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The effects of visual aesthetics and functionality in user interface design and perception

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Abstract

The objective of this Thesis was to study how the functionality and visual design of video game user interfaces can affect perception, and the different factors that may have further influence the viewer's attention and user experience. As such, the Thesis goes over the different aspects of the design process of both user interfaces and user experience, and what elements should be considered in order to achieve a comprehensive unit.

The methods used to study this involved a screening where the participants were directed to observe three different versions of a prototype that all have unique design choices. In order to examine their perception, the participants used an eye tracker to record the movement of their eyes during the screening. The records were then further analyzed to study such factors as what the viewers observed first, how long did it take for them to notice the user interface, and if there were other aspects of the design that influenced their perception. The results also helped to determine which prototype version worked the best. After the screening, the participants were then asked several questions regarding the experience.

In order to acquire more extensive results, the prototype screening would have required more participants and a better testing environment. However, based on the preliminary results gained from this thesis, the outcome was that there were certain factors that clearly affected the viewer's attention and experience with the user interface, thus supporting the hypothesis of this thesis.

Keywords

user interface, user experience, video games, thesis

CONTENTS

GLOSSARY

User Interface (UI)

The way a software application is interacted and controlled by an individual. Most applications have implemented a GUI (graphical user interface) which includes visual cues such as menu bars and buttons to control the user interface. (Tech Terms 2009.) An example of a commonly used user interfaces includes websites

User Experience (UX)

Any type of interaction between a product and its user. User experience focuses on determining the factors that affect the interaction – the experience – between the user and the product such as how it makes them feel or how much time the user needed to achieve their objective. (Stevens 2019.)

Head-Up Display (HUD)

A type of display that shows essential information such as health and ammunition count to the player in a manner that does not intrude the flow of the gameplay. (Beal no date.) An example of a HUD type of UI element could be a health meter visible in the upper left corner of the screen.

1 INTRODUCTION

One of the fundamental parts of video game development is to determine how to convey necessary information to the user. This task may seem to be one of the harder parts of the development, as every video game has unique information, and a way to convey it, making it sometimes difficult for the player to immediately adjust to the new information.

However, while having an understandable user interface and a good user experience are fundamental parts of an enjoyable video game, they sometimes seem to be rather invisible to the players. Based on my own observations, video games can often be praised for their beautiful graphics, fun gameplay or interesting storylines, but it is rare for there to be recognition for the user interface – that is, if it is not poorly designed.

The topic of this Thesis is to explore the relationship between the visual design and the functionality elements of the user interface (UI) and user experience (UX), and how they can influence the viewer's perception and behaviour. This Thesis will also examine the ways the elements could potentially affect each other negatively, and if there are any visual limitations that needs to be considered to ensure the functionality.

The theoretical section of this Thesis will address the theory behind UI and UX design, such as general principles, rules, and the psychology behind the design choices of various UI and UX constructions. This part has been divided further into two separate portions. The first part will concentrate on the visual design and aesthetics related to the UI and UX design, and the second part focuses on the functionality and the usability.

In order to research this topic, the author has developed a prototype based on the theoretical part of the thesis. This prototype will include a three different types of user interfaces that all have identical information on them, but the layout, visual design and the background behind the UI will differ.

The prototype will be examined via user testing and uses eye-tracker technology to further study the results to examine what elements drew the viewer's attention. This helps to determine which prototype works the best. With the aid of the eye-tracking technology, it is possible to observe where the general direction of the human vision will land when it first sees the prototype, and if certain type of stimulus, such as animation, affects the eye movement. The hypothesis regarding this subject assumes that the user's perception and experience are heavily influenced by the visual design elements such as the layout, aesthetic style, and colour of the user interface. The secondary hypothesis theorizes that the way the UI elements are positioned on the screen may also affect the viewer's viewing order of the elements.

2 WHAT ARE UI AND UX IN GAME DEVELOPMENT

User interface could be roughly described as the communication between the user and the machine. In order to use the machine correctly, the user must give the right commands to the machine and in turn, the machine must respond to the given commands properly and give back information to ensure future interactions. (Anderson no date.) Outside the realms of video games, examples of user interfaces include websites and ATM.

If user interface was described as the interaction between the machine and the player, then the user experience would be the system behind the machine that oversees the interaction. Typically, user experience focuses on the overall structures of the product, and how the users may experience it. (Anderson no date.)

At its core, every video game could be defined as an interactive entertainment that can be played via a digital platform such as computer, mobile device or a video game console (Owen 2016). In order to play the game, the user must give commands to the game and in turn, the game reacts accordingly. In many ways, this interaction between the video game and the player is quite literally the relationship between the user and the machine as mentioned above.

2.1 User Interface

As previously mentioned, the interaction between the user and the machine is the core fundamental of user interface – and by applying the same analogy to video game user interfaces, the complexity of that machine may vary from something as simple as the stop button on a bus to something as complicated as a computer.

In video games, some examples of possible UI elements include menus, HP (health point) bars that demonstrates how many hits the player character can take before resulting to a game over, and dialogue boxes. In some cases, the players may already have expectations regarding the user interface before they even play the video game. These expectations may be due to any previous entries or the genre of the game – for example, the Legend of Zelda game series (Nintendo 1986-2019) has included the usage of items as a part of its gameplay mechanics since the first game, thus the player may already assume there to be a menu for items.

Diegesis Theory

One of the theories designers use to develop a good user interface is Diegesis Theory that has been modified from the version used in other types of entertainment such as film, theatre and literature. The term diegesis refers to the world where the story – or in this case, the game – is located. The foundation of this theory revolvers around two notions: *narrative* and *fourth wall.* (Russell 2011.)

The broadest definition of narrative is the story the designers want to tell the users. Generally, game characters are not informed about UI elements such as HUD and some menus, making them not part of the narrative. However, UI can still support the narrative with design choices. For example, a game with a futuristic UI may already imply that the game is set in a futuristic world. (Russell 2011.) The depth of the narrative varies greatly depending on the game. In some games it barely exists; for example, the narrative of Pac-Man could be described

as a yellow ball wandering around a labyrinth, eating different types of foods and avoiding the ghosts that are chasing him. However, there are also story-driven video games where the narrative is a major part of the experience.

The term fourth wall may be familiar to many users from many different types of entertainment. For example, if a character from a movie suddenly addresses the audience about the events of the movie, this is known as breaking the fourth wall. In relation to video games, the fourth wall represents an invisible wall between the game world and the player. If the foundation of the Diegesis Theory consists of the narrative and the fourth wall, then the *Interface components* are the objects that the foundation supports. As shown in Figure 1, there are two relevant questions that must be considered when developing the user interface for a video game: does the user interface exist in the game world or the story? (Russell 2011.)

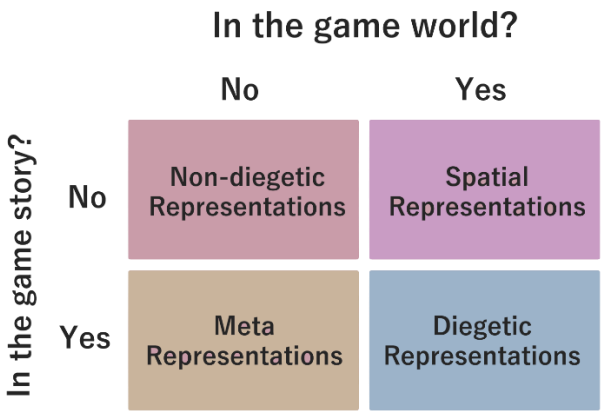

Figure 1. A diagram to demonstrate the different types of interface components relevant to the Diegesis Theory. Adapted from Russell 2011. (2020)

If the user interface exists in both the story and the world, it is known as Diegetic representation. In this case, the UI elements are provided in a manner that does not divert the player's attention from the narrative. This is achieved by making the UI elements part of the game world, and as something the game characters can interact with. (Russel 2011.)

An excellent example of a diegetic representation is the science-fiction horror game Dead Space (Visceral Games 2008). In Dead Space, the story takes place

in a space mining vessel called Ishimura, which is infested with humanoid monsters akin to zombies. The player plays as Isaac Clarke, who is an engineer sent to investigate the situation on Ishimaru. The lead UI designer of the game, Dino Ignacio, discussed the development of the UI of Dead Space as a speaker in GDC 2013 session *"Crafting Destruction: The Evolution of the Dead Space User Interface"*, and revealed that knowing the backstory of the game, the developers wanted to make the environment, Ishimaru, a character – and if Ishimaru was a character, then the UI would be its voice. Due to the futuristic story of the game, the developers had some freedom to make the UI diegetic, which led to the development of The Rig, an in-game suit that Isaac Clarke wears the duration of the game, and acts as the UI for health bar, inventory, ammunition count and map location. In Figure 2, the health bar is the light blue cord that is visible on Isaac's back and the inventory is a hologram he interacts with in the game.

Figure 2. A screenshot from Dead Space (Visceral Games 2008)

Non-diegetic representation is naturally the opposite of diegetic representation, where the UI is neither part of the game world or its story, and only exists for the player. Generally, games that have non-diegetic UI elements convey the necessary information to the player by using the HUD method. (Galati 2020.)

If the UI exists in the game world but not in the story, the components are part of the Spatial Representation. In this case, the UI elements appear in the game world, but the characters have no knowledge of them. Spatial components are ideal to decrease the amount of UI elements shown in the HUD. (Russell 2011.)

One game may have more than one type of UI component. For example, The Sims franchise (Maxis 2000-2014)), has both non-diegetic and spatial UI components, which can be observed in Figure 3. The UI elements visible in the bottom left corner of the screen are the non-diegetic HUD components and the speech bubble above the character's head is a spatial element.

Figure 3. A screenshot from The Sims 4 (Maxis 2014).

The last one of interface components related to the Diegesis Theory is the Meta representation, the UI elements that are part of the game story but not the world. UI components in this category are designed to provide an illusion that the game is interacting with the player directly through the fourth wall to maintain the immersion. For example, a great number of first-person shooter games have visual effects such as blood splatter on the screen to alert the player that the game character is close to death. These are part of the game story, as they represent what is happening to the character which, in this case, means them getting hurt by the enemy. (Galati 2020.)

There are also other possible components that can improve the immersion of the player beside the meta representation. One such method, known as meta-perception, is to use certain elements of user interface to provide more in-depth information to the player about the feelings or psychosocial state of the player character. Meta-perception is used in games such as the Uncharted series (Naughty Dog 2007-2017), in which whenever the protagonist, Nathan Drake,

sustained an injury, the colour saturation decreased on the screen to demonstrate Drake's mental state. (Galati 2020.)

2.2 User Experience

As previously mentioned, user experience can be roughly described as the structural system behind the user interface. However, in their article *'User Experience (UX) design'* (no date) Interaction Design Foundation has further defined it as the design process which aims to implement a positive experience to the users by designing a product that can be perceived as functional and usable.

In order to create a positive user experience, there are several tools the designers could find beneficial: the user experience design process method, and the UX honeycomb. The design process of developing a functional UX can be roughly divided into six steps (Figure 4).

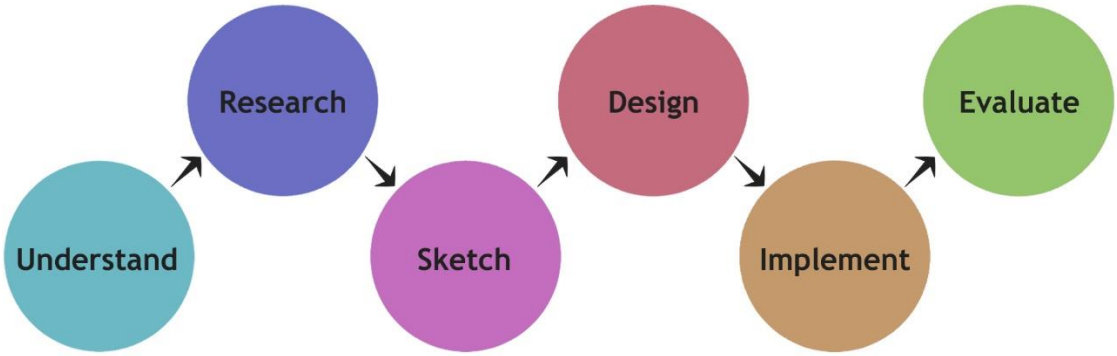

Figure 4. The design process of UX. Adapted from Minhas (2018) (2020)

The foundation of the design process should be understanding the target audience the design is for. In order to achieve an understanding regarding the audience, the designers may perform research such as interviews and studying the behaviour of the target group in natural situations. However, even though certain people may have qualifications that put them into the target audience – be it age or skill – each person is an individual with elements such as a unique background and preferences that may affect their personal user experience. As such, the designers can also create various user personas to determine the best course of action for their UX design. Once the designers have a solid

understanding of their target base, it would be recommended to perform research on external influences such as the competitors' UX methods, current trends and any features that are alike to their concepts. The third phase, sketching, is meant to focus on the initial development of the necessary UX features which can be achieved by paper prototypes and wireframing. (Minhas 2018.)

Wireframe is one of the essentials parts of the design process. It is a prototype of the UX that includes only the necessities, and act as a helpful outline to determining such concerns as the layout, how the information will be displayed. It can be used to determine the design direction of the user interface. (Tran 2019.)

Once the layout of the UX has been finalized, the next stage is developing the visual designs – which can include the necessary icons, typography, UI images, and the integration of the visual theme. However, the fifth stage, implementation, can be initiated before the end of the design phase. During the implementation process, the designers start building a functional user experience by focusing first on the functionality and attaching the user interface later. As a result, the product has acquired a functional UI with the suitable visual design. (Minhas 2018.)

During the evaluation stage, the user interface is assessed based on several types of criteria such as how easy it is to use, the flexibility, and how quickly the users can find an appropriate solution for any problems. At this point, it is possible for the developers to go back to one of the previous stages if there are any necessary adjustments to be made. Once the user interface and experience have achieved a satisfactory outcome, the product should be finalized. (Minhas 2018.)

UX honeycomb

In order to design a positive user experience, there are several elements to consider. In 2004, Peter Morville created the UX honeycomb, a visualization tool that can help the viewer to envision the fundamental elements of UX design. It consists of seven section, each depicting one of the fundamental aspects to

creating UX. However, in her article *'Optimizing the UX Honecomb'* (2018), Katarina Karagianni proposed an adjusted version of the honeycomb, where several sections have been relocated and the purpose of the sections have been written (Figure 5). As seen in Karagianni's version of the honeycomb, the elements can be divided into three separate categories that further help to explain their impact on the user experience; think, feel and use.

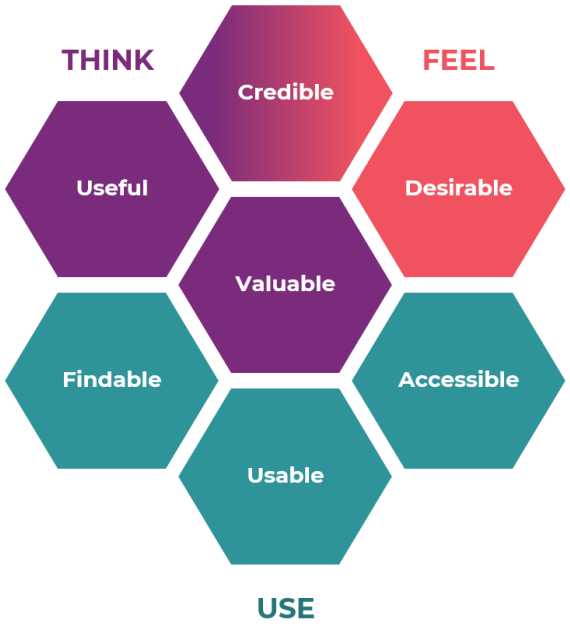

Figure 5. The improved honeycomb (Karagianni 2018)

The category that determines the way the users think about the user experience discusses how useful, valuable, and partially, how credible the UX is. The usefulness of the UX is determined by how well the product or feature serves its purpose. However, the usefulness is a matter of personal opinion – what one user considers to be an insignificant feature may be the selling point for another user. The second element in this compartment is how valuable the UX is for both the business as well as the users. The value relies on the users and their personal values – for example, a player with vision impairments may value accessibility over desirability. (Macpherson 2019.)

As previously mentioned, credibility belongs partially to the think category of the UX honeycomb as it is also related to the way the users may feel regarding the UX. As such, credibility applies to the users' capacity to trust the product – be it due to durability, ethics or accuracy. If the user does not trust the product or the developers, it may affect the way they view the company and even focus their attention elsewhere. While the designers' ability to control the credibility is limited, at minimum they should ensure that the finished product fulfils the promises they have made. (Macpherson 2019.) Regarding the desirability, there are a variety of ways it can be displayed – for example, the company brand, imago and identity as well as the overall aesthetic and emotional design can affect the desirability. (Interaction Design Foundation 2020.)

In the last division of the honeycomb are the components that can affect the usage of the UX. The findability refers to the navigation of the user interface and how easily the user can find the information they are searching for. If the user cannot find the desired content easily, it can affect their user experience negatively. Accessibility – which will be discussed more in-depth in 4.2 – permits more potential users for the product, which is why it should be encouraged to keep in mind during the development process. The last element of the honeycomb is usability which gauges the users' efficiency to achieve the desired objective. Ideally, one of the major essentials of UX design is to ensure that it is easy and intuitive to use, and that the user learn to use the user interface as quickly as possible. (Macpherson 2019.)

3 VISUAL DESIGN AND AESTHETICS

As previously discussed, the main function of a user interface is to convey information to the user. Regarding user interfaces in video games, these can be such components such as maps to help the player visualize their location, an item menu that shows what items the player has collected, or merely subtitles during a cutscene.

Generally, aesthetic can be defined as admiration of beauty in such examples as art. In user interface design, the use of aesthetic is essential, as the aesthetics of

the visual can affect the way the user views the experience and even functionality – a phenomenon known as the aesthetic usability effect, a topic that will be further discussed in 4.3. (Canhenha 2018.)

There are various ways to achieve an aesthetically pleasing user interface. For example, it would be recommended to keep the golden ration in mind when determining such objectives as the placements of the UI elements. As a general term, the golden ration describes the optimal proportions between different elements that will achieve the most pleasant looking design for human eye. (Tubik Studio 2018.)

3.1 Picture superiority effect

Rather than being applied just to make the design pretty, the visual design of the user interface can also be used as a tool. For instance, using the visuals may help the player memorize the information better, and in such case, the old saying *picture is worth a thousand words* is apt. Picture superiority effect is known as the phenomenon where people are more likely to remember pictures than words. There are two major theories, dual-coding and sensory semantics theories, that theorize the causes for the picture superiority effect. (Cad 2015.)

According to the dual-coding theory, the reason why humans can remember images better than just words is that people are likely to create verbal monologue in addition to the image whereas the opposite is less likely to happen. The sensory semantic theory is based on the belief that humans can easily memorize the meaning of images because it is easier to notice the difference between images rather than words. This theory is further supported by the fact that the picture superiority effect can grow weaker if people must recall a specific image from various similar ones. Because of this, it would be recommended to ensure that the visual elements of UI design are not too much alike. (Cad 2015.)

Jerry Cad (2015) has compiled a list of possible tips to take advantage of the picture superiority effect from the guide ‘Web UI Design Best Practices’ (no date). Examples from the list include tips such as the fact that people are likely to recall

impactful yet coherent images, which is why it is important to ensure that the visual design of the user interface is unique. Also, while people may remember pictures better than words, designers should be encouraged to use text when it is necessary, such as when the user needs guidance or clarification.

Age can also affect the effectiveness of the picture superiority effect as it is more evident for older population. Ailments such as Alzheimer's disease and mild cognitive impairments do not prevent the picture superiority effect. Applying various visual designs to the user interface could make the product more accessible for older people. Contrarily, children do not experience the picture superiority effect as strongly as adults and thus, need understandable verbal indicators for any user interfaces targeted for a younger audience. (Cad 2015.)

3.2 Platform

The platform of the video game in developed should also be taken into consideration when designing the UI. For example, if the game is for mobile devices, the interface should be clearly viewable on the smaller screen, and any UI elements the player can interact with via the touchscreen should be large enough to be pressed with a forefinger. If the UI element, such as a button, is too small or requires too much precision to be properly pressed, the mobile device may not register the attempted interaction, making the user experience both more difficult and frustrating. (Morris 2011, 19.)

Nevertheless, mobile gaming is not the only place where the platform should be considered – the games released on both consoles and PCs should also scrutinize the visual design modifications the change may cause. As Sinclair (2018) describes it, there are two central problems in designing a UI for both PCs and consoles: console players have more limited amount of input choices due to the need for controllers, and PC players often tend to be closer to the screen than the console players. Another issue between the console and PC user interfaces is the usage of mouse cursor on computer, which is often favored by PC designers as it is an easy and intuitive way for the players to interact with the game. However, the same design would be less effective and intuitive on console

controllers, which tend to have more prompt and button-press oriented way of interaction.

As such, Sinclair (2018) recommends designers to first create the user interface for consoles -- because if the control scheme is usable on a controller, it is easier to implement on a keyboard, and if the UI is visible on a television screen, which may be several meters away from the player, it is likely to be visible for a person who views it from a PC screen from a much shorter distance. Sinclair notes that Overwatch (Blizzard Entertainment 2015) is an example of good multiplatform UI design.

As seen in Figure 6 which depicts the hero selection screen, the essential information, such as the selected character, is clearly visible on the screen so that the distance from the screen is not an issue. While there are no notable differences between the visual design and layout, the way the player interacts with these screens differs greatly. In the console version of Overwatch, in order to choose the playable character, the player must first select a character and then confirm the selection. In the lower left and right corners there are displays of the buttons and their functions for referencing. Meanwhile, the PC players can freely use the mouse to choose their selection by hovering the cursor over the desired character. (Sinclair 2018.)

Figure 6. A comparison of the UI of Overwatch in Xbox One (left), and PC (right) (Blizzard Entertainment 2015)

However, Sinclair (2018) also notes that these core problems are slowly becoming outdated due to various factors such as the availability of HDMI for both television and PC screens, and rising awareness for accessibility issues.

Nowadays, there is an increasing number of PC players who own a console controller and assume it to work with their PC games. Furthermore, console games have also started to implement the support for a PC keyboard and mouse in order to make their games more accessible.

3.3 Gestalt Principles

The overall shape of the design should also be taken into consideration during the development process. The way human visual perception works is that the brains are wired to see structure and forms from the surrounding environment instead of detached areas and lines. This phenomenon was founded in the early twentieth century by a group of German psychologists and is nowadays commonly known as Gestalt Theory. The principles of the theory can be divided into several different areas: Proximity, Similarity, Closure, Continuity, Symmetry, Figure/Ground and Common Fate. (Johnson 2014, 11.)

With the aid of the gestalt principles, the designers can anticipate the way all users may comprehend their designs which makes them an essential part of the design process. They can be applied as a guideline for intuitive user interface design which, as previously discussed, is one of the most fundamental goals of the development process – not to mention, the principles can also explain the reasons why users may perceive the user interface as they do. (Chandra 2019.)

However, most designers do not apply only one principle per design – the gestalt principles are meant to be united rather than used separately – which may also cause the user to see connection between objects that were not intended to have one. Because of this, it would be recommended to view the design multiple times with each intended principle in mind. (Johnson 2014, 25, 27.)

Figure 7 demonstrates the use of gestalt principles in video game use interface design – namely, the principle of proximity. The skills the player can gain are separated into two groups: the offensive skills (the tiger), and the defensive skills (the elephant). By separating these skills into two clearly separate groups displays the use of proximity principle. (Hodent 2018, 29-30.) The way the layout

for these two groups has been designed and placed on the screen also demonstrates the use of symmetry.

Figure 7. A screenshot of Far Cry 4 skill menu (Ubisoft Montreal 2014)

Proximity

In terms of the Gestalt Principles and graphic design, proximity demonstrates the relative space between objects and the way human perception interprets that distance (Johnson 2014, 11). As demonstrated in Figure 8, the objects seem to be arranged into three different groups due to the distance between the rows. In other words, due to proximity, objects that are close together implies a relationship between them. This can help the user to quickly visualize the content and organization of the screen or paper in front of them. (Williams 2014, 15-17.)

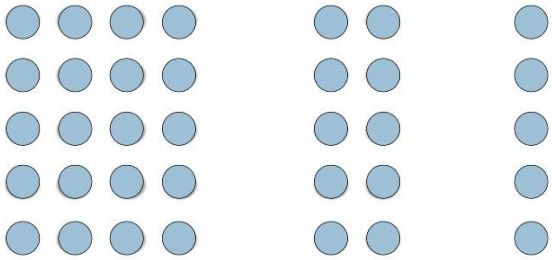

Figure 8. A demonstration of the proximity principle (Turja 2020)

Using the Proximity principle – which is also one of the four basic principles of design – in designing the user interface could make it easier to categorize the

information that the interface provides. If similar information is grouped together, it makes it easier for the observer to learn the interface. (Johnson 2014, 11-12.)

Similarity

However, the relative distance between objects is not the only reason why they can be perceived as a group; their similarities such as colour or shape may also affect the perception (Hodent 2018, 28). This can be directly viewed in Figure 9, where the stars seem to form their own groups based on their colours even though their size, shape and proximity are all identical.

Figure 9. A demonstration of the similarity principle (Turja 2020)

In other words, continuity can also be considered as consistency – if there were no repeating elements in a product such as pages or UI, the product would most likely appear confusing and inconsistent. The similarities do not always have to be identical; for example, including parts of text that have different colours and same font can also convey similarity for the viewer. (Williams 2014, 67.)

Closure

According the principle of closure, humans are more likely to perceive whole objects rather than separate pieces, which is encapsulated quite aptly in the motto of the gestalt psychology: the whole is greater than the sum of its parts. Creating negative space for user interfaces can work well as the human perception is likely to create closing lines for any open designs. (Hodent 2018 27-28.) The use of closure principle and negative space can both be observed in

Figure 10, where the figure appears to have a white square on top of four circle although there are no outlines to indicate such assumption.

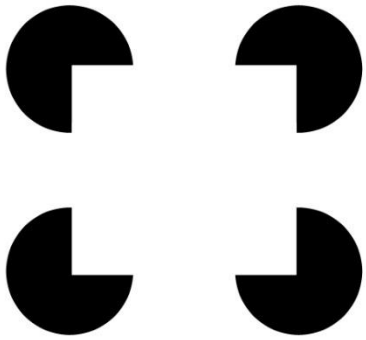

Figure 10. A demonstration of the closure principle (Turja 2020)

Continuity

Human perception has a tendency to attempt to establish the relationship between objects by following the patterns, lines and curves of the form, creating the principle of continuity. By applying continuity into design, the designers may find ways to make the user anticipate off-screen elements. (Chandra 2019.)
The principle of continuity can be viewed in Figure 11, where the image seems to be depicting a spiral despite the white spots interrupting the continuity.

Figure 11. Demonstration of continuity principle (Turja 2020)

Symmetry

As stated by Idler (2011), humans tend to favour symmetric elements over asymmetric ones. Symmetric objects can be viewed as stable and consistent while asymmetric design may seem unbalanced and lacking, which can leave a negative impression for the user.

In other words, human perception automatically attempts to lower the complexity of a view in order to simplify and create symmetry to the information, although there are various ways to decipher that information. This phenomenon can be seen in Figure 12 where the first picture depicts a shape, and the remaining ones demonstrate the ways the first one can be perceived. However, due to the principle of symmetry, humans are likely to view the diamonds as shown in the second picture, as two overlapping diamonds because it the simplest way to perceive the shape. (Johnson 2014, 20-21.)

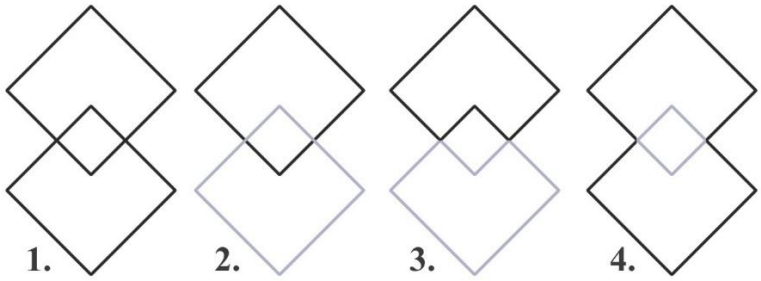

Figure 12. A demonstration of the principle of symmetry. Adapted from Johnson (2014). (2020)

Figure/Ground

According to the principle of figure/ground, the human perception visions various elements into two separate layers – the foreground (figure) in which the objects are likely to catch an individual's attention first, and the background (ground) which consists of everything else in the view. In user interface design, figure/ground principle can be exploited to guide the user's attention to any desired elements (Johnson 2014, 21, 24.) Figure 13 demonstrates the figure/ground principles, as the human eye perceives the lighter rectangle (figure) to be on top of the darker one (ground) due to the placement of the objects.

Figure 13. A demonstration of the figure/ground principle (Turja 2020)

How the objects can be categorized into the two layers can be influenced by the nature of the scene – for example, if a small object overlaps a larger one, the viewer may automatically assume that the small object is on top of the larger object, making it the figure of the scene and leaving the larger object as the ground. However, that is not always the case as the viewer's own focus of attention may also affect the characteristics of the scene. (Johnson 2014, 21-22.)

Common Fate

While the previous principles involved stationary elements, the common fate principle is about moving ones as well as the way they are grouped, making it similar to the proximity and similarity principles. In other words, if the objects are animated to move identically, the viewer is likely to believe there to be a relationship between the moving objects. (Johnson 2014, 24.)

3.4 Shape & form

One of the possible ways to convey information easily to the users is by taking advantages of the shapes in the user interface. Shapes can convey different types of meaning based on their form. For example, circles can be viewed as harmonious and soft due to the lack of sharp angles whereas squares and rectangles can be regarded as stable and secure thanks to the straight lines and right angles – making them the recommended shape for wireframing as they can be easily separate into logical components. The meaning of a triangle changes

depending on the angle it is portrayed as; if it is upright, it is deemed stable and balanced, and the opposite may make it seem risky. If the aim of the design is to be amiable and cute, it would be recommended to use squares or rectangles with rounded corners, while lines can demonstrate energy without the use of motion as well as be used as guide to categorize information into separate components. Polygons can make the visuals look futuristic and abstract shapes are not recommended to be used for elements with functions but work well as effects. (Galba 2019.)

Shapes can also be incorporated into the interaction of the user interface – be it by conveying an opportunity or selection status (Chiu 2018). Figure 14, which depicts the power menu of Dishonored 2 (Arkane Studios 2016) demonstrates the use of shape in selection. Not only does the currently selected icon, mesmerize, appear to be slightly bigger than the unselected icons, it is also encircled by a light blue circle to quickly draw the attention of the player.

Figure 14. A screenshot of Dishonored 2 (Arkane Studios 2016)

Having multiple shapes in the user interface may help the user to understand the hierarchy of the UI elements – for example, inserting a sharp angled shape to an otherwise rounded and softly shaped user interface can help to draw the user's attention to the former shape and its function. (Chiu 2018.)

Shapes can also be used to quickly inform the user of a status. For example, in Dragon Age: Inquisition (Bioware 2014) the player can choose different talents for

their characters from a talent tree. These talents are separated into two groups: those that can be activated, and passive skills. The talents can be deducted by the shape of the talent, as seen in Figure 15, where the active ones are diamond shaped and the passive ones are circular. This way, the players can quickly determine the nature of the talents without necessarily having to click the talent.

Figure 15. A screenshot of Dragon Age: Inquisition talent menu (Bioware 2014)

The term ‘form follows function’ was introduced by an American architecture Louis Sullivan (1856-1924) who is often regarded as the first modern architect in America. He argued that all natural things have an outer form that should reflect their inner meaning, the function. These functions could be such components like retail shops or offices. (Craven, 2020.)

While the origins of form follows function term stems from architecture, it can also be applied to the design process of video game user interfaces, in which the form refers to UI elements such as symbols and icons, and the function indicates their meaning. For instance, including items in the game environment that have a green cross on their form may make the players believe that the function of the item is to replenish health. Using form follows function as a visual guideline offers limitations to the artists, as the crucial goal of the visual design is to know what aspects of their form make them understandable to the players. The concept of affordances – which are discussed more in-depth in 4.1 – is similar to the form follows function concept. (Hodent 2018, 123-124.)

There are two requirements to properly achieve form follows function: easily identified form that cannot be mistaken for something else, and function that is correctly conveyed. If, for example, an icon seems to be representing a slice of pizza when it is supposed to be a radar cone, the icon has failed to accomplish proper form follows function. However, the function can also be misunderstood – an icon with a magnifying glass could potentially be misinterpreted as a function for searching when its true purpose was to demonstrate the ability to zoom in. Nevertheless, it should be noted that following the form follows function may be not possible in some cases – for example, various role-playing games have skills that cannot be properly conveyed with icons alone and need text descriptions to explain the purpose. Of course, form follows function does not only apply to the UI and UX design – it can be used for game assets such as characters, items and environments. For example, the characters in Team Fortress 2 (Valve 2007) all have unique silhouettes and shapes which makes it easier for the player to identify the characters and react accordingly. (Hodent 2018 124-125.)

3.5 Colour

In order to achieve a comprehensible user interface, it is important to pay close attention to the colours used in the visual design of the UI elements. In general, colours can communicate multiple meanings, from cultural significance to danger**.** However, choosing a proper colour palette may prove to be a challenge, even in the field of UI design. For example, using too many colours may make the design seem cluttered and confusing; low contrast may make it harder to separate different elements, and accessibility issues such as colour blindness – which are discussed more thoroughly in 4.3 – should be taken into consideration.

The colours used in the UI design are often tied to the overall art direction of the game – a realistic first-person shooter with a dark atmosphere is not likely to have an UI with bright, cheerful colours, unless it is specifically trying to break general design rules.

According to Mukamal (2017) scientists have estimated that humans can differentiate up to 10 million colours. The reason why humans can perceive colours is due to the retina; a lighting hitting an object leads to the aforementioned object absorbing some of the light and reflecting the rest, which penetrates the outmost part of the human eye, cornea. In turn, cornea bends the light into the pupil, which is the part of the eye that conducts the amount of light meant to hit the lens. The light is then directed to the nerve cell layer at the back of the eye, retina. There are two types of cells in the retina known as rods and cones, which are also called photoreceptors. While rods are activated in low light conditions, cones are responsible for working in the brighter environments, and differentiating colours.

Colour-detecting molecules, photo pigments, are stored in the cones, and generally human eyes have three different types of photo pigments: red, green and blue – all of which are sensitive to distinct wavelengths of light. However, some individuals may either have a fourth cone, or less than the standard three types of cones, a condition known as colour blindness which will be discussed more extensively in 4.2. (Mukamal 2017.)

The human perception is sensitive to the contrast of colours rather than sheer brightness. This can be observed in Figure 16, where the inner grey bar looks darker on the right side even though it is only one shade of grey. This is directly linked to the fact that the background colour of the right side is lighter on the right side whereas the left is darker and thus, the inner rectangle does not look s dark. (Johnson 2014, 39.)

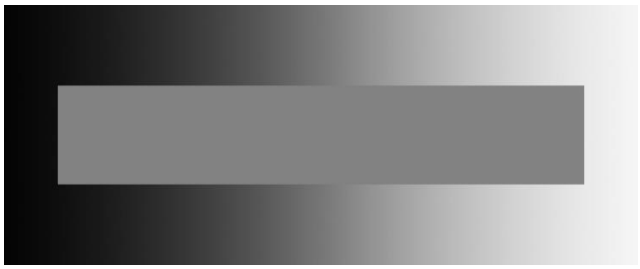

Figure 16. A demonstration of the way human eye sees contrasts. Adapted from Johnson (2014). (2020)

As stated by Mulholland (no date) there are three particular colours that have a great significance in user interface design; red, orange, and green. The reason why they are regarded important is due to their actionability and how their symbolism has been ingrained into the human psyche. In other words, the designers must be vigilant about the usage of red, orange and green since some users may associate these colours with certain elements due to external factors.

Red is often identified as the colour of danger and alerts. The exact reason why it is associated with crucial information varies by the person who answers the question. As previously mentioned, there are red photo pigments in the human eye. These red cones are located near the centre of the place where the eye forms the sharpest images -- which may be cause why people notice red first. Another possible answer is that red is prominent against green background which is why it is used as a warning signal. Red is also the colour of fire and blood which may also be the reason why it is associated with threat. (Science Focus no date.)

As such, red signifies importance, warning and error, which is also prevalent in video games. For example, various games may use red for the colour of the health bar or for the items that are unsafe. (Mulholland no date.)

Similar to red, orange is often used as a colour to catch the user's attention, although not as strongly. Instead, the two major factors associated with orange are waiting and reacting to urgent instructions. It can be used for warning signals such as unsaved changes or the pending status. Perhaps one of the most evident examples of using orange as the colour of waiting is its place in the traffic light, where orange means preparing for the change of colours. (Mulholland no date.)

In many ways, green is the opposite of red. It is associated with success and positivity – and has similar calming effect as blue does. Successful interactions such as saved documents or correct answers can be further signalled with green

colour, and it can be used as encouragement to make the user perform certain activities such as signing up for websites. (Babich 2019.)

The colours used for user interface design could be separated into five different divisions. The first category includes the primary colours, which are the dominant colours seen in the product. The ideal number of primary colours is maximum two. The second colours are the accent colours that are used to emphasize certain pieces of information or actions (Molly 2016.) For example, in some of the Legend of Zelda games (Nintendo EPD) such as the Breath of the Wild (2017), any words that has been deemed as important are coloured to create an emphasis that catches the player's eyes (Figure 17).

Figure 17. A screenshot from the Legend of Zelda: Breath of the Wild (Nintendo EPD 2017)

The semantic colours are used to convey signals such as errors, alerts, victory, and information. As previously discussed, red, orange, and green have a deeply rooted associations in the human mind, and the semantic colours are supposed to take advantage of those assumptions by, for example, making warning signals red. The fourth colours are the neutral ones such as grey, white and black that are meant to be used for components such as text and background. The fifth stage, related to charts, is optional and does not necessarily concern the video game user interfaces. (Molly 2016.)

The way humans think about colours is not tied only to the physiology behind the human vision – considering any potential cultural significances behind the variety of colours is also important. For instance, take the Persona franchise (1996-2020), a Japanese role-playing game series developed by Atlus. The last three

games – which drastically differ from the first three entries – have taken an advantage of the narrative regarding the colours used in their user interface design, which can be seen in Figure 18. Persona 3, which dealt with subjects such as isolation and sacrifice, used blue as the primary colour for the UI and the re-release, which included a female protagonist, removed the blue for pink. The next entry, Persona 4, had more upbeat atmosphere which manifested in the yellow UI colours. Lastly, Persona 5 included the theme of rebellion which reflected on the heavy use of red, white and black – which may have been influence by the English punk-movement. (Ridwan 2017.)

Figure 18. Screenshot of Persona 3 (Upper left), Persona 3 remake (Upper right), Persona 4 (Lower left), and Persona 5 (lower right) (Atlus 2006-2016)

As previously discussed, applying the rule of the golden ratio can guide the designers to developing a visually pleasant user interface. The same rule also applies to the usage of colours in UI design. In order to achieve a balanced, comprehensible colour palette, using the principle of 6:3:1 is ideal. As such, 60% of the UI space should use the primary colour, 30% the secondary colour, and the remaining colour should fill 10% of the space. (Tapaniya 2019.)

4 FUNCTIONALITY AND USABILITY

User Interface Engineer Jared Spool (2008) states*:* “Good design, when it’s done well, becomes invisible. It’s only when it’s done poorly that we notice it.” Spool’s quote can also be observed in the relation to the video game and their user experience design. A visually appealing UI alone should not be enough to provide an enjoyable and immersive experience; it should also strive to be functionable and easily usable for the player. In order to achieve such results, the game developers should strive to ensure that the UX design is logical and understandable.

Generally speaking, cognitive biases refer to the various ways a person’s judgement and decision-making may potentially be distorted due to different types of factors. Being conscious of cognitive biases may not dissolve them. A renowned psychologist Daniel Kahneman (2011) clarifies that people have two somewhat opposite modes of thought that shape mentality. The first one, system one, can be described as quick, impulsive, and emotional whereas system two is slower, conscious, and rational. The origins of cognitive biases are mostly born from system one since it tends to be an automatic reaction and thus, prone to mistakes. Due to its slow functionality, system two may not recognize the mistakes which in turn allows the biases to happen. (Hodent 2018, 12-14.)

There are nearly 200 cognitive biases that affect everyday life. 175 of them has been gathered into an illustration named Cognition Bias Codex (appendix 1), which was designed by Buster Benson and illustrated by John Manoogian III. (Ratner 2019). Some of the cognitive biases can also influence user experience, be it due to the designers or even the users. Sun (2017) has listed some common cognition bias examples that may occur during the design and testing process of user experience. Her examples have been categorized depending on the party whom the cognitive biases apply to. The examples that influence the designer are confirmation, and observer-expectancy biases. Confirmation bias occurs when the designer may potentially disregard information that does not align with their opinions and could cause incorrect data for the research. Observer-expectation bias in based on the human tendency to show mindset based on their own

beliefs, which may materialize as changes in the body language or tone of voice. If this was to occur during a user interview, it could compel the tester to give incorrect answers.

Cognitive biases that affect the users are known as the social desirability, and Hawthorne effect biases. The former bias can be defined as having test subjects whose answers are based more on their social desirability – that is, what the supervisors want to hear – rather than what they truly think and thus giving incorrect data. The latter bias ensues when the users unintentionally change their behaviour under the surveillance of the test supervisors. Lastly, there may be biases in the design of the project such as the wording, and sampling biases. If a question is worded in a manner that implies an answer – for example, asking how difficult it was to navigate an user interface already suggests that it was difficult – it is a wording bias whereas sampling bias may transpire if the testing has accidentally omitted certain types of users. (Sun 2017.)

4.1 Affordances and Signifiers

As described by Norman (2013, 11), an affordance represents the relationship between a physical object and the being that interacts with it – be it a person, animal or even a machine. The properties of the object and the capabilities of the interacting individual form the affordance relationship which in turn influences the way the object can be used. One of Norman's example is a chair, which affords sitting due to the support it is for. Some chairs can be carried by one person, thus making lifting another affordance the chair can provide, but if the person is unable to do that, then there is no affordance.

The concept of affordances was originally created by J. J. Gibson, an American psychologist who introduced the concept in his article *The Theory of Affordances* in 1977. Affordances were later implemented in the field of human-computer interaction by Don Norman. (Wesolko 2016.)

Taking advantage of the affordances is beneficial for the game user experience design as then the players do not need to learn or understand concepts that are

already intuitive for them. In other words, affordances can increase the usability and the game flow. Hartson (2003) concluded there to be four different types of affordance: physical, cognitive, sensory, and functional affordances. (Hodent 2018, 178-179.)

Physical affordances are the aspects that enable physical activity when doing something – be it such an examples like bottle caps that afford being twisted open rather than needing a bottle opener. In video games, an affordance that could be considered physical can be design choices like aiming at the button on screen either with a finger or cursor. When the affordances are meant to guide the player to learning and understanding such things like mechanics, they are known as cognitive affordances. UI elements that fall under this group can be such items like icon shapes, button labels and metaphors. If the player is supposed to use their senses such as vision, hearing or emotions to do something, they can be guided with the help of sensory affordances. An example of a sensory affordance in a video game is a large size font which affords visibility. The last type of affordance is functional affordance, which refers to functions that are designed to guide users to achieve certain goals such as sorting items in an item menu. (Hodent 2018, 179.)

Whereas affordance is the relationship between an object and an interacting individual, a signifier is a signal such as a symbol or a sound that provides a clue how an object can be used. A signifier is not always intentional – for example, footprints on a snowy ground are a signifier that signifies a path but it is unlikely that the person who left the footprints had the intention to create a sign of a path to the people who would come across the footprints. (Norman 2013, 14.)

Figure 19 gives a clearer demonstration of the differences between affordances and signifiers. It displays a picture of mobile game Granblue Fantasy (Cygames 2014), and its usage of affordances and signifiers. As Thornton regards in his article *'What is an affordance'* (2019), where he did a similar demonstration with Apple's Home app, the central affordance for the app was the touch screen of the mobile phone because it affords interaction based on tapping the screen, which

also applies to Figure 19. Each button on the screen is also an affordance as it affords an invisible target for the tapping. The signifier on the other hand, is the visual representation of the button. In Figure 19, some primary signifiers are the blue diamond shaped buttons. Each button has text on them to signify their meaning.

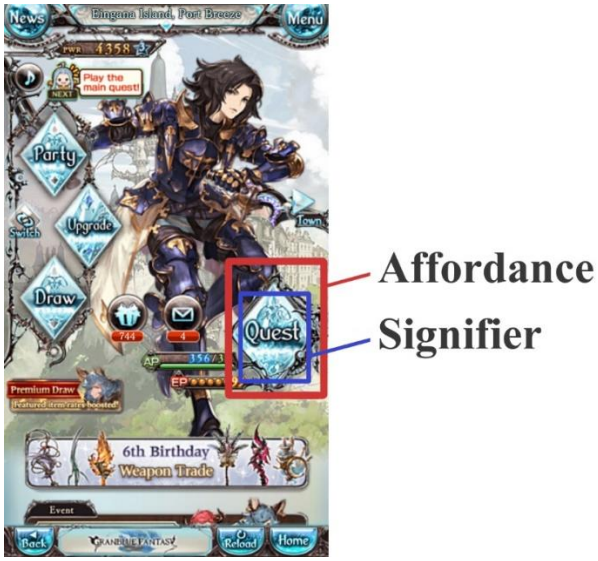

Figure 19. A screenshot of Granblue Fantasy. (Cygames 2014)

However, when determining the affordances and signifiers, the designers should avoid designing objects that could be perceived as multistable. A classic example of multistable perception is the Rubin's Vase (Appendix 2). Depending on the viewer, it can be viewed as either one vase or two distinct faces facing each other. It was first discovered by a Danish psychologist and philosopher Edgar Rubin (1886 – 1951) who published the figure in his doctoral thesis, *Synsoplevede figurer*, in 1915. The Rubin's Vase can be classified as an ambiguous illusion that can be perceived in multiple specific ways. (Donaldson 2017.)

Different approaches to showing signifiers in UI design

As previously mentioned, using affordances in the user interface design is beneficial for both the player and the designer since reducing the amount of time the player must be taught from the ground improves the flow of the game and the

user experience. One way the designers can accomplish this is by using skeuomorphism.

As Interaction Design Foundation describes it in *'What is Skeuomorphism*' (no date*)*, skeuomorphism means mimicking certain attributes of physical objects in order to help the user quickly understand the meaning of the UI element. The usage of skeuomorphism in user interface design comes from the times when mobile phones and computer were not as widely used, and people were not as accustomed to interacting with them as they are today. For example, it can be argued that one of the reasons why people were able to easily understand the early versions of iOS, Apple's mobile operating system, was due to the heavy use of skeuomorphism in its user interface design.

According to the Interaction Design Foundation article *'Skeuomorphism is dead, long live skeuomorphism'* (2018), skeuomorphism is accomplished by using colour gradients, edges, reflections and bevels to mimic the physical counterfeit of the object. However, the use of skeuomorphism in UI design has fluctuated ever since the creation of flat design. As the name suggests, elements with flat design do not have any features that would make it look 3D such as colour gradients, bevelled edges, lighting or shadows – a comparison can be seen in Figure 20 in order to give a better understanding of the differences. While the use of skeuomorphism was almost a necessity during the earlier days of computing technology, nowadays a great number of people are already familiar with the interaction between the user and the UI. Because of this, the argument that skeuomorphism was no longer needed was made.

As stated by Interaction Design Foundation in their topic 'Material Design' (no date) the third type of visual design is the material design, which was designed by Google in 2014. Elements created with the material design in mind are aesthetically pleasing, bold, and use minimal lighting and shadows to indicate 3 dimensionality – which can be viewed in Figure 20. In other words, whereas skeuomorphism mimics physical items, material design mimics the natural laws such as lighting and motion in its design.

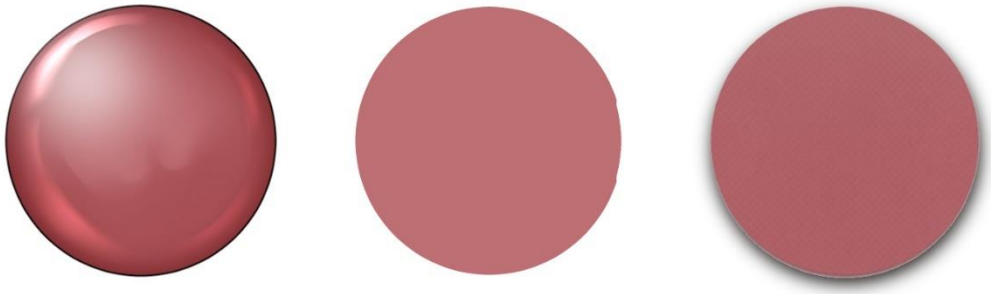

Figure 20. Comparing a button with a skeuomorphic (left), flat (middle), and material (right) design (Turja 2020)

In video game design, having a skeuomorphic user interface does not necessarily mean a 2D menu with seemingly 3D button – after all, the purpose of skeuomorphic design is to mimic the element's real-life counterpart. One of the examples of skeuomorphic user interface in video games is Splatoon 2 (Nintendo EPD 2017). The main menu of the game, which includes options such as solo, local or online play, and item vendors, is an actual in-game environment what the player can explore and interact with – which is also an example of a diegetic representation in user interface design previously discussed in 2.1. In order to perform an act such as purchasing items, the player must go to a specific place in the environment. Since the player can also interact with other players in the environment, using this type of menu can help the players to create a sense of culture and community in the game. However, one major problem is the speed as having to walk from one option to another can take longer than just choosing an option from a menu. In Splatoon 2, this problem was avoided by also including a menu system that follows the more traditional design architypes and can be used to immediately bring the player to the desired location to prevent the players becoming frustrated with the arguably unusual user interface. (Deets 2017.)

4.2 Accessibility

As previously discussed, accessibility is ideally an essential part of UX design that should be always be taken into consideration. If the game is not accessible, it

could affect the player's user experience negatively depending on the player's own unique needs and prowess.

According to The Game Accessibility Guidelines (no date), some of the most common complaints regarding accessibility in video games are remapping, text size, colour blindness and subtitle presentation. However, apart from vision and motor issues presented in the common complaints, there are other areas of accessibility that should be taken in consideration overall in game design, such as cognitive, hearing and speech issues.

One of the accessibility issues that is especially essential for the user interface development is regarding the usage of colours. As stated by Colour Blind Awareness in their article *'What is colour blindness'* (no date), colour blindness is a usually genetic condition that can also be acquired due to certain illnesses such as diabetes, multiple sclerosis, certain types of liver diseases and most types of eye diseases. As previously discussed in 3.3, human eyes have three types of cone cells – red, blue and green – and each of them can perceive light differently. While the exact cause for colour blindness is still unresolved, it is widely believed to be caused by faulty cones in the eye, or in some cases a deficiency between the brain and the cone. When one of the cones is faulty, it changes the way a person perceives the colour as demonstrated in Figure 21.

By observing Figure 21, it should help to conceptualize why using only colours to convey information may hinder the user experience of some players. One way to avoid this accessibility issue is to incorporate a different type of shape to a certain colour. This type of resolve can be observed in games such as Candy Crush Saga (King 2012), where the player must create a row or column of matching candies by swapping adjacent candies around. There are several types of candies and each type has a distinct shape, making it easier to distinguish them ever without relying solely on the colours.

Figure 21. A demonstration of different types of colour blindness (Turja 2020)

As of late, various games belonging to this generation have started implementing accessibility options into their mechanics. In his article *'For all the Players: A History of Accessibility In Video Games'* (2020) Wilds listed several examples such as Shadow of the Tomb Raider (Eidos Montréal 2018) in the subtitles could include closed captioning and different coloured text for each speaking game character, and in Borderlands 3 (Gearbox Software 2019) the UI could be scaled to a size that parts of it would go off-screen.

4.3 Aesthetic Usability Effect

As previously mentioned, the designers should strive to design their UX to be a positive experience for the player. However, there may be times when some issues regarding the functionality cannot be avoided, but that does not necessarily mean that the functionality should be redone.

Aesthetic Usability Effect refers to the occurrence where visually appealing products are regarded as more usable than the blander products, even if they both functioned identically. In other words, people will tolerate minor usability issues if the user interface appeals to them visually. Moran (2017) recounts how aesthetic usability effect in terms of human-computer interaction was first discovered in 1995 by two researchers, Masaaki Kurosu and Kaori Kashimura. They prepared a study regarding functionality and the aesthetic appeal of 26 different variations of ATM user interfaces. They discovered that the study participants were more likely to give higher ratings to the user interfaces with visually pleasant designs even though the usability was identical for all the variants.

This phenomenon is universal. Kurosu and Kashimura's ATM UI study was repeated in Israel by another researcher Noam Tractinsky (1997) who originally assumed that the Aesthetic Usability Effect was a cultural phenomenon in Japan, where the original study had been performed. After receiving the ATM layouts used by Kurosu and Kashimura, he translated the text into Hebrew and remade the experiment. Not only did he replicate the original findings, he discovered that the Israelis were more likely to regard the more visually designs as more usable. (Norman 2004, 17-18.)

The perception is also resistant to change and may affect any further interactions the user has. According to Lidwell, Holden and Butler (2003, 18) in their book *'Universal Principles of Design',* a study was performed to examine the interaction between humans and computers in which the research found out that the people's long-term attitude regarding the computer was influenced by the first impression the users experienced.

5 THE DEVELOPMENT OF THE PROTOTYPE

The production part focused on the development of three versions of a prototype that is further used to study how the visual design and functionality may affect the eye movement when looking at the user interfaces. The prototype could be roughly divided into two parts – the user interface, and the game environment. The game environment is built solely with 3D modelled assets and includes several animated pieces – the character, fire and dust particles. The player cannot interact with the game environment.

There are three different prototype versions, each of them having different features taken into consideration during the design process. Each version has been altered slightly to create unique atmosphere, and to study if the changes can cause any shifts in the user's behaviour. These modifications include changes into the placement of the 3D assets, lighting, and the animation visible on the screen.

5.1 Concept

The gameplay mechanics behind the user interface of the prototype are crafting-based, and the objective of the player is to craft medicine necessary for their current needs. The primary target audience for the prototype are people from late teens to adults, with small to moderate amount of previous experience with video games, and who enjoy life simulation games with crafting based elements such as Stardew Valley (Concerned Ape 2016) and Animal Crossing: New Horizons (Nintendo EAD 2020). The story behind the prototype is centred around the character seen in the prototype – who would a playable character in the hypothetical game product of the prototype. She is a witch who was revoked of her magic license and must earn a living by selling medicine and potions to the locals who are more interested in the potential hexes and curses she is no longer allowed to create due to the lack of license. As such, the character – and the player by extension – must choose which path to follow; barely earn a living by selling medicine or sell under the counter magic and risk being found out. The prototype revolves around the choice to crafting medicine.

The early development process involved deciding what purpose the user interfaces – and the whole prototype – was going to be. Three options were developed based on the backstory of the prototype, which can be seen in Figure 22, which was under consideration to be the second possibility for the prototype. The third option was to design a user interface for the creation of curses and hexes, which was put under the ‘orders’ option visible in Figure 22. Eventually, it was decided to further develop the user interface for medicine crafting as it was less ambitious than the orders option but more detailed than the option seen in the paper prototype.

Figure 22. A paper prototype of one of the early ideas for the user interface (Turja 2020)

There were several sources of inspiration for both the game environment and the user interfaces. For example, one source of inspiration that lasted from the very beginning of the development process were the early to middle 20th century pharmacies, which can be observed from assets such as the glass bottles and the vintage medicine labels used in version 2 user interface. Another major influence were the works of Sir John Tenniel (1820-1914), a British illustrator and artist whose art in Lewis Carroll's book 'Alice in Wonderland' (1865) served as an inspiration for the game environment and the user interface of version 2 (appendix 3). (Morris 2020.) In game environment, Sir Tenniel's influence can be noted in the asset textures; a variety of them, such as the blackboard and the floor have strokes that mimic organic pencil traces. Version 2 of the user interfaces was significantly inspired by Sir Tenniel's heavy usage of black shadows which can be seen in the icons of that UI.

The decision to have a background consisting fully of 3D assets was made early on during the development phase. Developing a fully 3D environment made it possible to modify the game environment quickly without the need to develop any extra assets. Having the same assets also ensured that the user's perception would not be affected by the sudden appearance of any new 3D models.

Originally, there were three different pieces of concept art created for the character seen in the game environment. The middle concept idea from Figure 23 was chosen, as it was deemed to reflect the personality of the character the

best. However, as seen in the finalized version, the character was modified during the 3D-modeling process due to the difficulties of sculpting the hair. When the hair seen in the concept art proved to be too challenging to model, the author decided to style it in the twin buns to give the character a unique silhouette. However, the colour palette and the shape of her eyes remained same throughout the development process.

Figure 23. Concept art of the character (left) and the final model (right) (Turja 2020)

As previously mentioned, the character in the game environment would be the playable character for the final game product. The reason to include a character for the game environment was to create some element of movement to the prototype as well as to add more immersion for the users. The main focus of the character development was simplicity due to the lack of experience in 3D modelling complex figures.

5.2 The finalized prototype versions

In version 1, which is shown in Figure 24, the colour contrast between the UI and the game environment is subtle. However, the fireplace in the game environment is prominent in the view as it is the only bright object with warm temperature colour. The character is also looking away from the viewer which could potentially distract the viewer. Based on these observations, the hypothesis regarding this version would assume that the viewers are likely to notice the moving fire first before moving either to the UI or the character due to her proximity with the fire and her idle animation.

Figure 24. A screenshot of the version 1 (Turja 2020)

Version 2 differs drastically from the other two prototypes in both the game environment and UI design, which can be observed in Figure 25. The 3D assets have been relocated, the game environment has been adjusted, and the character is looking towards the viewer and the user interface. Due to the warm lighting, the fire is not as visible as it is in the version 1 but it is still a moving object.

Since there are no particularly drastic contrast changes between the game environment and the user interface, the hypothesis for this version assumes that the viewer's eye is likely to go to the moving pieces: the character and the fire. This hypothesis is based on the peripheral vision of the human eye, which will be discussed further in 6, and how motion can be perceive from a wide angle no matter the focal point of the human eye.

Figure 25. A screenshot of Version 2 (Turja 2020)

Version 3, which is displayed in Figure 26, is meant to study the contrast and the gestalt principle of figure/ground and how the viewers perceive it. The contrast between the user interface and the game environment is drastic; a semi-transparent panel has been applied over the game environment to decrease its visibility, and the animation of the character and fireplace have been stopped to remove the element of motion from the game environment. Version 3 was created by making minor modifications to version 1.

As previously mentioned, the human eye perceives contrast rather than mere brightness regarding colours. Since the contrast between the dark background and the light user interface is drastic and there is no other stimulus such as motion to distract the viewer, the hypothesis regarding this version would assume that the viewer's eyes would quickly move to the UI.

Figure 26. A screenshot of Version 3 (Turja 2020)

5.3 Designing and applying the UX and UI

As previously mentioned, the recommended starting point of designing the UX is understanding the target audience. The prototype was designed for late teens to adults with low to medium amount of experience in video games. While the prototype is meant to have a heavy focus on crafting, the user experience was purposely designed to be as simple as possible in order to ensure that the players with less amount of gaming experience would not get overwhelmed, which is why the under interface consists only of three separate elements. Figure 27 displays three wireframes options that all have different types of layout regarding the way information is presented. However, every one of them has a grid-based inventory system.

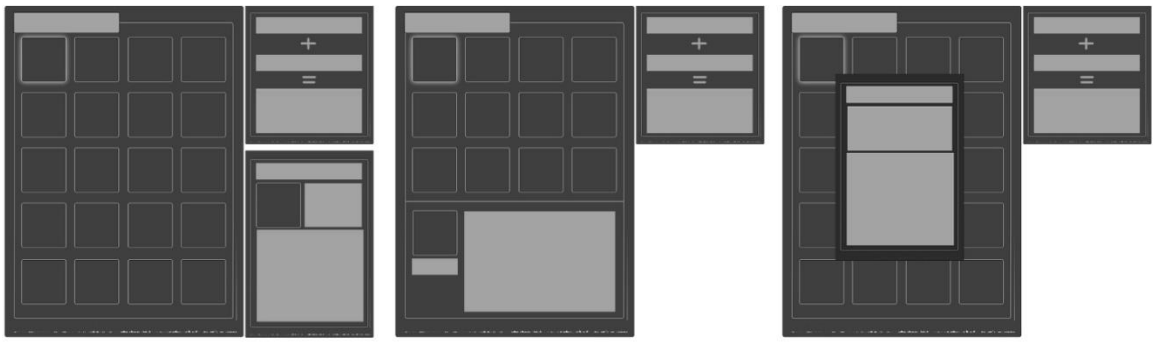

Figure 27. The wireframe options (Turja 2020)

Briefly, another type of inventory system was considered where the items are organized into a list (Appendix 4). However, the concept was discarded in favour of the grid-based system as it allowed more freedom to study if any specific icons would potentially affect the user's eye movement.

The UI designing phase of the UX process began soon after the wireframes were finalized. Figure 28 offers a visualized guide to demonstrate how the same UI elements have been placed in each version. The part surrounded by the light blue border is the inventory of the items the player currently has. Each box with an icon inside is an interactable button, a signifier, that offers information regarding the clicked item which is the first item in the item list in each version of the prototype. The icons circled with a red border signify a category of the inventory which was set to 'herbs' for each prototype version. The pink border surrounds the description box of the item that is currently clicked whereas the yellow box inside of it is for the hypothetical gameplay status effects the chosen item has. Lastly, the component encircled by the white lines is for the results of the crafting process in which the viewer can note the currently chosen items and the potential results.

Figure 28. A visual demonstration of the elements visible on each prototype user interface version (Turja 2020)

Various gestalt principles were used during the creation of the user interface. As the user interfaces of each prototype version has a grid-based inventory system, it was essential to implement the gestalt principle of proximity to help the viewer to understand the structure of the user interface. The use of proximity can be

observed in the way each element – the inventory, description and the result components – have clear distance between them. The category and status effect icons have also been clearly grouped together to further help the viewer to visualize each layout. Version 2 also uses the principle of similarity which can be observed in the small black spots in the lower right corner of every item box. Not only did these black spots create a clear background for the number which demonstrates the amount of the boxed item the inventory has, it also creates a sense of similarity with the other inventory boxes. Meanwhile the empty box seen in the result box does not have the black spot since the resulting item is still unknown, but it also can help the viewer to understand that it's meaning differs from the other boxes. As previously mentioned, version 3 also studied the effects of figure/ground principle by ensuring a great amount of contrast between the user interface (figure in this scenario) and the game environment (ground).

The design style of the user interfaces resembles the material design the most, as there are no realistic skeuomorphic elements used as signifiers, and the UIs all have slight texture, colour gradient, and slight indications of light and shadows. However, while the boxes in the inventory compartment would be clickable to show more information regarding the item in the description box, their visual design does not necessarily work as a clear signifier for a person with no previous gaming experience.

Accessibility issues regarding visuals were also taken into consideration for the development process. This was achieved by design choices such as testing the text size and colour to ensure best possible visibility against the background, and using colours that would not impact the user experience negatively for a person with colour blindness.

6 THE PROTOTYPE EYE-TRACKING

While the original aim of the research was to perform the testing in a manner where the author was physically present with the test users, the ongoing global COVID-19 pandemic prevented the usage of such testing environment. Instead, the test subjects were given two URL links: one for GazeRecorder application

and one for the website that included the three different variations of the prototype. All viewers received the same prototypes in the same order and were guided to observe them for around 10 seconds. The viewers were meant to put the URL of the prototype into GazeRecorder application which would then record the user's observations of the prototype. These recording were then given to the author for analyzation. After the viewer had seen all three prototype versions, they were given two questions to answer to: which UI left the biggest impression and why?

The overall hypothesis for the prototypes assumes that the users' perception can be affected by the changes in the layout, colour and the motion. The secondary hypothesis is that the way the UI components are laid on the screen may affect the viewer's viewing order of the elements. This hypothesis is supported by Nick Dika's lecture *'Visual Design for Immediacy'* (2019), which demonstrates the angles of human peripheral field of vision with the graph seen in Figure 29.

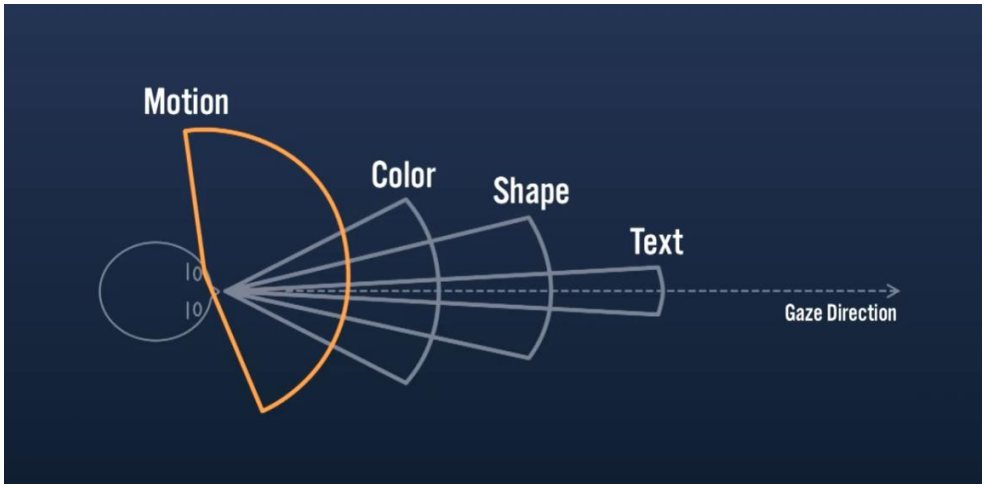

Figure 29. A visual graphic to show the angles of human's field of vision (Dika 2019)

As stated by Dika, the part of the screen a person can see in sharp detail is barely the size of a coin – which is known as the central fovea vision. As demonstrated by Figure 29, it can be observed that human eye cannot see text in large detail unless it is almost completely focused on it, whereas motion can be noticed even in the corner of the eye.

The Results

There were three test users, two of them in their early to mid-twenties with moderate to high amount of experience with video games. The third test user, who was in their late fifties, did not have previous gaming experience which allowed the author to study if this could potentially alter their behaviour during the testing process. Two of the test users also wore glasses during the testing.

However, it should be noted there are several factors that may have affected the results of the recordings. The application used to track the eye movement was not fully accurate, and any sudden changes in the tester's head position may have altered the eye tracking process. The website that hosted the prototype versions also added a picture of the title of the prototype in the lower left corner that appeared briefly as soon as the prototype was displayed, which may have attracted the viewer's attention. There is also the possibility that the viewer's may have experienced certain cognitive biases which were previously discussed – for example, the viewers may have unintentionally altered their behaviour and the way they view the screen because they knew they were under surveillance.

Figure 30 demonstrates the heatmaps of each tester's eye movements. Number 1 was the tester in their late fifties and had no previous gaming experience. The author was also physically present during this testing. Number 2 and 3 both had history with gaming and their testing was concluded remotely. It should also be noted that the first recording of tester 2 may have experience some technical difficulties as the recorded video suffered from lags, leading to a potential loss of proper information.

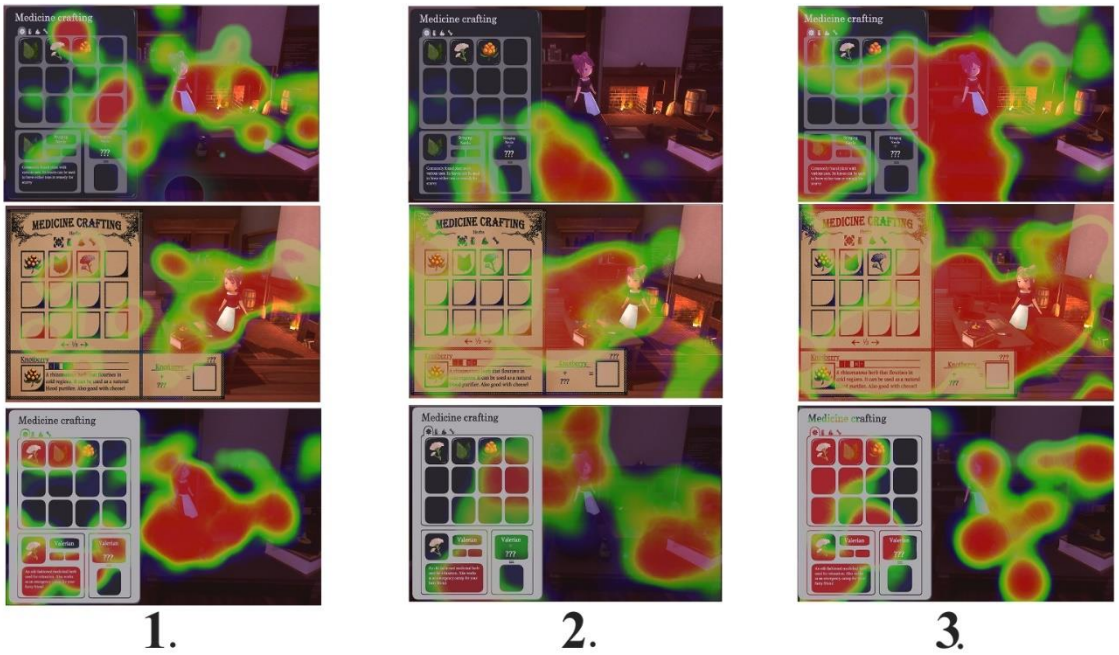

Figure 30. The heatmaps of each tester's eye movements (Turja 2020)

By comparing the heatmaps and the recordings of prototype version 1, it can be noted that the heatmaps have some differences. Both viewer 1 and 3 found the user interface quickly after the prototype version was visible on the screen. Interestingly, while their eyes did land on the fireplace, it was not as immediate as the hypothesis had assumed. The hypothesis had also pointed out the option where the viewer's eyes would move either to the user interface or the character after noticing the fire. The results of this assumption differed between viewers 1 and 3 – viewer 1 acted accordingly to the hypothesis and moved to the character whereas 3 continued to study the game environment.

When the version 2 was displayed, all viewers first took noticed of the moving character. It took a noticeably long time for viewer 1 to finally observe the user interface while viewer 3 moved their eyes from the character to the user interface element in the down middle part of the screen moderately quickly. Meanwhile, viewer 2 detected the inventory element after observing the character. The unique hypothesis regarding this version assumed that the viewers would first notice the moving objects due to the lack of any drastically contrasting elements, which was proven correct in this regard.

Interestingly, each viewer reacted differently to seeing the version 3 of the prototype. Viewer 1 took a significantly long time until their eyes moved to the user interface – instead, they first focused on the dark game environment and the motionless character before eventually shifting to the UI. Viewer 2 first noticed the book seen in the lower right corner of the screen – which was noticeably lighter than the rest of the game environment – before observing the user interface. Unlike the previous two testers, viewer 3 went immediately to the user interface. The hypothesis regarding this version had previously assumed that all viewers would quickly move to the user interface due to the lack of motion and the high contrast between the game environment and the user interface.

The results indicated that the process was not as universal as previous assumed. There are some other observations regarding the heatmaps of the version 3 of the prototype. It can be noted that both viewer 1 and 3 seem to have viewed the user interface and the game environment as separate entities. This is especially noticeable in viewer 3's results, where there are no heatmap marks to bridge the eye movement from the game environment of the user interface and vice versa. Interestingly, by viewing the heatmap it can be observed that each viewer seemed to look more at the UI compartment that displayed the description compared to the heatmaps of the other versions in that area. In fact, it seems that each viewer – especially viewers 1 and 3 – spent more time observing the inventory list in version 3 than in the version 1. This could be due to the increased contrast between the UI background and the buttons that signify an item which may have helped the viewers to separate the items on the list, further proving the significance of the figure/ground principle.

In 8 out of 9 heatmaps, the viewer's eyes lingered on the character seen in game environment for enough times to make the heatmap appear red around the character even when the animation was removed. However, as previously mentioned, viewer 2 may have experienced a faulty recording for the first prototype version which may have affected their eye movement – or the lack of thereof.

When the testers were asked which user interface left the biggest impression on them, 2 out of the 3 tester's thought that the version 2 was most memorable. However, their reasons were different – the first tester noted it to be their favourite of the three versions due to the visual design of the UI and the warm atmosphere whereas the second tester had observed it to be the clearest looking UI. The latter tester also speculated the reason for it to be the added details. However, the third tester found the first one to be the most memorable – although they noted the fireplace in the game environment to be the reason, which was not part of the user interface. When asked to recall the user interface that they deemed most memorable, the third test user replied the third version due to the description box on it.

When comparing the answers of the testers, there is one clear difference between the testers themselves: the testers who answered the version 2 had previous gaming experience whereas the third tester did not. As such, it is possible that the previous gaming experience influenced their understanding of the prototypes whereas the tester with no previous experience perceived the testing in a completely different manner. One theory could be that the two testers who recalled version 2 the best were able to separate the user interface from the game environment while the last tester was more likely to visualize the prototypes as complete units.

Another theory could be tentatively be linked to the aesthetic usability effect – while the testing did not include any interactable elements, the two testers who remembered version 2 the most had played games with crafting elements before and understood the mechanics behind them. They were more likely to understand the meaning behind every UI element and thus could be more focused on the aesthetics of each user interface. This theory is further supported by the testers' answers, where they both commented on the visual design of the user interfaces – and as previously discussed in 4.3, humans are likely to perceive visually pleasing user interfaces are more functional, and one of the tester commented that version 2 seemed more clearer than the other versions

even though the only change in the layout was the minor location change of the result box.

The overall results of each prototype version have found a link between the visual design and functionality of the user interfaces and how they can influence the user's perception of these elements. The viewers' perception was influenced by the colour contrast, aesthetics, and the layout of the user interfaces. The perception was also influenced by the game environment, which was proven by the way each viewer reacted to the motion and the character regardless of her state of animation. As such the overall hypothesis regarding the subject has been supported.

7 CONCLUSION

The purpose of this Thesis was to study how a viewer's perception can be influenced by the design choices in the user interfaces and their effects on the user experience. The research and prototype development of this Thesis were achieved successfully within the limits created by the current global pandemic that affected the screening of the prototype. The Thesis addressed the creation process of the user interface and user experience and their influence on the development of the prototype. The design choices regarding the aesthetics and functionality were also discussed to further explain the design choices of the prototypes and their effects on the human perception.

The main results showed that the hypothesis regarding the subject was supported by the viewers' perception and thus, met the Author's expectations. Furthermore, this Thesis achieved less important but worth mentioning results on the way human eye has a tendency to notice human figures on the screen despite their state of motion, which could be taken advantage of in the user interface process, and how previous gaming experience can influence the way the viewer perceives the user interface.

Based on the results of the eye-tracking, there are several good design choices that could have been added to the prototype. For example, this Thesis did not

include any animated elements in the user interfaces and their effects on the eye movement. The prototypes also included only a grid-based item system so there is no data to compare that type of layout with another such as a list-based system. However, the small testing group and the remote nature of the screening may have altered the results which is why further research with a larger variety of participants would be recommended. Nevertheless, the outcomes of this Thesis have proven that the aesthetic design and functionality choices of the user interface greatly influences the viewer's perception and experience with the product. In conclusion, while there are still certain fields that need further research such as potential UI elements with motion, the results of this Thesis can be used to recommend the best possible course of action regarding the visual design choices such as colour contrast, aesthetical details and the layout of as user interface.

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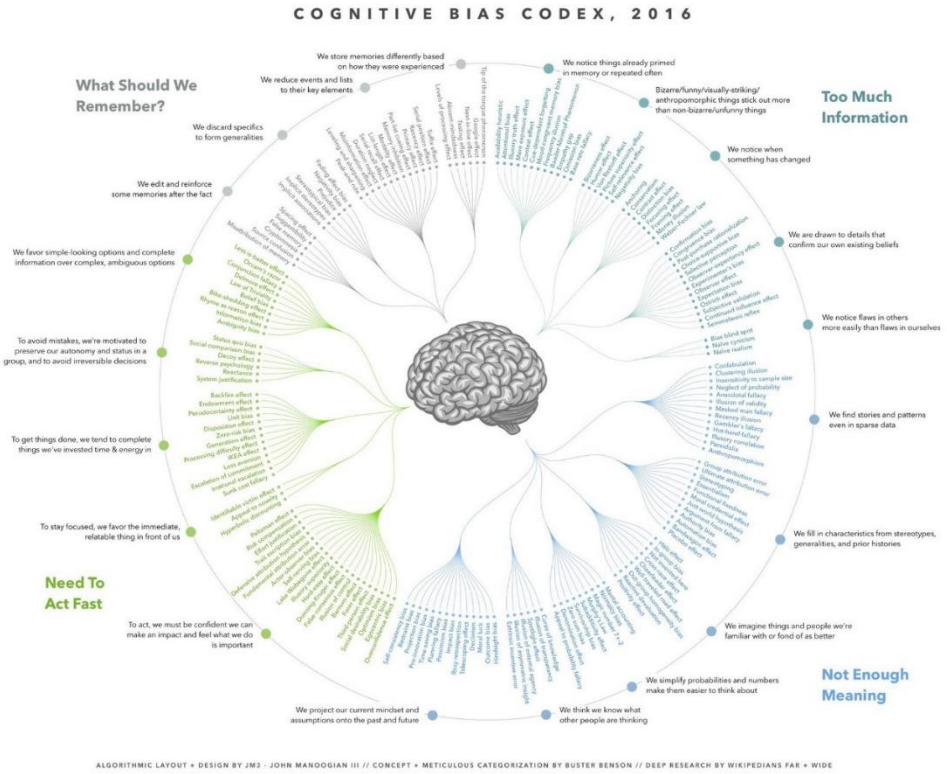
LISTS OF FIGURES



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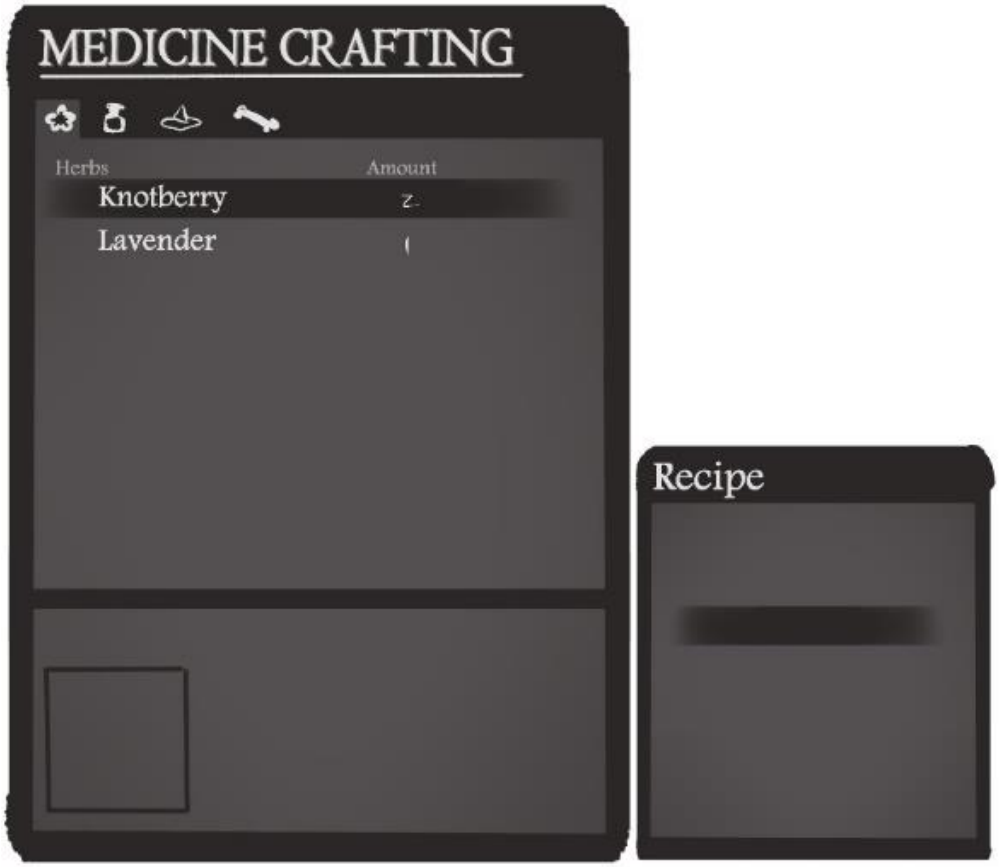
MEDICINE CRAFTING
Herbs
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