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*INVESTIGATION OF TYPOGRAPHY USE AND FONT DESIGN IN VIRTUAL REALITY ENVIRONMENT**

SANAL GERÇEKLİK ORTAMINDA TİPOGRAFİ KULLANIMININ İNCELENMESİ VE YAZI KARAKTERİ TASARIMI

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Abstract
Thanks to developing technology, the use of virtual reality has become increasingly widespread. With the widespread use of virtual reality, design in virtual reality has become increasingly important. One of the design elements that should be considered in the virtual reality environment is typography. Different design and production processes have occurred in the use of typography in the virtual reality environment. Nowadays, typography can be used more uniquely in different forms in virtual reality environments. This article focuses on the relationship between virtual reality and typography, one of the new medium that emerged with the development of technology. This article is a qualitative study and the usage of typography in the virtual reality environment is examined. Based on the reviews, a font design was created. The project produced was produced as an example project for the use of the font in the virtual reality environment.

Keywords: Virtual Reality, Typography, Virtual Typography, Letter Design.

Öz
Gelişen teknoloji sayesinde sanal gerçeklik kullanımı giderek yaygınlaşmaya başlamıştır. Sanal gerçeklik kullanımının yaygınlaşması ile birlikte, sanal gerçeklikte tasarım giderek önem kazanmıştır. Sanal gerçeklik ortamında dikkat edilmesi gereken tasarım ögelerinden biri tipografidir. Tipografinin, sanal gerçeklik ortamı kullanımlarında farklı tasarım ve üretim süreçleri oluşmuştur. Günümüzde tipografi, sanal gerçeklik ortamlarında farklı formlarda daha özgün bir şekilde kullanılabilmektedir. Bu makalede teknolojinin gelişimi ile ortaya çıkan yeni mecralardan biri olan sanal gerçeklik ve tipografi ilişkisi üzerinde durulmuştur. Bu makale nitel bir çalışma olup tipografinin sanal gerçeklik ortamındaki kullanım biçimi incelenmiştir. İncelemelerden yola çıkılarak bir yazı karakteri tasarımı oluşturulmuştur. Üretilen proje, yazı karakterinin sanal gerçeklik ortamında ki kullanımına dair örnek proje olarak üretilmiştir.

Anahtar Kelimeler: Sanal Gerçeklik, Tipografi, Sanal Tipografi, Yazı Karakteri Tasarımı.

*(Derived from a master's thesis.)

INTRODUCTION

With the rapid development of technology, computers, smartphones, digitalization, internet, etc. It has become a part of our lives. We live in a technological world dependent on digital environments for needs such as data collection and access to information in the field of communication, as well as many issues such as workplaces and education areas.

One of the digital technologies is virtual reality, which provides abstract design opportunities. With virtual reality, a three-dimensional design is made in a virtual environment with a number of software programs and equipment, creating a feeling of the real world in the mind and allowing the person to interact with virtual objects (Şekerci, 2017, p.1127). Thus, the perception of reality changes in the human mind.

In virtual reality, we encounter two important concepts: virtual and real. A virtual place that has no place in reality but is designed in the mind. Reality is defined as existing as a situation, an object or a quality, whose existence is not denied (sozluk, 2023). The basis of virtual reality is the idea that what is virtual is actually a different version of reality (Ropolyi, 2015).

Virtual objects that emerge by adapting reality to technology do not exist on their own like real ones, but they imitate reality and can reshape it (Avcı, 2022). On the one hand, while the representation of the object in the physical world is formed in the mind, on the other hand, sociocultural values, personal characteristics, expectations, emotions and thoughts are effective when the perceived information is interpreted and selected (Özkirişçi, 2020). With the concept of virtual reality, phenomena such as time, reality, virtuality and space are reinterpreted. The concept of reality has weakened with the increase in virtuality. "*In a world dominated by the principle of reality, there was an "excuse" called fantasy. In today's world determined by the principle of simulation, reality serves no purpose other than proving the existence of the model*" (Baudrillard, 2021, p. 165).

Virtual reality, augmented reality and mixed reality are the concepts that are popular today and that we hear frequently. Tokareva explained the reality technologies respectively; Virtual reality involves users in a completely artificial virtual environment. Augmented reality places virtual objects in real environments. Mixed reality, on the other hand, creates a connection between the real world use of virtual objects (Tokareva, 2018). Thanks to new technologies, our digital boundaries are expanding further.

With the development of the Internet and computer technologies, virtual reality has left large laboratories and started to be included in our daily lives. The use of virtual reality has increasingly become popular in areas such as entertainment, health and education (Aslan & Erdoğan, 2017; Baran, 2021; Çavaş etc., 2004; Demirci, 2004; Demirezen, 2019; Tepe, 2022).

The relationship between typography and technology has always been important. Typography consists of symbols used in the visual expression of thought and its purpose is to convey information through writing. Typography consists of designed elements, it is also a product of technology (Yazar, 2020). Typography used in the virtual reality environment has some differences in terms of its use and production to date. New design problems created by virtual reality have encouraged designers to produce different solutions.

In this article, the relationship between virtual reality and typography is examined. The use of typography in different digital environments was investigated according to basic typography principles, and the characteristics of the typeface were emphasized within the scope of the opportunities and limitations brought by digital environments. As a result of studies on virtual reality and typography, a font design was created. In the application study, font design was studied with three-dimensional modeling.

To obtain a realistic experience, the font, designed by taking into account the characteristics of

typography in a virtual reality environment, was tested using virtual reality glasses. In this study, characters were not developed for any sector in the virtual reality environment, only creativity and artistic production were studied.

Examining typography in a virtual reality environment is important in terms of using correct typography in future typography studies. This article plays an important role in seeing and continuing the impact of typography and creativity at the point where technology and communication come together.

TYPOGRAPHY

Typography has its place in every aspect of life. It is found in many places, on street signs, on the telephone, in books. Typography is always communicating with people, sometimes with emotional and sometimes political messages. It is possible to see the presence of typography everywhere.

Typography is literally living with the same dynamism in the flow of life; It is a type of communication that can serve many functions such as teaching, conveying news, informing, attracting attention and satisfying curiosity. Words formed by bringing letters together, sentences formed with words, and accompanying visuals convey messages to people (Bilirdönmez, 2020, p.874). The importance of typography in conveying the message and carrying information has always been important since ancient times.

At the same time, typography has an abstract visuality. According to Hillner, typography is the visual representation of text. It can be said that every typographic arrangement creates the image of a text (Hillner, 2009, p.12). Typography conveys a message with this visual arrangement of letters and words.

The history of typography, of which we come across countless examples everywhere, from digital screens to our keyboards, from t-shirts to signs, dates back to cave times. In this process from past to present, the development of typography has been linked to innovations. Each new trend affected the process, and typography continued its development along with the developing technology.

The word typography is formed by combining the Greek words "typos" (form) and "graphia" (to write) (Kızılşafak, 2014, p.56). When we look at the formation of the term typography, we come across form and text. Typography can be interpreted as the text transformed into a certain form.

With the discovery of writing, the most powerful communication tool from past to present, humanity started a new era and directed communication. According to Sarıkavak, "Writing is a visual expression of language-based communication. "*The most basic indicator and result of human social development*" (Sarıkavak, 2017, p.2). By communicating in writing, people were able to preserve information and pass it on to subsequent generations. The ability to store information and transmit it to new continents and societies has led to new discoveries and inventions in many fields. With this progress, human life has developed and has come to this day.

There are very few resources on the relationship between virtual reality and typography. This paper study examines the development of writing, sees how typography adapts to the virtual reality environment, which is a new medium, understands what kind of a basis it provides for the increasing and developing different digital environments, understands the relationship between the changing medium and typography at the design stage, and how this change in typography is reflected in letter design. It seeks answers to issues such as seeing.

Designing a Font

The terms typeface and font are often confused with each other. This situation is generally experienced in typography terminology. For the term typeface, words such as "*typeface, typeface, font, typographic character, letterform*" may be preferred. Globally, the definition of terms such as font and typeface

may vary (Pehlivan Baskın, 2022, p.106). According to Gavin Ambrose and Paul Harris; The term font is used for physical tools such as stencils, typewriters, letterpress blocks, or fonts produced with PostScript code. Font is a collection of characters, letters, numbers, symbols and punctuation marks with the same special design (Ambrose & Harris, 2012, p.40). Typography is about structuring and organizing visual language. Font design is concerned with the creation of units to be arranged, the characters that make up a font (Baines & Haslam, 2005, p. 6).
The font can convey different messages to us with its form. Fonts not only convey information to us, but also convey emotions. The article communicates both with the reader and with the subject it covers.

> The basic structure that creates typography, that is, designed writing, and is its skeleton is the 'letter'. The letter, which has survived from pictography to the present day, represents, in addition to its own geometric structure, the personal characteristics, cultural structure, belief characteristics, geographical features, social and social structure of those who designed it. (Kaptan, 2020, p.124)

The designer must carefully consider how the font he will produce will convey the message and what emotion it will highlight. The font used in an emotional text is different from the font used in an action-themed game. The reason for this is the relationship of the article with the subject. "*With the choice of font, it is possible not only to complete the general atmosphere of the design, but also to provide effective communication that can convey the message correctly even at first glance*" (Işır etc., 2021, p.663).

In the font design process, before starting the letter design, the outline of the first sketch is determined by asking questions such as in what context the design will be used, where it will be located in the context in which it is used (title, text, etc.), who will use it, the content of the message it will convey, and to which audience it will be conveyed. Answering these questions before starting the design plays a big role in making the font a preferred font. It is possible not to choose a font that is not needed, and it is possible that a font that is disconnected from the context in which it will be used may irritate the eyes. For this reason, the production of useful fonts that meet the needs will be more successful. With the information collected, the designer can start his first sketches on paper or digitally. After the final version of the font is decided, the wall thickness is adjusted by working in different thicknesses. Letter studies begin with the capital letters H and O. The straight standards of the capital letters are determined by the letter H, and the round standards are determined by the letter O. For lowercase letters (miniscules), the letters n and o are used to determine straight and rounded lines. The lowercase letter d is used as a reference for setting the ascender, and the letter p is used as a reference for setting the descender (Ambrose & Harris, 2013, p.57). During the typeface design process, the designer must repeatedly check the anatomy. Knowing the anatomy of typography well and understanding the small illusions that letters contain is important for the correct letter design. A successful font should make itself readable and make the reader feel the emotion.

A typeface design can be completed in very different periods of time, from one month to one year. People who design fonts are called typeface designers or typographers. Every designer's source of inspiration and design process is different. The methods of designers who produce font designs are also different from each other. Although there is no exact way to complete the creative process, how and in what time a creative process is completed depends entirely on the designer.

X-Height: It is the general body length of the letters. The height is based on the letter x. It is based on the height of the letter. The x height of each font may be different. Two different. When letters with height X are written side by side (See Figure 1.), it can give the illusion that they are used in different font sizes. As the x-height increases, the areas covered by the letters expand. At the same time, as the area occupied by the line expands, the number of letters that fit on the line decreases.

Figure 1. X-height example (Zeynep Sena Bağrıaçık personal archive).

Baseline or Baseline: It is the imaginary line that the base of the font touches. A fixed position for the baseline is required, otherwise the characters will not be aligned.

Meanline: It is the middle line where the tiny letters between the base line and the top line touch.

Capline: The point where the head of the major letter touches the base line is the imaginary top line.

Ascender: The part that extends to the x height in letters such as "B, d, k, h". In other words, it is the height of the part extending above the middle line of the lowercase letters.

Descender: It is the part of some minuscule letters, "p","y","g", that goes down from the base line (See Figure 2.).

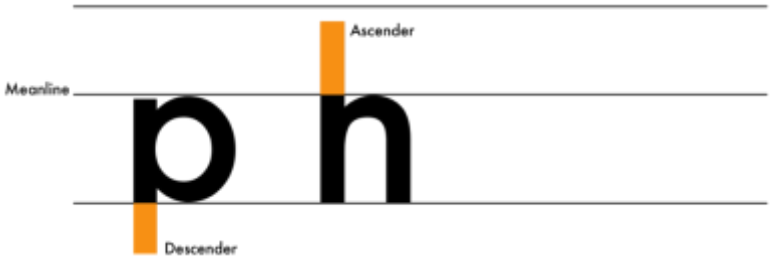

Figure 2. Ascender and Descender extensions example (Zeynep Sena Bağrıaçık personal archive).

Kerning: It is the space between two letters or characters (See Figure 3.). If there is a problem with the spacing between letters, it can be corrected by adjusting the kerning. When equal space is given, the desired arrangement may not be possible. Adjustments should be made by considering the extensions of the letters one by one.

Figure 3. Kerning setting example (Zeynep Sena Bağrıaçık personal archive).

Letter Spacing: It is the space between characters in a text block (See Figure 4.). When adjusting the space between characters, the space should be adjusted by considering the area occupied by the letter itself.

Letter spacing
Letter spacing

Figure 4. Example of letter spacing (Zeynep Sena Bağrıaçık personal archive).

Leading: The distance between the baseline and the base of the top or bottom line is space.

Serif / Sans-Serif (No Serif): Basic fonts are classified into two main categories as "Serif (With Serifs)" and "Sans Serif (Without Serifs)" (See Figure 5.). "Serif" fonts have small lines at the end of the accent that intersect with the accent, but the "No Serif" font does not have these. A serif is the small decorative line that begins where the letter ends. Sans-serif is defined as a sans serif character.

Figure 5. Serif/ Sans-Serif example (Zeynep Sena Bağrıaçık personal archive).

Italic: Italic fonts are specially drawn and do not have a standard curvature.

Artificial Oblique: It is the slope that the program automatically sets for the letter. The designer does not adjust the slope.

Character: All signs in the font.

When we look at typographic arrangement in texts, the issue we encounter is text alignment. Some errors may occur when aligning text. These are errors that can occur in text editing, which designers called widow and river avoid making.

Text Alignment: Text can be aligned to the right, middle or left of a text block (See Figure 6.) or justified on both sides. Justified texts need to be carefully adjusted as needed. For example, in justified text, the last line has very wide spacing. It is possible to encounter problems like this. It is possible to solve such problems by editing the letters, words and line spacing of the text.

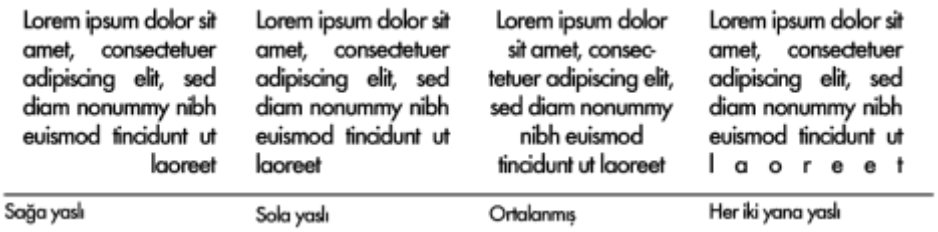

Figure 6. Text alignment example (Zeynep Sena Bağrıaçık personal archive).

Widow: It is the only word left in the last line of the paragraph.
River: It is frequently encountered in text alignment, especially in narrow and long texts (See Figure

7.). Excessive white spaces in between distract the eye from the flow of the text.

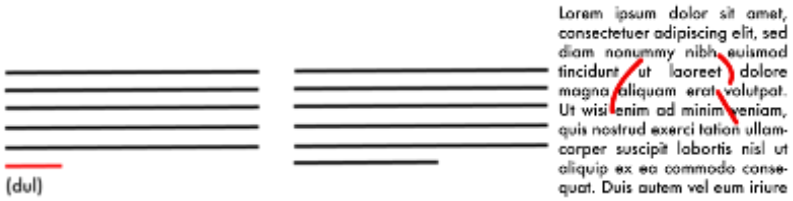

Figure 7. Widow and river bug example (Zeynep Sena Bağrıaçık personal archive).

Typography has a very wide place in the field of design, and knowing the anatomy of typography is one of the knowledge that every designer will need. (Adobe, 2023; Ambrose, Harris, 2012; Kesgin, 2021). Knowing typography terms is important not only for font design, but also for different graphic fields such as editing text and designing logotypes (logos consisting of letters, shapes or words).
Today, when we need a font for any work, we have the opportunity to access countless different fonts on the internet. While most of the fonts are produced by professional designers, some are produced by curious people and students who are educated in this field. Nowadays, it is possible for a person who wants to create his own font to do so easily. It is possible for users to simply convert their own handwriting into a ready-to-use font on the computer by simply using Adobe Illustrator or Procreate programs and the brush tool in a similar interface. In this way, while it becomes easier for those who are curious to gain design experience in a different field, it also causes the emergence of too many fonts on the market.

The format of each font design program is different. Depending on the platform on which the font you designed will be used, it can be exported in one of the formats OTF, OpenType-SVG, WOFF (Web Font), or TTF. With internet technology, it is now possible to access fonts, examine them, obtain them, and try them before purchasing. With font sites, it has become easier to obtain and purchase fonts and obtain information about the font's designer and features (Sarıkavak, 2014, p.90). Although producing fonts has become easier today, this situation does not direct us to produce more fonts, but to produce more creative and convenient fonts. In today's age where every opportunity has become easier, thanks to technology, many things that were difficult to obtain in the past are now available to us without even thinking about it.

Thanks to developing computer technologies, there are various programs for font design. There are various typeface and font design programs available, both paid and free, such as Fontlab and Glyps. "*Today, all fonts produced are drawn on a computer with software such as FontLAB Studio, Fontographer, Font Creator, some after going through a sketch stage on recording, and become available as OpenType or TrueType*" (İpek, 2016, p.799). The programs available today are quite practical and easy to use.

Virtual Reality Technology

Virtual Reality Technology (VR), has become one of the most important technologies of today. Today, virtual reality technology can provide many opportunities to its users. Virtual reality technology, also known as experience technology, provides convenience in areas that are very costly to experience or have limited access due to difficult conditions in real life. For example, providing training on the subject or gaining experience for the user in a virtual reality environment with a space simulation will be both easy and inexpensive. In the coming years, there will be a technological development that we will actively use in our lives.

Virtual reality technology does not have a single definition, but has multiple definitions.

> Virtual is a concept originating from virtualis, which refers to a situation that does not exist but creates the illusion that it exists by directing perception. Virtual Reality, on the other hand,

> is based on the basic principle that the viewer or user is included in a created image space, within an editable time structure, and interacts with it at a later stage; It is an environment consisting of technological tools such as three-dimensional image and sound devices, devices that simulate and reproduce sensory effects such as power, movement and touch, consisting of various data input and output technologies. (Kuruüzümcü, 2010, p.2)

According to Hoffman and Vu; Virtual reality (VR) is a fundamentally different mode of communication between computer and human. It is a highly interactive and dynamic form of simulation in which one can "enter" a computer-generated world or virtual environment. (Hoffman & Vu, 1997, p.1).

To briefly define virtual reality, where it is difficult to find a common denominator; It is an experience technology that allows the active use of the five senses and can give the user the illusion of a real feeling in a virtual environment.

Although virtual reality technology remains up-to-date, it is a very old technology. Virtual reality technology, whose emergence dates back to the 1960s, was not as widespread and practical in its early days as it is today. It took a long time to reach today's level. When we return to the years when the virtual reality environment emerged, we encounter literary figures, not scientists. Before a virtual environment was created, imaginary fantasy universes were created in novels and screenplays. Literary writers who are among the most important creators of virtual reality are Ray Bradbury and William Gibson. Using their imagination, they paved the way for the realization of a technological metaphor fictionalized in the texts.

Virtual Reality and Typography

Virtual reality appears as a technological development. Typography is available in all digital media today and is involved in new developments. In this section, the communication of typography with virtual reality within the framework of its interaction with technology will be examined. The effects of virtual reality on typography and the parts that need to be considered in typographic arrangements will be discussed. In virtual reality, freedom of movement with a 360-degree viewing angle gives us a different experience than the two-dimensional environments offered by screen technology so far.

Virtual typographic designs have a separate use and structure from screen and print typography. In virtual reality environments, independent motion graphics and the fact that the user can be on the move at all times create serious differences in the readability of typography and the way it conveys the message. Typography in the screen and printed media we are accustomed to is two-dimensional. In two-dimensional use, font choice is made according to the size of the medium to be used. "*Computers, tablets and phones generally stand or are used at different distances from the user. Apart from having different physical screen sizes, this requires changes in usage distance, font, font size and line spacing*" (Alican, 2014). It can be said that the regulations that apply to screen technologies are different in virtual reality.

The most obvious of these differences is size and perspective in the virtual reality environment. In the virtual environment, virtual typography is mentioned, which grows as the user approaches, shrinks as the user moves away, and does not distort when viewed from different angles. The user's perspective changes many times with the freedom of movement and depth perception in the virtual reality environment. In this case, it is possible for the text's readability to decrease and its form to deteriorate. Readability and readability are two different concepts, but they can often be confused with each other. Readability is a measure that evaluates the difficulty, ease and pleasure of reading. Legibility is the value criterion of an efficient and understandable reading (Pehlivan Baskın, 2022, p.176). Readability, the width of the screen or the surface to be printed, point size according to the area to be used for the text, line spacing, spacing, paragraph spacing and whether the font is serif, sans-serif or condensed are the criteria that affect readability. Since there is no screen in the virtual reality environment, it is not possible to adjust the readability according to a screen size. The text is part of the medium. The most

important thing to consider to ensure readability in the virtual environment is perspective.

> In virtual typography, the interaction between the user and the text is two-way. So not only does the user interact with the text, but the text also interacts with the user. This interaction is shaped by the user's relationship with the text and can show predetermined attitudes or improvised results. One of the primary topics of discussion in virtual typography is the reconsideration of traditional typography's relationship with readability and visibility. Virtual typography includes not only the geometric but also the formal transformation of the text in the axis of movement and time into the communication process. In other words, with the movement of the writing, it makes its transformation real not only physically but also conceptually and emotionally. (Atiker, 2019)

Although it is difficult to use typography in a virtual reality environment, the method of conveying the message or emotion has also changed. Virtual typography, which has different aspects, does not require full readability; especially in artistic works and games. However, the same situation is not valid for every virtual environment. For example, readability is required in a virtual navigation application, and the typography used here must be resolved in a way that is readable from all angles. With virtual reality, users' relationship with typography has changed, and the process of reading a text has become a more difficult experience. Designers' analysis of typography also varies depending on which virtual reality application it will be used for.

Those who produce work in a virtual reality environment are expected to be knowledgeable about modeling. In order to produce in a virtual reality environment, it has become a necessity to know a few of the various modeling programs.

Modeling is creating a three-dimensional product of an object or surface with polyons, edges and vertices. "Animation use of 3D designs has increased greatly since the 1990s. Research conducted; The use of 3D designs, printers and 3D animation has proven to make industry processes smoother, more economical and more attractive. Designs can be viewed on screen before wasting material, and they can customize designs as they see fit without any consequences. Defects in designs can be identified and changed. This technology is important for users to experience. "*This also means it is more widely available, cheaper and easier to build*" (Boratav & Yozgat, 2021, p.1481).

In the virtual reality environment, modeling is essential for environment design, interface design and the creation of similar things such as characters and products to be used in virtual reality. Modeling programs provide the opportunity to create a design in which we can see three dimensions on the x, y, z axes. The modeling to be used in the virtual reality environment must be suitable for the 360-degree viewing angle and perspective of virtual reality.

The modeling phase in virtual typography is important in terms of its effect on the correct readability and perception of the text. With good modeling, an effective design can be created in the virtual reality environment, it can influence users in a way that will increase their feeling of being in the virtual environment, and a successful experience can be provided in every aspect.

In virtual reality, rectangular vision is replaced by 360-degree spherical vision (Erkılıç & Dönmez, 2018, p.49). In the virtual reality environment, the reading system we are accustomed to today has taken on a more complicated structure. As the virtual reality user changes angles at any time, the text will constantly come into view from different angles. In this case, stable texts need to be positioned in accordance with different angles from all directions, which is quite difficult. Designers' consideration of the angle that can be perceived by the human eye (45 degrees) as a basis will contribute to text placement. With virtual reality, texts move out of two dimensions and become three-dimensional. "*Even though perspective allows creating images close to the perception of three dimensions, what we have is still not a model, but an image of the model. The model can be changed or tested if desired, but*

the perspective does not allow this" (Felek, 2019, p.16). Although it does not seem possible at the moment to organize the perspective in virtual reality and calculate all possible perspective angles, virtual reality designers should be careful when placing text in line with the possibilities.

Implementation Work

Typography study in virtual reality environment is a step towards the use and analysis of typography for virtual reality technology. Today, virtual reality technology is a popular technology and reaches more users every day. Virtual reality technology is quite remarkable with the digital features it can offer us in today's conditions. In the future, today's conditions will continue to develop further, and this will lead to more widespread use of virtual reality, as well as a higher probability of it being preferred as a more comprehensive technology. Considering the increasing use of virtual reality and the rapid advancement of technology, there is a need to analyze the text design used in the field of virtual reality. In this direction, a font design was made for the virtual reality environment. The font design is shaped according to the needs and features of a virtual environment and is designed in a form suitable for the virtual environment**.**

The font designed for the virtual reality environment is not intended for use in any specific interface or concept. The designed font design was designed assuming that it can be used in virtual environments under appropriate conditions, like today's fonts.

Users can encounter various typographic uses such as preference menu or promotional text in the virtual reality environment. There is a need to use three-dimensional typography because the typography used can be seen from constantly changing perspectives. With the 3D produced letter, the letter will be given dimension. It is possible for the volume and size of the letter to support readability when viewed from different angles.

Font design started with sketches in the first place. After the sketch phase was completed, Adobe Illustrator program was used to vectorize the designed font. All letters, numbers and punctuation marks of the font were pathed and turned into vectors in the Adobe Illustrator program. In order to size the vectorized letters, the Blender program, which allows three-dimensional modeling, was used.

The sketching phase first started with freehand drawings. Various drawings were made. After the preliminary draft studies, more detailed sketches were made on grid paper.

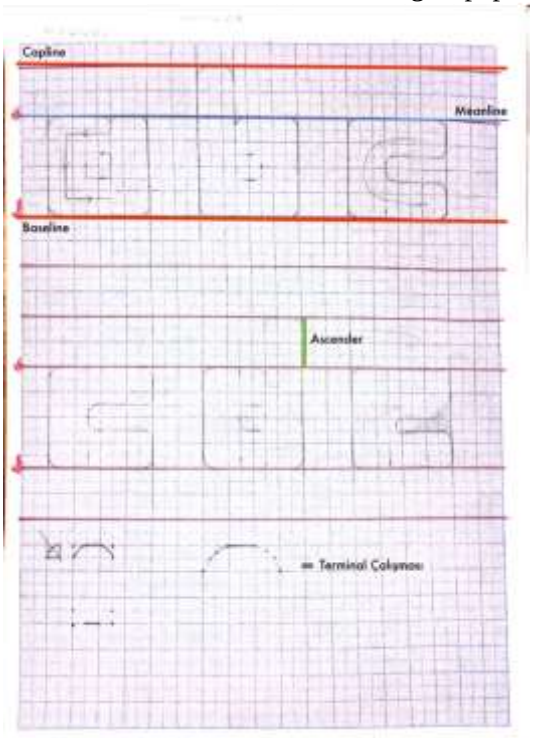

Figure 8. Sketch work miniscule example (Zeynep Sena Bağrıaçık implementation work).

Different styles of sketches were tried. During these experiments, angular square shapes were inspired. Based on cubic forms, thick, plump-looking drawings without thin folds and corners were made. A sans-serif work was done, far from details. It was not preferred in the angular test of the terminals due to the effect created by the sharp corners. A softer appearance was desired. It is adjusted so as not to disrupt the cubic structure.

The entire alphabet is completed in sketches. First, the studies on the lowercase letters were started. After the miniscule letter set was completed, the studies on the capital letters continued. When the sketch phase of the capital letters was completed, punctuation marks and numbers were started, respectively.

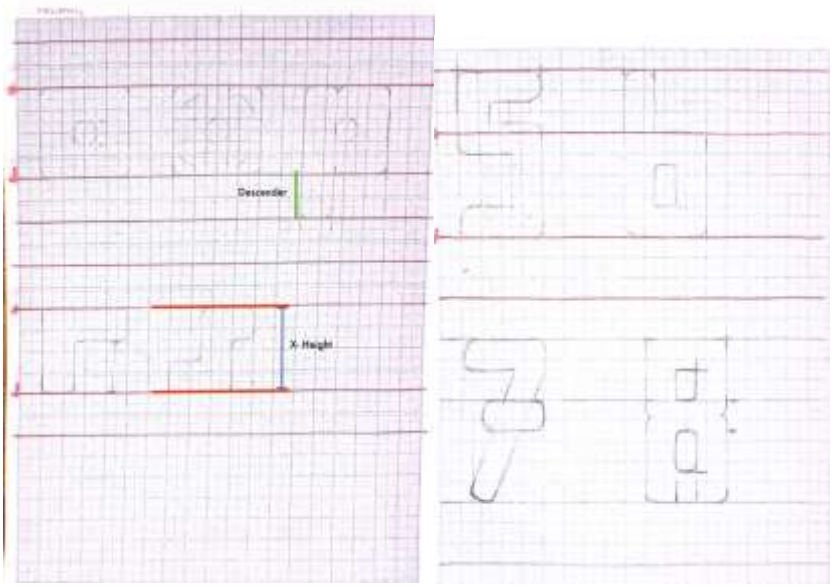

Figure 9. Sketch work, magiscule and number example (Zeynep Sena Bağrıaçık implementation work).

The drawings completed on grid paper were scanned and transferred to the computer environment. The drawings transferred to the computer environment were opened in the Illustrator (a.i) program. Minimal and major letters, punctuation marks and numbers were turned into vectors, respectively.

Letter designs lose their readability when using small font size. It would be best to choose them in areas where they can be used larger, such as headboards.

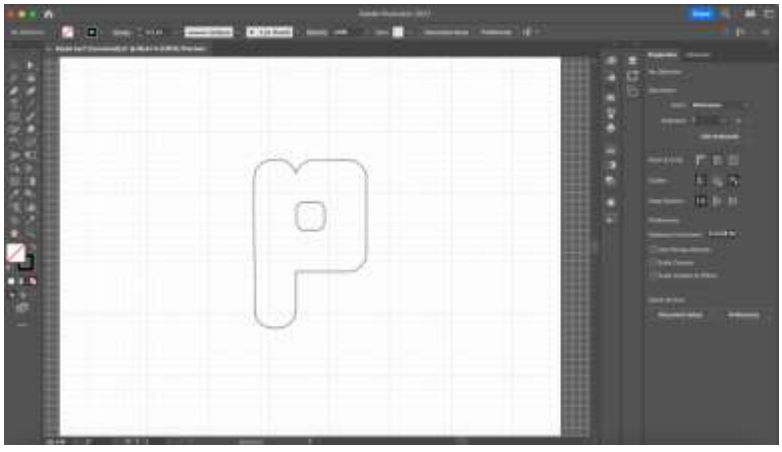

Figure 10. a.i letter work screenshot (Zeynep Sena Bağrıaçık implementation work).

Figure 11. a.i punctuation marks screenshot (Zeynep Sena Bağrıaçık implementation work).

Choices in letter design were made according to the virtual reality environment. Its features such as wall thickness and a structure without details were preferred based on the studies on the virtual reality environment. Letters need to be modeled in order to gain a three-dimensional form. Therefore, it was aimed to create a design that would also work in the form it would have when modeled. Only Blender (version 3.4.1) was used in the three-dimensional modeling process.

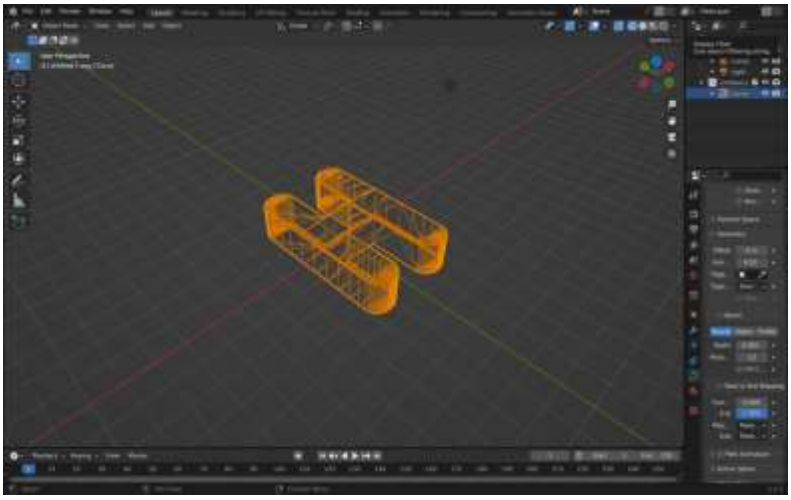

Figure 12. Blender program screenshot. (Zeynep Sena Bağrıaçık implementation work).

Vector designs were opened in object mode in Blender. We can use the Extrude option when we come to the Geometry section in the Curve settings (located in the right tool bar). The letter appearing as Path has been extruded. There are parts of the extruded letter that appear sharp. To soften this sharpness, the Depth setting was made from the Bevel Option option. In this way, the sharp parts are softened.

The color of the letter has been adjusted in the Shading section. The thickness, color preference and texture of the font were adjusted considering that it would attract attention in a virtual reality environment. The dynamic, moving structure in the virtual reality environment was designed and modeled assuming that it could be read and attract attention on a moving background.

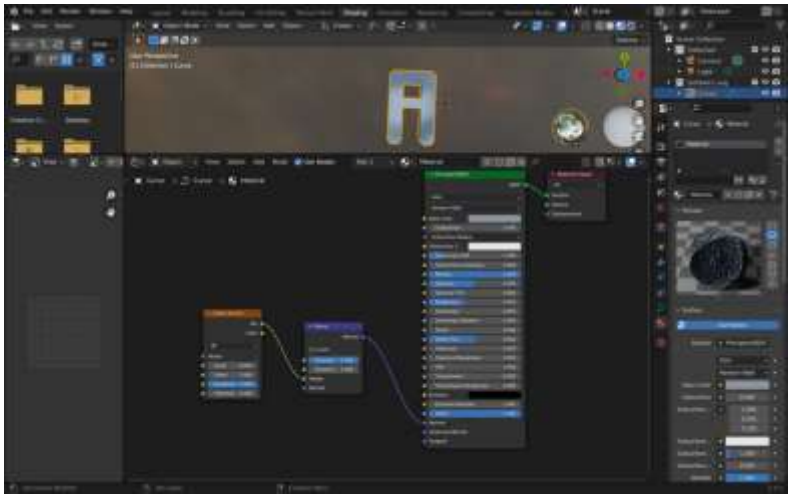

Figure 13. Blender program screenshot. (Zeynep Sena Bağrıaçık implementation work).

The designed font was placed in a scene in the Blender program. It is possible to upload the video and visual outputs (render) obtained here to a free VR video player and experience them. There are many paid and free program options in the field of virtual reality. It is possible to experience many videos suitable for VR display that have been prepared or are available on the internet, thanks to paid and free VR video player sites and applications. Virtual reality glasses can be sorted from high to low price. Nowadays, it has been determined that virtual reality equipment requires a high budget. Thanks to VR-supported glasses with a simpler structure on the market, curious people of all budgets have the opportunity to experience virtual reality. The outputs (render) of this application work have been prepared to be experienced in a VR video player with a smartphone-supported VR glasses.

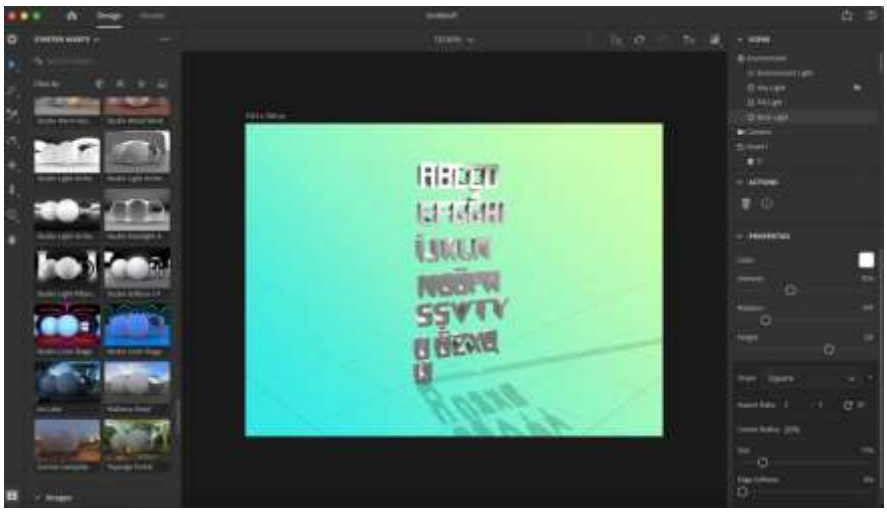

Figure 14. Adobe Dimension screenshot. (Zeynep Sena Bağrıaçık implementation work).

Adobe Dimension program was preferred for sample designs. Letters saved as objects were transferred to the Adobe Dimension program using the 3D Material tool in Illustrator. Texture and material were added to the letters with the Dimension program. Background colors of letters with added metal texture Dimension program was added with. The color scale, materials and textures available in the program were used.

Different textures were tried on the letters with the Adobe Dimension program. Metal and glass materials were preferred in the prepared images. Environment visuals were also used within the program.

Minuscule and major letters are shown with the modeled letter set. Images have been prepared to show how the font designed in sample uses might appear in a virtual reality environment. The font can be used in a virtual reality environment on a nearly transparent background, as in the examples. The structure of the preferred ground was chosen based on the effect of virtual reality on vision. The reason for creating a panoramic screen effect is that it is thought to provide visibility from varying angles depending on our head movement. At the same time, the font can exist freely in the virtual environment without the need for any background.

Figure 15. Minuscule letter. (Zeynep Sena Bağrıaçık implementation work).

Miniscule letters are shown from a side angle with metallic texture. The letters, which use a metallic texture with reflections on a gradient background, are placed at an angle so that their size can be understood. Capital letters are shown with metallic texture on gradient background. In order to understand the three-dimensional volume of the letters, they are placed at an angle and shown.

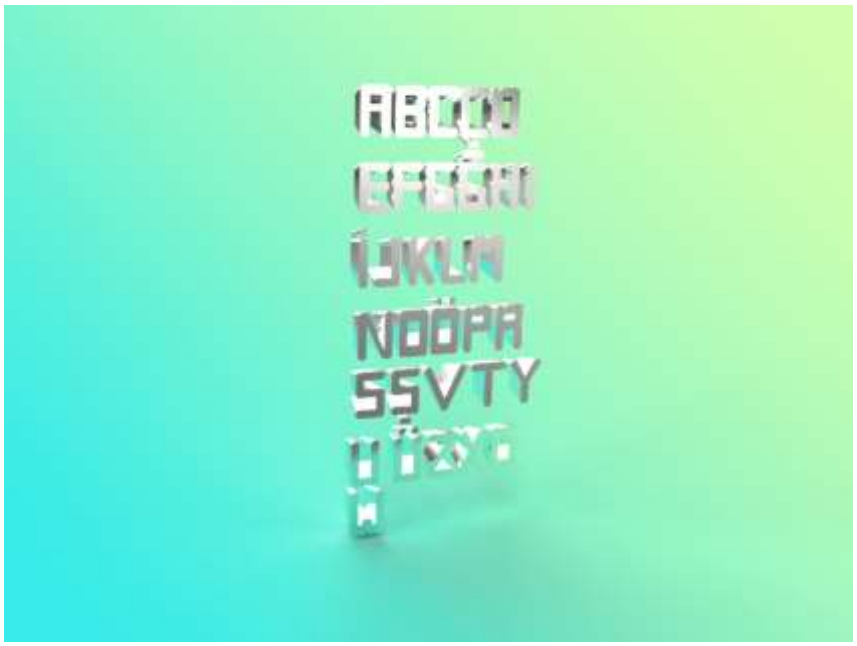

Figure 16. Major letter. (Zeynep Sena Bağrıaçık implementation work).

Figure 17. Example usage 1. (Zeynep Sena Bağrıaçık implementation work).

In this design, it is a plate used on the back as a screen. An elliptical half plate with a glass texture was used to separate the text from the background.

Figure 18. Example usage 2. (Zeynep Sena Bağrıaçık implementation work).

The navigation application was considered as another example. It is assumed that a virtual navigation application provides a realistic map or directions within the existing space or environment. In this

design, a study was carried out in which the directions in these directions were specified in three dimensions on the space.

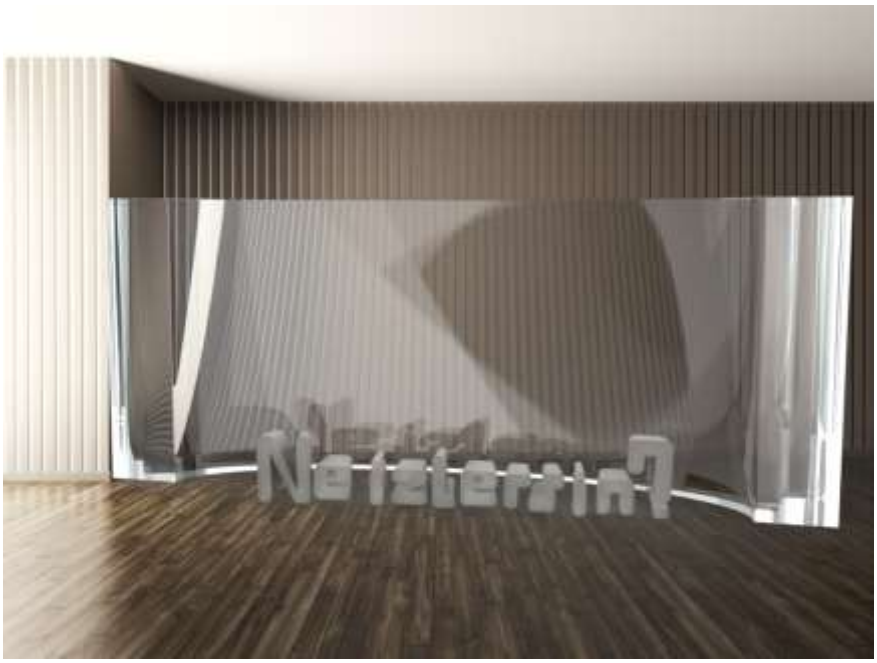

Figure 19. Example usage 3. (Zeynep Sena Bağrıaçık implementation work).

In the designs, the use of fonts in the virtual reality environment is exemplified. Studies have been carried out to create ideas about various uses of the designed font in a virtual environment.

CONCLUSION

In this study, virtual reality technology, one of today's popular technologies, was investigated. Research shows that virtual reality technology takes a more active role in daily life and the number of users is increasing. This situation causes different design needs to arise in the virtual reality environment. Designers need to follow new technologies, and when producing design solutions, they should be based on the changes brought by technological innovations. With virtual reality technology, the boundaries have expanded and the opportunity to produce more free and original works has arisen. Innovative typographic uses have revealed situations that can create changes in the known rules of typography.

In the research, there are suggestions on the use of typography in the virtual reality environment according to typography rules. When a font design is produced in line with these recommendations or an existing font is used in accordance with the recommendations, it is assumed that it will be used correctly in the virtual reality environment. The use of typography in new digital areas plays an important role in terms of affecting the design process, reaching users and affecting the font production process. It has been determined that due to the dynamic structure of virtual reality environments, attention is quickly distracted and text reading time is quite short. As another issue, it was understood that letter legibility decreased due to the movement brought by the dynamic structure. Thanks to the three hundred and sixty degree viewing angle of virtual reality, it is possible to view the typography used from different angles. Additionally, the distance between the user and the typography is not stable. The user adjusts the distance to the typography himself, and can try reading from close distance, long distance or from completely different angles, depending on his wishes. The application study is designed to address certain points. In line with the problems identified as a result of research on virtual reality, the font design designed in the application study was adjusted to be read from different distances.

Studies have been made on typography and virtual reality technology. As a result of the examinations,

findings were reached about the use of typography in the virtual reality environment and the font design process and application. The application study was developed within the framework of the findings. The completed application work complies with the virtual reality environment criteria. A sample font design is shown in the virtual reality environment with the application study created. It is thought that this case study will guide designers, design students and enthusiasts working on virtual reality.

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