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Sanat&Tasarım Dergisi, 15 (Özel sayı), 2025:407-432
Derleme Makalesi / Review Article
Geliş Tarihi / Received: 06.03.2025
Kabul Tarihi / Accepted: 19.05.2025
DOI: 10.20488/sanattasarim.1804333

Three Dimensional Illustration: New Approaches In Graphic Arts*

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ABSTRACT

With the pervasive integration of computing technologies into everyday practice, digital illustration has assumed a central role within the visual arts and graphic design disciplines. Contemporary digital illustrations are generated primarily through three modalities—raster-based software (e.g., Adobe Photoshop), vector-based applications (e.g., Adobe Illustrator), and three-dimensional modelling environments (e.g., Blender, Cinema 4D, Autodesk Maya). By alleviating many of the technical constraints inherent in traditional media, these digital platforms afford designers unprecedented aesthetic versatility and opportunities for innovative expression. In particular, three-dimensional illustrations may be produced either by constructing diorama-like physical scenes—carefully lighting and photographing models from predetermined vantage points within a fictional framework—or by directly creating volumetric forms in a virtual workspace. The resulting three-dimensional data not only enriches spatial perception but also facilitates the precise communication of intended messages. Employing a descriptive-analytical methodology, this study examines the role and significance of three-dimensional illustration in graphic design, offers a theoretical definition of the discipline, and proposes a coherent taxonomy for its principal subcategories. Findings indicate that applications of three-dimensional illustration extend far beyond animation and gaming to encompass medical, technical, and educational imagery, as well as editorial and print media such as posters and book illustrations. Accordingly, it is recommended that the adoption of three-dimensional illustration be expanded within the graphic design sector in Türkiye.

Keywords: *Graphic design, Illustration, 3D illustration, Three-dimensional illustration.*

* This article has been produced from the unpublished proficiency in art thesis "Lec. Sema YOZGAT/ Ankara Hacı Bayram Veli University / Institute of Graduate Studies, Department of Graphic Design / Advisor: Assoc. Prof. Dr. Tutku Dilem ALPASLAN "3D Illustration in Graphic Design:ZBrush".

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ÜÇ BOYUTLU İLLÜSTRASYON: GRAFİK SANATLARDA YENİ YAKLAŞIMLAR*

•Öğr. Gör. Sema YOZGAT**

ÖZET

Bilgisayar teknolojisinin günlük yaşama entegrasyonu ile birlikte dijital illüstrasyon, görsel sanatlar ve grafik tasarım disiplinlerinde önemli bir konuma ulaşmıştır. Günümüzde dijital illüstrasyon; raster (Adobe Photoshop), vektörel (Adobe Illustrator) ve üç boyutlu modelleme (Blender, Cinema 4D, Autodesk Maya vb.) yazılımlarıyla üç ana kategoride üretilmektedir. Dijital ortamlar, teknik sınırlamaların azalması sayesinde tasarımcılara estetik çeşitlilik ve özgün ifade alanı sunmaktadır. Özellikle üç boyutlu illüstrasyonlar, fiziksel ortamda diorama benzeri sahnelerin ve karakterlerin kurgu çerçevesinde ışıklandırılıp belirli açılardan fotoğraflanması yoluyla ya da doğrudan dijital ortamda modellenerek oluşturulur. Elde edilen hacimsel veriler, mekân algısını güçlendirerek hedeflenen mesajın etkili biçimde iletilmesini sağlar. Bu çalışmada, üç boyutlu illüstrasyonun grafik tasarım alanındaki yeri ve önemi betimsel analiz yöntemi ile incelenmiş; buna ek olarak, çalışmada üç boyutlu illüstrasyonun tanımı teorik olarak ele alınmış ve ilgili alt kategoriler tutarlı bir taksonomiye dayanarak sınıflandırılmaya çalışılmıştır. Bulgular, üç boyutlu illüstrasyonların yalnızca animasyon ve oyun alanlarıyla sınırlı kalmayıp, grafik iletişim tasarımı bağlamında dünya çapında tıbbi, teknik, eğitimsel ve kitap illüstrasyonları ile afiş gibi basılı materyallerde yaratıcı ve estetik değer sunduğunu ortaya koymaktadır. Bu doğrultuda, üç boyutlu illüstrasyonların grafik tasarım alanında ülkemizde de daha yaygın biçimde kullanılması önerilmektedir.

Anahtar Kelimeler: *Grafik tasarım, İllüstrasyon, 3B illüstrasyon, Üç boyutlu illüstrasyon.*

* Bu makale, Sema YOZGAT/ Ankara Hacı Bayram Veli Üniversitesi/ Lisansüstü Eğitim Enstitüsü Grafik Tasarımı Anasanat Dalı/ Danışman Doç. Dr. Tutku Dilem ALPASLAN/ "Grafik Tasarımda 3B İllüstrasyon:ZBrush" başlıklı yayınlanmamış sanatta yeterlilik tezinden üretilmiştir.

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1.INTRODUCTION

The use of three-dimensional elements in the field of graphic design and illustration, with the desire to overcome the limits of traditional two-dimensional expression, initially emerged as an effort to create the illusion of depth with shading and perspective tricks, and since the early 21st century, digital 3D modelling, real-time rendering and interactive applications have both expanded the creativity of designers and transformed the viewer experience. As Shan Wu notes, 3D digital art in packaging design goes beyond flat product photographs to create aesthetic impact and emotional connection (Wu, 2022), while Lican Chen emphasises that 3D software strengthens both visual impact and freedom of expression in disciplines such as advertising, animation and education (Chen, 2020). Finally, studies on the potential of photo-realistic, animated or AR-enhanced 3D illustrations in children's books to capture the reader's attention and enrich the learning experience show how this technology has evolved from a mere innovation to a universal design standard (Головачук, Воробчук, Лелик & Шмельов, 2023).

In this study, in order to examine the use of three-dimensional illustration in graphic design products, firstly a conceptual framework will be established; the definition of illustration and its different forms of formation, as well as the views of local and foreign illustrators on developing technologies and methods will be compiled and analysed. Three-dimensional approaches will be positioned under the title of digital illustration and it will be emphasised that these techniques are applicable not only in the virtual environment but also in the physical world. Then, using visual and content analysis method, the differences in three-dimensional modelling will be systematically classified under the sub-heading of three-dimensional digital illustration. Finally, how the visual elements obtained from three-dimensional modelling are applied as three-dimensional illustration in scientific design products that cannot be photographed, such as book covers and advertising posters, will be revealed through case studies.

2. ILLUSTRATION

The art of illustration is a branch of art that has existed for centuries. The techniques used vary simultaneously with the developing technology. It is used as a visual language in products such as advertising and press-publication. As it reflects the artist's feelings and thoughts, it is generally designed to explain the service provided with commercial concerns. Illustration book covers, children's books, posters, advertising posters, packaging, websites, social media designs have been used in many media to shape public opinion and influence large masses. Children's book illustrations have been used to enrich

their imagination and improve their learning skills. In addition, illustrations have the power to draw attention to social issues by creating imaginary worlds that serve practical purposes.

Illustration is the visual transfer of an idea to a surface with various tools. A figure or an object gains a form by being limited by contour lines. Forms gain volume with toning. With color, it is given an identity. Illustration, known as "resimleme" in Turkish, is a word of French origin. According to the Etymology Dictionary, the French word illustration originates from the Latin word illustrare. The word illustration, which is used in the meanings of enlightening, illuminating and explaining, is also used in the sense of decorating with pictures (Illustration, 2017). Andrew Loomis states that the primary function of illustration is to make a graphical interpretation of an idea. With illustration, an abstract idea can take on a real appearance. Therefore, a picture without an idea or a defined purpose cannot be considered an illustration (Loomis, 1947, p. 178). Mustafa Aslıer, who has an important place in the history of Turkish graphic design, states that book illustration was first born from ornamentation. Written sources were tried to be beautified with motifs to make them more attractive. The second reason for the emergence of book illustration is to ensure that the text is understood, adopted and understood even by those who cannot read and write (Aslıer, 1981, p. 22-23). Founded in 1993, according to the Turkish Illustrators Association, the definition of illustration is as follows:

> "It is the most common type of illustration applied to depict and explain texts and ideas. It is one of the most important factors that produce visual solutions in promotion, advertising and design media. Illustration complements the text to which it is related and helps it to be perceived again in different meanings and dimensions. Illustration arouses an aesthetic pleasure in the reader/audience with the different interpretations of the pictorial value it contains, fusing with the artist's original character. This aesthetic pleasure is realized with the power of illustration, which is elevated to the level of art; reflecting, endearing and contributing to the transformation of life." (İşli & Durmaz, 2018).

Turkish art historian Prof. Dr. Selçuk Mülayim likens illustration to miniature, the Turkish-Islamic art of painting. According to him illustration, just like miniature, explains the text and the miniaturist paints it according to his own fantasy while remaining faithful to the text (Mülayim2010, p. 127-128). The primary purpose of illustration is to convey an idea. The technique used is its secondary purpose. It is designed to clarify a subject with visual tools (Doyle, Grove & Sherman, 2019, p. 2).

Technological innovations, which are developing day by day and whose speed cannot be kept up with provide advantages to achieve fast and effective results in the field of design. In the field of illustration, which is a field of art and design, technological possibilities provide convenience compared to traditional methods. The use of different techniques

in illustration design adds richness to the field in terms of creating effective visual stories. In an interview in 2020, Turkish academic and world-renowned illustrator Gürbüz Doğan Ekşioğlu emphasized the importance of using different techniques in illustration. In particular, he stated that he admired illustrations produced with digital technology (Bozyel, 2020). Ukrainian illustrator Vladyslav Yerko states that there are no technical limitations in illustration; "In my experience, every illustration can be done in thousands of ways, but no one knows which is the best way. Artists cannot explain it in any way. If anyone can explain it, it is a writer, art critic or therapist." (Yerko, 2019).

Illustration is one of the visual elements used in the field of graphic design to convey the message to the target audience more effectively. In illustration, where abstract emotions are concretized, an emotional bond is established with the audience. In addition, the identity of the brand is reflected in an original and creative way in advertising designs with illustrations. Increasing the aesthetic value of the design, illustration is a memorable visual communication tool in conveying information. Just like the misconception that illustration would disappear when photography was invented two hundred years ago, in recent years with the production of visuals with artificial intelligence tools, there has been concern that the field of graphic design will disappear. Photography is a reflection of things that exist in reality. Illustration, on the other hand, is an extraordinary painting that reflects the artist's imagination and ideas. Recent technological innovations are being integrated into the field of art and design by artists experimenting with different approaches. But no innovation can overshadow Michelangelo's Pietà.

3. DIGITAL ILLUSTRATION

These visuals produced with digital tools are called digital illustration. Digital illustration refers to artistic visuals created using various software and digital tools and has a wide range of uses in many visual media fields such as graphic design, animation, game development and advertising. Offering artists the opportunity to experiment with different color palettes, layers and effects, the digital medium is a unique platform that supports creativity. Furthermore, the fact that these illustrations can be easily edited, saved and shared in different formats makes them extremely popular in the modern world of media and communication.

When it became clear that traditional narrative illustration was insufficient to meet the needs of the time, the communicative image was reshaped after World War I to reflect the advanced visual ideas of the period and the machine age. In this process, images went beyond merely conveying narrative information and became an important tool for

conveying ideas and concepts, thus the conceptual image emerged. This new understanding was deeply influenced by 20th century art movements. Cubism's spatial arrangements, Surrealism's approaches based on changes in space and scale, Expressionism and Fauvism's use of pure color purified from natural resources, and Pop-art's techniques of recycling mass media have been inspiring elements in the development of the conceptual image. Graphic designers found more opportunities for self-expression during this period and became pioneers of individual styles and techniques. Over time, the traditionally clear boundaries between fine art and visual communication for the public were gradually erased. In this process of transformation, Poland, the USA, Cuba and Germany were among the leading countries in the creation of the conceptual image. Graphic designer Armando Testa, one of the important names in this field, produced remarkable works by utilizing metaphysical combinations to express a subject with basic truths (Meggs, 1983, p. 390).

The development of computer graphics began in parallel with the birth of computer engineering. The ability to see is a fundamental skill that enables people to understand their environment and express their thoughts. With the introduction of computers for visualization, virtual realities were created that went beyond the imagination. Although the first computers were large and cumbersome devices, programmers tried to show their artistic side even with these limited possibilities.

MIT student Ivan Sutherland's 1963 Sketchpad for the TX-2 computer—written in an object-oriented language—introduced user-interface elements and laid the groundwork for CAD systems, enabling vector drawing with a light pen, predefined shapes, object copying and image saving. In 1967, Sutherland and David Evans founded a computer graphics research center at the University of Utah, which became Evans & Sutherland in 1968. There, pioneers such as John Warnock (PostScript), James Clark (Silicon Graphics, Netscape), and Edwin Catmull (Pixar) advanced real-time rendering, 3D graphics and image devices. As film and television sought digital imagery, limited hardware prompted algorithmic innovations like Pierre Bézier's 1962 curves for Renault—now the basis of the pen tool in vector and 3D programs—critical to typography and CAD. In 1971 at Utah, Henri Gouraud devised smooth shading for 3D surfaces and modeled the first 3D human face; in 1973, Bui Tuong Phong developed a more realistic lighting algorithm. The Intel 4004 (1971) matched ENIAC's 1946 performance in a matchbox-sized chip, and the 8088 (1979) powered the IBM PC (1981). In 1972, Sutherland's team—including Phong, McDermott, Clark and Rom—created a 3D Volkswagen Beetle model in Sketchpad (Novikov, Firsov & Karşakova, 2021, pp. 284–286).

Key peripherals and platforms followed: Douglas Engelbart's mouse (1968); ARPANET

(1969); Apple II (1977); IBM PC (1981); Adobe Systems (1982); and the Macintosh (1984), which, despite its black-and-white display, pioneered desktop publishing (Wands, 2006, pp. 24–28). Apple's 1984 commercial boosted the Mac's profile; the color-capable Mac II (1987) and Knoll brothers' Image Pro (later Photoshop) transformed digital illustration (Zeegen, 2010, p. 21). By the late 1980s, Apple (Macintosh), Adobe (PostScript, Photoshop) and Aldus (PageMaker) had digitized graphic design workflows. Throughout the 1990s, advanced computer graphics reshaped design education and practice, embedding digital technology as a fundamental creative tool (Meggs, 1983, pp. 455–461).

As one of the most important achievements of the information age, computers have assumed a central role and become indispensable in many fields, especially in art education. In addition to facilitating the transformation of designs into functionality, computer technology offers the opportunity to realize faster and more effective works. It transforms the creative process by providing diversity in elements such as shape, texture, color, perspective, volume and animation, which are difficult to create by hand. This technology supports and accelerates the creative process by enabling users to quickly access new formations.

Digital art and illustration, as the outputs of graphic design processes through technological infrastructure, bring together image chains in a holistic image flow until the end user; while the adoption of computer-aided design (CAD) graphics on an industrial scale paves the way for the formation of new commercial fields, the continuous evolution of software tools offers artists more advanced digital expression possibilities every day, and these technological innovations, combined with the intercultural interaction of globalisation, trigger the emergence of new art movements every day (Eren & Dilim, 2022).

Based on digital and new media technologies, digital illustration is an art form that combines human rational thinking capacity and artistic creativity with digital methods. With the advances in information technologies, the art of digital illustration makes its impact felt in all areas of life today (Liu, 2019, p. 1). Digital illustrations designed in the computer environment can be examined under three headings; Illustrations Designed in Pixel-Based Software produced with brush tools, Illustrations Designed in Vector-Based Software consisting of geometric shapes created with bezier curves, and Three-Dimensional Illustrations consisting of three-dimensional objects.

3. 1. Illustrations Designed in Pixel Based Software

Pixel-based images are constructed on a virtual grid of tiny squares pixels each defined by a fixed size, color, position, and grayscale value; image quality thus scales with pixel count. Commonly captured by digital cameras, scanners, and screen-shots, these raster

graphics are edited in software like Adobe Photoshop (first released in 1990 after its 1987 inception by the Knoll brothers), which evolved from monochrome to full color and remains the industry standard thanks to annual feature updates (Photoshop). In such programs, artists draw with "brush" or "pen" tools, often using pressure-sensitive hardware (graphic or drawing tablets paired with stylus pens) to replicate traditional techniques digitally, enabling precise line work and nuanced effects.

Pixel-based digital illustrations stand out as both a technical and aesthetic form of expression in the development process of digital art. Initially a necessary consequence of low-resolution screen technologies, pixel art has become a conscious choice over time and has developed a unique language of expression in the field of graphic design. Today, this art form is considered not only as a reproduction of a nostalgic retro aesthetic, but also as a creative tool that pushes the boundaries of graphical expression. Especially in areas such as posters, logos, animations and video games, simplified forms, limited colour palettes and modular structure can create a remarkable visual effect. Research shows that pixel art offers powerful expression possibilities both aesthetically and conceptually and is effective in the formation of new visual languages (Tokgöz, 2021).

3. 2. Illustrations Designed in Vector Based Software

Vectors are mathematically defined shapes (lines, curves and forms) whose images scale infinitely without loss of quality, as their resolution is determined at render time by output devices (monitors or printers). Common tools include Adobe Illustrator (first released for Mac in 1987 (Illustrator)), CorelDRAW, Inkscape, FreeHand and Canvas. Unlike raster graphics whose resolution (ppi) is fixed by pixel count and can only be down- or up-scaled at quality expense vector artwork is stored as formulas and converted to pixels only when needed. While vectors can be rasterized (with minimal shape distortion), rasters cannot be turned back into true vectors.

CorelDRAW, as an alternative program to Adobe Illustrator, is widely preferred especially in the printing and advertising sector in Turkiye. Adobe Illustrator, on the other hand, is more frequently used in advertising agencies due to its international popularity. Various works such as logo design, packaging design, infographics, font design and vector illustrations can be done with vector-based programs. According to Dey, Adobe Photoshop (41.7%) and InDesign (26.1%) rank first and second in terms of product group, Illustrator ranks third (12.3%) and CorelDRAW ranks seventh (1.34%) (Dey, 2024).

As stated in the article "Two-Dimensional Analysis of Digital Images through Vector Graphic Editors in Dentistry: New Calibration and Analysis Protocol Based on a Scoping Review" by López et al; Vector Graphic Editors feature unlimited scalability,

allowing objects created by means of mathematically defined curves and nodes to be reproduced at any scale without loss of quality; they also provide a high level of compatibility between storage, transfer and output media thanks to their much smaller file sizes compared to their bitmap-based equivalents and support for multiple formats such as EPS, PDF, SVG, etc. With functions such as linear and angular measurement, image calibration, object-based editing and file migration, these programs significantly increase the objectivity and reproducibility of two-dimensional visual analysis protocols, thus paving the way for both maintaining aesthetic integrity in graphic design and illustration processes and obtaining consistent data in applications requiring scientific precision (Rodríguez-López, Escobedo Martínez, Junquera, García-Pola, 2021).

3. 3. Illustrations Designed in Three Dimensional Software

Software that helps to make three-dimensional models are three-dimensional programs such as Blender, Autodesk Maya, Autodesk 3ds Max, Cinema 4D, Rhinoceros, SolidWorks, ZBrush, Subtance Painter, Houdini, Unity and Unreal Engine. In these programs, the surface of the modeled objects or characters is given an appearance by coloring or adding texture surface. The scene created in the virtual world is rendered into its final form, i.e. image file, in rendering engines within the program or in rendering software such as V-Ray, KeyShot, RenderMan, Maxwell Render. Three-dimensional programs are often used in the game, animation and film industry.

Three-dimensional illustration is a type of illustration in which visual elements consist of three-dimensional objects. Illustrations consisting of digitally modeled elements can be called three-dimensional digital illustration. This illustration, which is considered as an alternative to illustrations designed on a two-dimensional surface, is preferred by designs in search of a different type. Three-dimensional illustrations designed through three-dimensional software can evoke a more realistic and remarkable effect on the viewer with the materials used and the lighting in the virtual environment. In addition, compared to two-dimensional illustrations, objects created with three-dimensional modeling allow objects to be viewed from different angles without the need for remodeling, enabling versatile and flexible visual production from a single digital model.

4. THREE DIMENSIONAL ILLUSTRATION

Mengü Ertel, one of the important names of Turkish poster design, stated that many fields are utilized in graphic arts and that there is no clear technical limit in graphic design. Ertel also emphasized the lack of three-dimensional effect in the designs of graphic artists (Madra, 2009). In this context, the three-dimensional effect in graphic design

products can be achieved through the use of three-dimensional illustration. In order to create a deeper visual effect by overcoming the limitations of two-dimensional spaces, research on the integration of three-dimensional elements in artistic expression and developing innovative techniques will bring an innovative approach to the field of graphic design.

"The graphic designer cannot afford the folly of limiting conceptualization and thinking to only two dimensions." (Blanchard, 1984, p. 35). Historically, it has been thought that the left brain represents scientists and the right brain represents artists. Although it was assumed that individuals with technical intelligence could not engage in art, many great artists in history are also architects, mathematicians and inventors. Artists with technical intelligence are individuals who can use both halves of the brain effectively. Today, designers who produce art using computer technology have the qualities of these great artists. For a trained and talented artist, the computer acts as a brush or a pen (Weishar, 2004, p. 11). Illustrators, on the other hand, continue to explore new fields of application to improve their skills (Hall, 2011, p. 182). According to Bülent Erkmen, in an effort to diversify expression methods and create new forms of expression, even a crumpled paper can be considered an illustration (Erkmen, 2021).

Ilisulu, one of the first researchers to express three-dimensional illustration in our country, states that three-dimensional design applications have increased recently and that drawing tablets and touch screens facilitate the use of this technology. He also stated that the use of traditional and digital by combining traditional and digital in three-dimensional illustrations is important in terms of personalization and uniqueness of design products. The frequent use of ready-made visual elements in graphic design products has caused the designs to resemble each other. He emphasizes that the use of three-dimensional elements in illustration can be useful for designers to make a difference (Ilisulu, 2019, p. 23-25).

Compositions created from three-dimensional objects created in the digital environment in line with the possibilities provided by computer technology or three-dimensional figures and objects derived from clay or rags in the real world can be created to reflect an idea. These compositions can be converted into .jpeg image format with rendering engines in the digital environment. Those created in the real world can be converted into digital image format with a camera. Images converted into image files can be used as illustrations for graphic design products such as children's books, advertising posters, cultural posters and book covers. These illustrations are called three-dimensional illustrations because they are created from three-dimensional elements. The illustrators who design these illustrations are called three-dimensional illustrators. Three-dimensional

illustrator can be called an expert artist who adds volume, depth and aesthetics to graphic design products with 3D models and compositions created digitally or physically. Three-dimensional illustrations can be examined under two headings: Three Dimensional Illustrations Designed in Real Environment and Three Dimensional Illustrations Designed in Virtual Environment.

4. 1. Three Dimensional Illustrations Designed in Real Environment

Stop-motion, an animation technique, is a technique in which the illusion of motion is created by photographing static objects in the real environment by moving them frame by frame and combining these images consecutively. The materials used are usually clay, toy figures or specially designed models. The production stages of stop-motion animation consist of a series of technical processes such as script writing, character design, set construction, lighting, shooting and finally digital editing. Three-dimensional illustrations designed in the real environment can be considered as a scene of stop-motion animation. A location, lighting, objects and characters are used to convey an emotion or thought to the viewer. Finally, this scene, which is photographed, can be used as a visual element in graphic design products with the help of design programs in computer environment.

Contemporary design practices increasingly emphasize the integration of handcrafted physical models with advanced digital technologies to generate distinctive three-dimensional visual narratives. A prevalent methodology involves the fabrication of tangible prototypes (utilizing materials such as clay, paper, cardboard, or wood) followed by their digitization through photographic documentation or three-dimensional scanning. These digitized assets subsequently serve as foundational elements within digital illustration or virtual composition workflows. Recent scholarly investigations conceptualize this analog–digital convergence as indicative of a "New Bauhaus" paradigm, wherein artisanal craft is systematically interwoven with computational processes. In this context, Maria Mandea underscores the pedagogical shift towards the post-processing of manually constructed forms, facilitating an epistemological synthesis between tactile, material engagement and digital visualization. The amalgamation of analog and digital modalities affords designers both the embodied, haptic cognition derived from physical manipulation and the operational flexibility afforded by digital editing environments (Mandea, 2018).

Chris Sickels is a three-dimensional illustrator. Interested in animation and illustration, he describes his style as follows:

"As a 3D illustrator, stop-motion animation has always been an interest of mine. I hesitate

to call myself an animator as I am mostly self-taught in stop-motion, but I absolutely love to help bring these characters to life whenever I can. I think the current crossover between illustration and animation is fascinating." (Sickels).

Sickels' three-dimensional illustration (Figure 1), designed for the horror-themed magazine Plansponsor, deals with the fear factor in case employees react. The composition depicts a clown-like figure in the middle of a children's party. The crying facial expressions of the children and the confused looks of the adult character in the middle emphasize the general atmosphere of the scene. The metaphor of a clown at a children's party as a way of conveying the situation of the bosses against the possible reactions of the employees offers a creative approach. In particular, the extraordinary figure in the center of the three-dimensional illustration both attracts attention and arouses curiosity in the viewer.

Figure 1. Chirs Sickels, Illustration design of the magazine cover Plansponsor on the theme of horror, Three Dimensional Illustration example (Sickels).

Liz Lomax is a leading figure in the field of three-dimensional illustration based in New York. She realizes her work by photographing the figures she designs in her own environment (Figure 2). Her illustrations have appeared in prestigious publications such as Communication Arts, American Illustration, and Society of Illustrators Annuals (Lomax, 2008).

Figure 2. 50 Cent, Three-dimensional illustration, polymer clay, oil paint, jewellery, fabric, faux fur and digital photography for Rolling Stone magazine, 2004 (Wiedemann, 2011).

4. 2. Three Dimensional Illustrations Designed in Virtual Environment

In computer technology, data are processed using the binary system of 0 and 1. In this context, 0 represents the absence of a stimulus and 1 represents the presence of a stimulus. All operations performed in the computer environment are data. Powerful processors are needed to process this data and advanced graphics cards are needed to perform graphical operations. Especially in three-dimensional software projects such as animation and games, the hardware and operating system used must be compatible with current technology. In animation production, it is preferred to keep the polygon count of three-dimensional modeling low for easy movement of the character. While designs in virtual environments are expected to be realistic and high quality both visually and structurally, moving millions of points continuously poses significant technical difficulties. This can be illustrated with the example of cotton and iron, which have similar volumes; although both objects cover the same area, the energy required to move cotton is different from the energy required to move iron. Similarly while low-polygon models can be moved more easily, high-polygon models can be a serious burden on computer systems because they are composed of millions of points.

Looking at the short history of the development of three-dimensional software, the EDSAC (Electronic Delay Storage Automatic Calculator) developed at Cambridge University in 1950 was the first computer to visualize graphical information using an electronic tube display. In the 1960s, advances in computer graphics were used especially in aerospace and military projects; applications such as displaying the positions of targets on radar screens came to the fore in this period. By the late 1970s, significant innovations

took place in computer graphics. The development of raster displays enabled the visualization of large datasets, the production of stable and high quality images, and color studies. In 1976, the SIGGRAPH conference became an important platform for showcasing computer graphics products. In the 1980s, companies such as IBM, Apple and Commodore revolutionized the field by introducing personal computers with graphical user interfaces. In 1995, 3dfx introduced Voodoo Graphics, which revolutionized the graphics card market. Later, companies such as ATI and Nvidia joined the market with similar products. During this period, computer graphics software also developed rapidly. Programs such as MS Paint, Adobe Photoshop, Corel Draw, 3D Studio Max and Maya became the standard in graphic design and three-dimensional modeling (Kirsanov, 2008).

Three-dimensional modeling software such as Autodesk Maya and Maxon ZBrush are among the most popular programs in this field. These software programs work in an integrated manner with each other and offer the opportunity to make detailed edits to the models. High-quality visuals can be achieved with realistic surface views, appropriate material usage and various rendering engines. Render engines are specialized software for visualizing three-dimensional models and scenes; they convert scenes into two-dimensional images by calculating light, shadow, texture and other visual effects. Thus, three-dimensional designs are often created through the integrated use of multiple software programs, not just one. This approach aims to achieve the best visual effect. Thanks to the possibilities offered by computer technology, sculptors, in particular, can use three-dimensional software to examine their designs in detail before starting their projects and get information about how the implementation process will turn out. This makes the design process more efficient and economically advantageous by enabling the evaluation of potential difficulties before investing in expensive materials and big budget projects.

Chiaroscuro, derived from the Italian words chiaro (light) and oscuro (dark), is a visual method that aims to create the impression of volume and depth on surfaces through the balanced interaction of light and shadow. According to Sannino, this technique not only defines the forms of objects, but also increases the believability and expressive power of the visual composition. In photorealistic rendering processes, chiaroscuro is the key to adding volume to the scene through careful planning of lighting scenarios. This approach, which creates a realistic impression by increasing the perceptibility of surface materials, is an indispensable component of the three-dimensional effect in digital illustration and architectural visualisation (Sannino, 2019, pp. 36-41; 84-93). Chiaroscuro is historically defined as a painting technique that systematically uses the contrast between light and shadow to give the illusion of depth and form to surfaces. The basic aesthetic principles of this method are also valid in today's three-dimensional digital illustration

applications: The most effective means of creating volume and atmosphere in digital scenes is the construction of light-shadow balance with academic criteria. Thus, the chiaroscuro principles of classical art function as both a structural and narrative reference in photorealistic rendering, concept design and game visualisations.

Three-dimensional illustrations in computer environment are modeled with three-dimensional software. These software are divided into two in terms of modeling differences. These are; NURBS (Non-Uniform Rational B-Spline) modeling and polygonal modeling.

4. 2. 1. NURBS Modeling

NURBS modeling consists of basic components such as point, line and surface (area). While modeling the design in these software, reference is taken from two-dimensional front and side images. Such modeling is done in programs such as Maya, Blender, 3Ds Max, Cinema 4D. Maya is one of the most popular software among character designers. Prameswari, Basori, and Wihidayat (2019) stated that Blender is preferred by students because it is a free 3D modeling software and this increases accessibility in the learning process (p. 30). The NURBS modeling process consists of three basic steps: First, NURBS curves are generated for each row using the measurement data, where the degree, control points and node vector are determined. Second, the data is regularized by resampling the curves. Finally, a NURBS surface is created with the regularized data and the fit of the surface to the data is improved by iterative projection optimization. This method provides high accuracy, especially when working with irregular data in reverse engineering (Mao, Liu, Wang & Ma, 2018, p. 23-24).

Alberto Sdegno's What about 3d? Modeling, Visualizing, Materializing, Alberto Sdegno states the following about three-dimensional modeling; "3D modeling means creating a digital form starting from a set of graphic bases within a grid of three-dimensional coordinates defined by the designer using a drawing software. Modeling is transforming an idea into a morphology that we can work with. It is the designer's main activity." (Voyatzaki, 2014, p. 821).

Maya is a software that allows users to produce images and animations in a three-dimensional virtual work environment using virtual light and camera. Famous animated movies such as A Bug's Life, Toy Story and Shrek were produced with Maya. In addition, computer games, advertising, promotional videos, architectural and forensic animations, industrial design and animation projects can also be prepared using 3D Maya software (Lammers & Gooding, 2002). In Maya software, the outlines of the character are defined by profile curves and NURBS surfaces are created from these curves. Different

body parts are modeled with lofting or patch techniques and then joined together with smooth transitions. The resulting surfaces provide a high level of precision and fluidity, and are often transformed into polygonal structures to suit the animation process. This process was used as one of the most advanced techniques of its time to create the natural and organic look of the characters.

Computer-generated artworks are called CGI (Computer Generated Image) or *Computer Generated Images*. This term is widely used, especially for three-dimensional designs. In the film industry, CGI artists are not only limited to the production of special effects, but also contribute to feature-length animated films such as character design. Especially after the release of Toy Story by Disney and Pixar in 1995, CGI artists have taken an active role in animated films. CGI artists, like printmakers and photographers, also produce collectible works. These works can be reproduced with high-resolution prints after being finalized in the digital environment. According to some critics, the ability to preserve the original copy of the works in digital media may decrease their value due to their reproducibility. However, artists who are aware of this situation aim to preserve the value of their works by keeping the prints they produce in limited numbers (Weishar, 2004, p. 12-13).

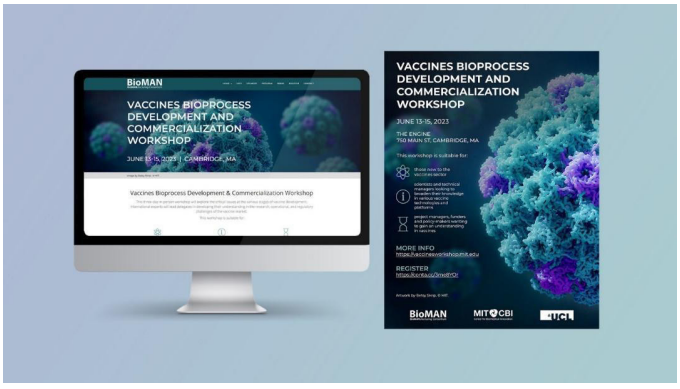

Figure 3. Betsy Skrip, Three Dimensional Design and Its Use in Graphic Design Sub-Branches (Skrip,2023).

Human Papillomavirus three-dimensional illustration designed by Betsy Skrip for the MIT's Center for Biomedical Innovation 2023 Vaccines Workshop. Betsy Skrip is a biomedical illustrator and art director at The MIT[1] Center for Biomedical Innovatio". She used Blender and Photoshop software in the design process. In the work in Figure 3, three-dimensional elements designed in Blender were transformed into poster and website banner designs using Photoshop. Skrip also worked with Tedrick Lew and Dr. Michael Strano from the Department of Chemical Engineering at MIT on a project titled *Plant Protoplasts: Rational Design Principles for the Transport and Subcellular Distribution of Nanomaterials into Plant Protoplasts* by Dr. Tedrick Lew and Dr. Michael Strano from the Department of Chemical Engineering at MIT, and used software such as Maya and Photoshop for the magazine cover design Small (Figure 4). In this three-dimensional illustration, the passive transport process of a nanotube into chloroplast in a plant cell (protoplast) without a cell wall is visualized.

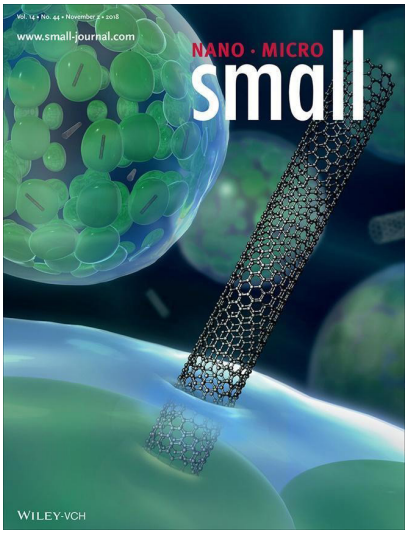

Figure 4. Betsy Skrip, Small Magazine, Cover Design of Volume 14, Number 44 (Skrip, 2018).

4. 2. 2. Polygonal Modeling

Polygonal modeling is modeling that consists of many surfaces. In programs such as the polygonal modeling tool ZBrush, which is called digital sculpture software, the number of dots increases as the surface of the three-dimensional modeling is detailed. While modeling in these software, unlike NURBS modeling, it does not start from a certain geometric shape. Shaping is done by starting from a sphere such as a lump of clay. Also,

[1] Massachusetts Institute of Technology

unlike NURBS modeling, these software require the use of a tablet instead of a mouse. With polygonal modeling, more detailed images are obtained by adding surface texture to the three-dimensional design.

ZBrush is three-dimensional software based on polygonal modeling. Yıkaroğlu describes polygonal modeling as follows:

> "The main feature that distinguishes polygon modeling from other methods is that it is an intuitive modeling method. Before starting to create a model in polygon modeling, a simple polygonal object is usually started. The simple object is elaborated with various polygon modeling tools to reach the final detailed version of the model and finally, the model is finalized by applying various smoothing operations to the simple polygon model." (Yıkaroğlu, 2010, p. 31).

The ZBrush programme is a software that helps to make digital sculptures. As it is understood from the letter Z, it is a three-dimensional programme. In the three-dimensional virtual world, X is the horizontal coordinate, Y is the vertical coordinate and Z is the depth. In the animation and game industry, this software is used when it is desired to design characters in more detail. For example; in the creation of Davy Jones for Pirates of the Caribbean: Dead Man's Chest, ZBrush was crucial for sculpting highly detailed facial features, sea life textures, and tentacle structures, allowing artists to craft a believable and richly textured character surface (Maxon, 2008). The word *Brush* in the name of ZBrush is used because of its function. Instead of sculptors' sculpting tools, three-dimensional brushes were used in this software. All kinds of changes on the surface are achieved through these brushes. The most known sculpting software are ZBrush and Mudbox. Three-dimensional designs with ZBrush provide ease of modelling as desired. The most important factor of this is that it allows intuitive intervention. Since the designer can intervene on the three-dimensional surface as desired, this software is popular with artists. Zbrush software has revolutionised the world of three-dimensional design in terms of easy texturing and colouring of the surface of a three-dimensional model. Illustrator Derek Lea expresses his experience with ZBrush as follows: "Zbrush is a really amazing software. When I first heard about this programme, I thought everything I had heard about it was a lie, but I was wrong. This intuitive 3D sculpting programme is one of a kind. Working with it is really like drawing and painting in 3D space." (Lea, 2010).

According to Wands, the origins of digital sculpture date back to the first practical applications of computers. Initially, computer-aided design (CAD) and computer-aided manufacturing (CAM) technologies were adapted for use in various fields ranging from the defence industry to the space and automotive industries (Wands, 2006, p. 76). Over time, a parallel increase in the use of digital sculpture has been observed in line with developments in modelling and animation software. Produced in 1997 by Ofer Alon and Jack Rimokh, founders of the American-based Pixologic company, ZBrush was released

in 2002. Maxon, a software company with digital content production and processing technology, acquired ZBrush in December 2021. While the smallest unit in two-dimensional digital images is the pixel, in ZBrush it is the pixol. Yıkaroğlu defines the pixol as follows:

"ZBrush has a structure between 3D and 2D. This is a situation arising from the pixol technology that forms the infrastructure of ZBrush. The most important feature that distinguishes pixol technology from other 2D programmes is the display and interpretation of points. For example, in all 2D image editing programs we use (e.g. Photoshop), each point in the image contains coordinate information and colour information in a 2D plane. Unlike this display system in ZBrush, each point also contains depth, orientation and material. Each point that contains all this information is called 'Pixol'. ZBrush technology has a structure based on pixols. This different functioning and structure sets Zbrush apart from all other conventional software." (Yıkaroğlu, 2010, p.154).

Illustrators often choose ZBrush software when they want to quickly sculpt a model, colour it and then render it from different angles. Thanks to its organic modelling possibilities and user-friendly interface, ZBrush has become the basic software for many users. Today, the number of concept designers using ZBrush is not less than Photoshop users (Alba, Attaran, Quesne, Southern, Stuben & Tavares, 2021, p.15).

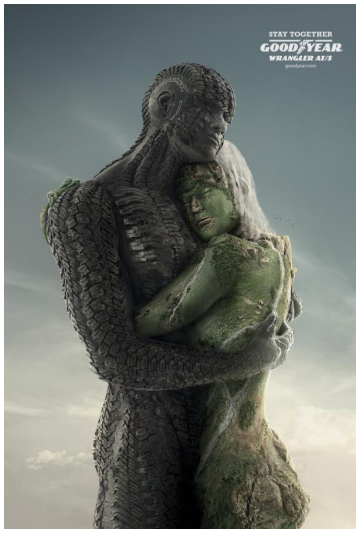

Figure 5. Good Year Brand's Ad Poster with 3D Illustration (Good Year ,2014).

Three-dimensional illustrations created using ZBrush software are used in graphic design products. One of them, the three-dimensional advertising posters of the Good Year brand, consists of visual elements created using three-dimensional software. The poster

design in Figure 5, called Hug Mountain Terrain, was prepared by the advertising agency Lunch Communications Selangor in 2014. In this poster, the hugging of a male figure covered with tyre patterns and a moss-covered female figure representing nature highlights the durability and environmentally friendly structure of Goodyear tyres. The use of detailed texture and the hugging of the figures emphasise the durability and confidence of the tyres and draw attention to the product's character in harmony with nature.

Marianna Yakimova is a 3D artist and art director known for her hyper-realistic 3D sculptures and high quality CGI works. She is the founder and CEO of the 3D art studio Pompidou in Funchal, Portugal, which serves international clients in various industries such as film, gaming, advertising. Having studied fashion design at Moscow State Textile University, Yakimova says that she has developed her expertise largely through online sources, especially YouTube and digitaltutors.com. Throughout her career, she has collaborated with famous brands such as Dior, Prada and Ubisoft, and has achieved a prominent place in the 3D art community by participating in Hum3D competitions and winning awards. Yakimova is noted for her expertise in detailed character modelling, clothing design and digital sculpting. Using software such as 3ds Max, ZBrush and V-Ray, her works blend artistic vision with technical skill, bringing her to the forefront of 3D art and animation.

Figure 6. Marianna Yakimova, Morton: Hamster Wheel-Tram (Yakimova, 2016).

The advertisement poster designed by the artist for Moscow Media Storm Advertising Agency (Figure 6) is a striking example of three-dimensional illustration work. The three-dimensional image in this poster is designed in ZBrush software and attracts the viewer's attention with Yakimova's original fiction. The poster conveys a strong message that neighbours who constantly complain cannot escape the noise. The use of realistic

textures and detailed design give the three-dimensional designs quality and impressiveness, strengthening the purpose of the poster.

CONCLUSION

In this study, it has been determined that three-dimensional illustrations are not only limited to computer generated images, but also images obtained by photographing models shaped in the real world are used as visual elements in graphic design products such as posters and children's books. Examinations of the digital three-dimensional illustration process reveal that there are significant differences between modelling techniques; these techniques, classified as NURBS (Non-Uniform Rational B-Splines) and polygonal modelling, correspond to pixel and vector-based approaches in two-dimensional visual arrangement. Especially the flexibility provided by polygonal modelling makes it possible to produce detailed designs and three-dimensional images that increase the aesthetic effect in digital environment.

Advanced technological infrastructure, high-budget projects and comprehensive training programmes play a critical role in the spread of three-dimensional illustration in the USA, UK and India. In Russia, the Soviet engineering heritage, international collaborations between visual effects studios based in Moscow and St. Petersburg, and the demands of the large-scale gaming industry support the development of 3D illustration. In Ukraine, outsourcing in the IT sector, a cost-effective and skilled workforce, and the integration of traditional folk art with contemporary 3D approaches reinforce regional superiority. In Türkiye, the still dominant two-dimensional-oriented education models, high hardware costs, flat design preferences of brands and limited public-private sector support significantly limit the spread of three-dimensional illustration.

The first use of the term three-dimensional illustration is not known for certain due to the lack of written sources. It is clear that it was three-dimensional designers who used this term. The multi-layered structure of digital technologies and NURBS and polygonal modelling techniques have led to radical transformations in the production and aesthetics of illustration by providing full control in volume, perspective and light-shadow manipulation. In particular, techniques such as chiaroscuro can be applied more precisely in a three-dimensional environment, making it possible to reproduce scenes that do not exist in reality with superior expressive power. As in Armando Testa's digital representation experiments, metaphysical combinations of conceptual images are given a unique visual language through three-dimensional illustration; these methods provide depth, realism and striking visual impact in a wide range of works from children's books to

advertising posters and scientific visualisations; in addition, algorithmic solutions such as artificial intelligence-assisted texture synthesis and style transfer accelerate production processes and significantly expand the creative horizons of artists.

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