential-Facts-About-the-Computer-and-Video-Game-Industry.pdf

2D Game Art Styles: The Ultimate Guide. (n.d.). Retrieved June 7, 2021, from 3D-Ace: https://3d-ace.com/press-room/articles/2d-game-art

2D VS 3D games: Differences, benefits and cost. (n.d.). Retrieved June 7, 2021, from Apps Hunts: https://www.appshunts.com/blog/2d-vs-3d-games-differences-benefits-and-costs/#header

Aalto, E. (2020). Creating immersive 2D world visuals for platform games – Skytails Post-Mortem. Retrieved June 7, 2021, from https://aaltodoc.aalto.fi/bitstream/handle/123456789/101851/master_Aalto_Eveliina_2020.pdf?sequence=1&isAllowed=y

Acno's Energizer/Level editor. (2013, August 24). Retrieved June 7, 2021, from StrategyWiki: https://strategywiki.org/wiki/Acno%27s_Energizer/Level_editor

Ahmed, S. (2021, June 1). *20 Games To Play If You Love Pixel Art*. Retrieved June 7, 2021, from GAMERANT: https://gamerant.com/games-play-love-pixel-art/

Anderson, D. (2019, July 23). *S.T.A.L.K.E.R.: Shadow of Chernobyl System Requirements*. Retrieved June 7, 2021, from Gaming System Requirement: https://gamingsystemrequirements.com/s.t.a.l.k.e.r.shadow-of-chernobyl/

Anhut, A. (2014, November 9). *Color Theory For Game Design 1 of 4 – Fundamentals*. Retrieved June 7, 2021, from HOWTONOTSUCKATGAMEDESIGN: http://howtonotsuckatgamedesign.com/2014/11/color-theory-game-design-1-fundamentals/

Anhut, A. (2014, November 20). *Color Theory For Game Design 2 of 4 – Glyphs And Neutrals*. Retrieved June 7, 2021, from HOWTONOTSUCKATGAMEDESIGN: http://howtonotsuckatgamedesign.com/2014/11/color-theory-game-design-2-4-glyphs/

Art styles for 2D games. (2021, May 28). Retrieved June 7, 2021, from Unity Manual: https://docs.unity3d.com/2021.1/Documentation/Manual/Quickstart2DArt.html

Baalu. (2020, September 1). *10 Trending Gaming Genres in 2021*. Retrieved June 7, 2021, from Lead Bloging: https://www.leadbloging.com/best-trending-gaming-genres/

Bancroft, T. (2006). *Creating Characters With Personality* (1st ed.). New York: Watson-Guptill.

Beachpainting. (n.d.). *Color, Hue, Tint, Tone, and Shade*. Retrieved June 7, 2021, from BEACH PAINTING: https://www.beachpainting.com/blog/color-hue-tint-tone-and-shade/

BEAUTIFUL AND SIMPLE SQUARE MAZE. (n.d.). Retrieved June 7, 2021, from Squaremaze: https://www.squaremaze.gladiogames.com/

Benjaminsson, K. (2019, January 20). *WHAT IS PIXEL ART?* Retrieved June 7, 2021, from nicepixel: https://nicepixel.se/what-is-pixel-art/

Bramwell, T. (2015, February 9). *Hotline Miami review*. Retrieved June 7, 2021, from EUROGAMER: https://www.eurogamer.net/articles/2012-10-23-hotline-miami-review

Calculate the Cost of Mobile Game Development – Step by Step Guide 2021. (n.d.). Retrieved from Capermint Technologies: https://www.capermint.com/blog/how-to-calculate-cost-of-mobile-game-development/

Clement, J. (2021, June). *Number of games released on Steam worldwide from 2004 to 2021.* Retrieved June 7, 2021, from Statista: https://www.statista.com/statistics/552623/number-games-released-steam/

Color Wheel. (n.d.). Retrieved June 7, 2021, from Adobe Color: https://color.adobe.com/create/color-wheel

Colormind. (n.d.). Retrieved June 7, 2021, from Colormind: http://colormind.io/

Dota 2 Workshop - Character Art Guide. (2012). Retrieved June 7, 2021, from Steam Support: https://support.steampowered.com/kb/9334-YDXV-8590/dota-2-workshop-character-art-guide

DVNC. (n.d.). *Color Theory in Games – An Overview*. Retrieved June 7, 2021, from DVNC TECH: https://dvnc.tech/2018/06/04/color-theory-in-games-an-overview/

Egenfeldt-Nielsen, S., Smith, J. H., & Tosca, S. P. (2019). *Understanding Video Games* (4th ed.). New York: Taylor & Francis.

Ekström, H. (2013). How Can a Character's Personality be Conveyed Visually, through Shape. Retrieved June 7, 2021, from https://www.diva-portal.org/smash/get/diva2:637902/FULLTEXT01.pdf

Espineli, M. (2016, January 26). *SteamWorld Heist Review*. Retrieved June 7, 2021, from Gamespot: https://www.gamespot.com/reviews/steamworld-heist-review/1900-6416338/

Fussell, M. (n.d.). *The Elements of Art - "Space"*. Retrieved June 7, 2021, from THE VIRTUAL INSTRUCTOR: https://thevirtualinstructor.com/space.html

Game perspectives for 2D games. (2021, May 28). Retrieved June 7, 2021, from Unity Manual: https://docs.unity3d.com/2021.1/Documentation/Manual/Quickstart2DPerspective.html

Gupta, K. (n.d.). *How to Use Foreground, Middleground, and Background in Photography*. Retrieved June 7, 2021, from ExpertPhotography: https://expertphotography.com/foreground-middleground-background/

Hosch, W. L. (2019, February 21). *Raster graphics*. Retrieved June 7, 2021, from Britannica: https://www.britannica.com/technology/vector-graphics

How many colors should you use in your designs? (n.d.). Retrieved June 7, 2021, from TIGER color: https://www.tigercolor.com/color-lab/tips/tip-01.html

Hunicke, R., LeBlanc, M., & Zubek, R. (2004, January). MDA: A Formal Approach to Game Design and Game Research. 3. Retrieved July 20, 2021, from https://www.researchgate.net/publication/228884866_MDA_A_Formal_Approach_to_Game_Design_and_Game_Research

Ignatchenko, S. (2016, August 8). *Game Graphics 101: Static 2D (Vectors/Rasters, Color Spaces, 2D Anti-Aliasing, etc.)*. Retrieved June 7, 2021, from IT Hare: http://ithare.com/game-graphics-101-static-2d-vectorsrasters-color-spaces-2d-anti-aliasing/

Introduction To Thumbnailing And Quick Sketching. (n.d.). Retrieved June 7, 2021, from Concept Art Empire: https://conceptartempire.com/intro-to-thumbnail-sketching/

Jan, M. (2017, November 2). *Game developer's guide to graphical projections, Part 1: Introduction*. Retrieved June 7, 2021, from Medium: https://medium.com/retronator-magazine/game-developers-guide-to-graphical-projections-with-video-game-examples-part-1-introduction-aa3d051c137d

Jan, M. (2017, 12 02). *Game developer's guide to graphical projections, Part 2: Multiview*. Retrieved 06 07, 2021, from medium.com: https://medium.com/retronator-magazine/game-developers-guide-to-graphical-projections-with-video-game-examples-part-2-multiview-8e9ad7d9e32f

Jan, M. (2017, December 2). *Game developer's guide to graphical projections, Part 2: Multiview*. Retrieved June 7, 2021, from Medium: https://medium.com/retronator-magazine/game-developers-guide-to-graphical-projections-with-video-game-examples-part-2-multiview-8e9ad7d9e32f

Jeckson. (2020, September 4). *2D GAME ART STYLES: FASCINATING JOURNEY THROUGHOUT THE TWO-DIMENSIONAL COUNTRY*. Retrieved June 7, 2021, from The Wow Style:

https://www.thewowstyle.com/2d-game-art-styles-fascinating-journey-throughout-the-two-dimensional-country/

Kantilaftis, H. (2014, November 25). *How To Form A Solid Indie Game Development Team*. Retrieved June 7, 2021, from NEW YORK FILM ACADEMY: https://www.nyfa.edu/student-resources/forming-solid-indie-game-development-team/

Kennedy, S. R. (2013). *How to Become a Video Game Artist: The Insider's Guide to Landing a Job in the Gaming World.* New York, USA: Watson-Guptill.

Khalid, A. (2020, February 21). *Game Development - 2D Games Perspectives And Z Order*. Retrieved June 7, 2021, from C# Corner: https://www.c-sharpcorner.com/article/game-development-2d-games-perspectives-and-z-order/#:~:text=In%20this%20article%2C%20you%20learned,orthogonal%20view%2C%20and%20isometric%20view

Koncewicz, R. (2009, April 11). *A Layman's guide to projection in videogames*. Retrieved June 7, 2021, from Significant Bits: https://www.significant-bits.com/a-laymans-guide-to-projection-in-videogames/

Larochelle, A. (2013, February). A new angle on parallel languages: the contribution of visual arts to a vocabulary of graphical projection in video games. *G|A|M|E Journal*(2), 35-39. Retrieved June 7, 2021, from gamejournal.it: https://www.gamejournal.it/a-new-angle-on-parallel-languages-the-contribution-of-visual-arts-to-a-vocabulary-of-graphical-projection-in-video-games/

Levinson, J. (2009, 09). *Philosophical Aesthetics: An Overview*. Retrieved 06 07, 2021, from OFXORD HANDBOOKS ONLINE: https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199279456.001.0001/oxfordhb-9780199279456-e-1

Lovato, N. (2015, September 17). *3 Simple Steps To Improve Your Game's Graphics*. Retrieved June 7, 2021, from GameAnalytics: https://gameanalytics.com/blog/3-steps-to-improve-your-games-graphics/#vibrant-colors

Manan. (2019, September 24). *What are the benefits of 3D and 2D game development?* Retrieved June 7, 2021, from 21TWELVE: https://www.21twelveinteractive.com/benefits-3d-2d-game-development/

Masuch, M., & Röber, N. (2005, January). Game Graphics Beyond Realism: Then, Now, and Tomorrow. Retrieved July 20, 2021, from https://www.researchgate.net/publication/252486461_Game_Graphics_Beyond_Realism_Then_Now_and_Tomorrow

Mattesi, M. (2008). *Force: Character Design from Life Drawing* (1st ed.). Oxford, United Kingdom: Taylor & Francis Ltd.

Mehrafrooz, B. (n.d.). *Principles of Game Art Design*. Retrieved June 7, 2021, from Pixune: https://pixune.com/principles-of-game-art-design/

Melissinos, C. (2015, September 22). *Video Games Are One of the Most Important Art Forms in History*. Retrieved June 7, 2021, from TIME: https://time.com/collection-post/4038820/chris-melissinos-are-video-games-art/

Moos, C. (2019, July 4). *The Multiplane Camera*. Retrieved June 7, 2020, from Medium: https://medium.com/animation-appreciation/the-multiplane-camera-a5581d7ea926

Mozolevskaya, V. (2021, March 9). *INDIE GAME DEVELOPMENT: GUIDE TO REVENUES, MOST PROFITABLE GENRES & MONETIZATION*. Retrieved June 7, 2021, from Kevuru Games: https://kevurugames.com/blog/indie-game-development-the-all-you-need-guide-to-revenues-most-profitable-genres-monetization-bonus-top-10-best-indie-games-2020/

Mudcube. (n.d.). Retrieved June 7, 2021, from MUDCUBE: https://galactic.ink/sphere/#

Niedenthal, S. (2009, 9). What We Talk About When We Talk About Game Aesthetics. *Digital Games Research Association 2009*, (p. 2). Retrieved July 20, 2021, from

https://www.researchgate.net/publication/235963478_What_We_Talk_About_When_
We_Talk_About_Game_Aesthetics

Oravakangas, L. (2015). Game Environment Creation: Efficient and Optimized Working Methods. Retrieved June 7, 2021, from THESEUS: https://www.theseus.fi/bitstream/handle/10024/101918/Thesis_LauraOravakangas.pdf?sequence=1&isAllowed=y#page=19&zoom=100,160,394

PALETTE LIST. (n.d.). Retrieved June 7, 2021, from LOSPEC: https://lospec.com/

Parallax Scrolling. (n.d.). Retrieved June 07, 2021, from GIANTBOMB: https://www.giantbomb.com/parallax-scrolling/3015-2915/

Parker, L., & King, D. (2008, April 17). *Why Pong scored so highly for Atari*. Retrieved June 7, 2021, from The Guardian: https://www.theguardian.com/technology/2008/apr/17/games.atari

Pav. (2021, May 9). *Color Theory for Game Art Design – The Basics*. Retrieved June 7, 2021, from Pav Creations: https://pavcreations.com/color-theory-for-game-art-design-the-basics/#lightness-Value

Pavlovic, D. (2020, July 23). *Video Game Genres: Everything You Need to Know*. Retrieved June 7, 2021, from HP: https://www.hp.com/us-en/shop/tech-takes/video-game-genres

PlamzDooM. (2021, June 15). *2D*. Retrieved July 20, 2021, from GIANTBOMB: https://www.giantbomb.com/2d/3015-1427/

Ran. (2021, February 6). *15 Proven Ways to Draw the Illusion of Depth in Art*. Retrieved June 7, 2021, from Ran Art Blog: http://ranartblog.com/blogarticle20.html

Reeves, B. (2020, January 15). *To The Moon - New Moon, Same Cycle*. Retrieved June 7, 2021, from Gameinformer: https://www.gameinformer.com/review/to-the-moon/new-moon-same-cycle

Reeves, B. (2021, January 7). *Super Meat Boy Forever Review – Hardcore Hurdling*. Retrieved June 7, 2021, from Gameinformer: https://www.gameinformer.com/review/super-meat-boy-forever/super-meat-boy-forever-review-hardcore-hurdling

Schell, J. (2019). *The Art of Game Design* (2nd ed.). CRC Press.

Schlitter, R. (2018, September 10). *Color Palettes*. Retrieved June 7, 2021, from Gamedev: https://www.gamedev.net/tutorials/visual-arts/color-palettes-r4964/

Scott, D. (2017, August 2). *What Is Value In Art And Why Is It So Important?* Retrieved June 7, 2021, from DRAW PAINT ACADEMY: https://drawpaintacademy.com/what-is-value-in-art/

Silber, D. (2015). *Pixel Art for Game Developers.* New York: CRC Press.

Soegaard, M. (2020). *Recalling Color Theory Keywords: a way to refresh your memories!* Retrieved June 8, 2021, from INTERACTION DESIGN FOUNDATION: https://www.interaction-design.org/literature/article/recalling-color-theory-keywords-a-way-to-refresh-your-memories

Solarski, C. (2012). *Drawing Basics and Video Game Art.* New York, United States: Watson-Guptill.

Solarski, C. (2012, October 4). *Sponsored Feature: Drawing Basics and Video Game Art: Character Design*. Retrieved June 7, 2021, from GAMASUTRA: https://www.gamasutra.com/view/feature/178656/sponsored_feature_drawing_basics_.php?page=4

Solarski, C. (2013, January 30). *The Aesthetics of Game Art and Game Design*. Retrieved June 7, 2021, from GAMASUTRA: https://www.gamasutra.com/view/feature/185676/the_aesthetics_of_game_art_and_.php

Stegner, B. (2020, October 7). *2D Games vs. 3D Games: What Are the Differences?* Retrieved June 7, 2021, from MUO: https://www.makeuseof.com/2d-games-vs-3d-games-differences/

Stegner, B. (2020, November 26). *First-Person Games vs. Third-Person Games: What Are the Differences?* Retrieved June 7, 2021, from MUO: https://www.makeuseof.com/first-person-games-vs-third-person-games-differences/

Stevens, J. A. (2008, May 30). *Easy Atmospheric Perspective in Photoshop*. Retrieved June 7, 2021, from Gamedev: https://www.gamedev.net/tutorials/visual-arts/easy-atmospheric-perspective-in-photoshop-r2521/

Stewart, D. (2017, April 6). *Color in Video Games: How to Choose a Palette*. Retrieved June 7, 2021, from KONGREGATE DEVELOPER: https://blog.kongregate.com/color-in-video-games-how-to-choose-a-palette/

Tanner, L. (2010, November 25). *The Pixel Art Tutorial*. Retrieved June 7, 2021, from Pixel Joint: http://pixeljoint.com/forum/forum_posts.asp?TID=11299

The 60-30-10 rule. (n.d.). Retrieved June 7, 2021, from MMICREATIVE: http://mmicreative.com/the-60-30-10-rule/

The Arithmetic of Color Depth. (n.d.). Retrieved June 7, 2021, from SCSS: https://www.scss.tcd.ie/Cathal.OConnor/website-digital-video/4%20The%20Arithmetic%20of%20Color%20Depth.html

The Elemental Tetrad of Games. (2015, April 13). Retrieved June 7, 2021, from Cleveland Institute of Art: https://www.cia.edu/blog/2015/04/the-elemental-tetrad-of-games

The Psychology of Color for Game Development. (2018, March 18). Retrieved June 7, 2021, from Disrupted Logic: https://disruptedlogic.com/2018/03/18/the-psychology-of-color-for-game-development/

Tiles and tilemaps overview. (2021, May 25). Retrieved June 7, 2021, from MDN Web Docs: https://developer.mozilla.org/en-US/docs/Games/Techniques/Tilemaps

Tulleken, H. (2015, July 29). *Color in games: An in-depth look at one of game design's most useful tools*. Retrieved June 7, 2021, from GAMASUTRA: https://www.gamasutra.com/blogs/HermanTulleken/20150729/249761/Color_in_games_An_indepth_look_at_one_of_game_designs_most_useful_tools.php

Welsh, O. (2015, February 9). *Fez Review*. Retrieved June 7, 2021, from EUROGAMER: https://www.eurogamer.net/articles/2012-04-12-fez-review

WePC. (n.d.). *Video Game Industry Statistics, Trends and Data In 2021*. Retrieved June 7, 2021, from WePC: https://www.wepc.com/news/video-game-statistics/

What's the Difference Between Raster and Vector? (n.d.). Retrieved June 7, 2021, from PsPrint: https://www.psprint.com/resources/difference-between-raster-vector/

Wijman, T. (2021, May 6). *Global Games Market to Generate $175.8 Billion in 2021; Despite a Slight Decline, the Market Is on Track to Surpass $200 Billion in 2023*. Retrieved June 7, 2021, from newzoo: https://newzoo.com/insights/articles/global-games-market-to-generate-175-8-billion-in-2021-despite-a-slight-decline-the-market-is-on-track-to-surpass-200-billion-in-2023/

Williams, M. (2013, November 16). *Assassin's Creed 4: Black Flag PS3 Review: Better Than AC3?* Retrieved June 7, 2021, from Usgamer: https://www.usgamer.net/articles/is-assassins-creed-4-black-flag-better-than-ac3-review

Wilson, S. (2010, December 11). *Color Theory*. Retrieved June 7, 2021, from INKFUMES: http://inkfumes.blogspot.com/2010/12/color-theory-poster-version-2.html

Wolstenholme, K. (2018, April 17). *5 Reasons for creating mood boards in game development*. Retrieved June 7, 2021, from RisingHigh: https://risinghighacademy.com/5-reasons-for-creating-mood-boards-in-game-development/