BAŞKENT UNIVERSITY

INSTITUTE OF SOCIAL SCIENCES

DEPARTMENT OF INTERIOR ARCHITECTURE AND

ENVIRONMENTAL DESIGN

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MASTER'S PROGRAM

CORRELATION BETWEEN ARCHITECTURE

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VIRTUAL WORLD AND REAL WORLD COMPARISON

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Prof. Dr. Adnan TEPECİK

ÖZET

Teknolojinin gelişimi ile birlikte bilgisayar sistemlerinin ilerlemesi ve sanal gerçeklik olgusunun her dizayn ve üretim sistemine yansıması da hızlanmıştır. Video oyunları ve bulunduğu eylence endüstrisi dünya üzerinde sürekli kullanılan ve çok yaygın hale gelen bir endüstri ürünü olarak artık karşımıza çıkmaktadır. Video oyun endüstrisi ve geliştiriceleri bu teknolojileri daha gerçekçi ve dünyayı mimikleyen hiper-realistik görüntüler ve deneyimler elde etmek için kullanmıştır. Bu gelişim mimarlık mühendislik ve inşaat endüstrileri yanında dizayn mesleklerini de etkilemiştir. Video oyunlarında kullanılan gerçekçi atmosfer ve etkileyiciliğin oyuncuyu video oyunlarının sanal gerçekleğinin içine çekmesi için, geliştiricileri mimarlık mühendislik ve inşaat endüstrilerinin bilgilerini ve sistemlerini de kullanmıştır. Mimarlık mühendislik ve inşaat endüstrileri yanında içmimarlık ve tasarım meslekleri de bu paylaşımdan yararlanmıştır. Bu tez bu yuzden mimarlık ve içmimarlık meslekleri ile video oyunlarında kullanılan sistemlerin benzerliklerini literatür araştırmaları, geçmiş araştırmalar, teorisyenlerin çalışmalarını ve akademik araştırmacıların sanal gerçekliği tasarım sürecine katmaya çalışan çalışmalarını araştırarak, iki farklı mesleki alanın birbiri için önemini ortaya çıkarmaya çalışmaktadır. Bu tezin ana amacını ispatlamak için araştırma, sanal gerçekçilik, sanal dünyanın içine çekicilik üzerine odaklanmakta ve sanal gerçekliğin tasarım meslekleri için nasıl daha kolay kullanılabiliceğinden bahsetmek olucaktır. Bu bağlantı ve benzerlikleri bulmak için tasarım ve oyun endüstrisinin incelemeleri mimarlık ve içmimarlık, başarılı gerçekçi hissiyat ve içine çekmek olarak alınıcaktır. Tezin sonucunda sanal gerçekliğin ve sanal gerçekliğin tasarımsal olasılıklarının mimarlık, içmimarlık ve ilgili tasarım meslekleri üzerinde nasıl bir etkisi olabiliceğinden ve video oyunlarının sanal gerçeklik kavramı ile birlikte gelişmesiyle tasarım mesleklerine nasıl bir katkıda bulunabiliceğinden ve gelişimi hedeflenmektedir.

Anahtar Kelimeler: Sanal Gerçeklik, Video Oyunları, İçmimari, Mimari, Sanal Alanlar.

ABSTRACT

With the evolution of technology, the implementation of computer technologies and virtual reality systems into every aspect of design and construction systems have also increased. Video games and its entertainment industry have become one of the major industries in the world that are widespread continuously used these technologies. The video game industry and developers have used the technology to its fullest to achieve hyper-realistic graphics and fluent gameplay experience that mimic real-life properties. This addition also was used by the AEC industries and design mediums as well. To achieve this genuine atmosphere and immersion that embodies the player into the virtual reality of video games, the video game industry has used AEC industries knowledge addition on top of technological benefits. The same developments video game industry have used has also been used in AEC industries, architecture and interior design mediums as well. This thesis is aimed to achieve a correlation between the architectural and interior design mediums with video games with literature reviews and researches of important theoreticians works, and academic researchers pursuits of integrating virtuality into design cycle to clarify the importance of both mediums are crucial to one another. The central aspect of this thesis will be focused on immersion and embodiment into virtuality and how virtuality can be utilized in design mediums for further ease of design. In order to find these correlations, aspects of both mediums will be scoped under architecture, interior architecture, successful immersion, embodiment and realism. The result of this thesis shows the importance of virtual reality and its virtual possibilities importance in architecture, interior design and affiliated design mediums.

Keywords: Virtual Reality, Video Games, Interior Architecture, Architecture, Virtual Space.

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LIST OF ACRONYMS

2D	Two Dimensional
3D	Three Dimensional
AAA	Informal acronym for video games produced by major video game developers
AEC	Architecture, Engineering, and Construction
AR	Augmented Reality
BIM	Building Information System
CAD	Computer-Aided Design
CPU	Central Processing Unit
DOF	Degree of Freedom
ESO	Elder Scrolls Online
FPS	First-Person Shooter
GPU	Graphics Processing Unit
HID	Human Interface Device
HMD	Head-Mounted Display
LOD	Level of Detail
MIT	Massachusetts Institute of Technology
MMORPG	Massively Multiplayer Online Role-Playing Game
MR	Mixed Reality
NPC	Non-Player Controllable
OS	Operating System
PC	Personal Computer
RPG	Role-Playing Game
USB	Universal Serial Bus
VR	Virtual Reality

INTRODUCTION

With the invention of computers in the late 1940'ies, and their specific use for military industry allowed computers to jumpstart into creation. The realization of potential benefits of machines to military powers resulted in a focused search of electronics, conductor technology and computers in turn. In a short time, so-called early computers started having small screens which used to display specific data that military installation is providing. Therefore the use of computers in every manner on the decade has risen exponentially. The first computer game made was the first amusement device created by Thomas Goldsmith Jr. and Estle Ray Mann. Goldsmith and Mann used the very first Cathode Ray Tube (CRT) screens attached with custom made two analogue controllers build a system to draw a vector controlled dot on the screen which user can control. This system was called "CRT Amusement Device" (Wolf, 2007, p. 25). Therefore the creation of very first of computer games and gaming platforms paved a road to turn into a global industry and economy.

Following Goldsmith and Mann's creation, several enthusiasts and engineers kept working on these systems; however, the computer systems were still insufficient. IBM pioneered these advancements as a progression inability to reprogram computers of that time to be capable of multiple tasks. (Cerruzi, 2003). Moreover, with the evolution of computers, the first virtual concept was mentioned in 1965 by Ted Nelson, which in turn created further progression Computing Industry.

With the evolution of technology to contemporary state; where it got embedded into every aspect of human life, the importance of computers and its systems are crucial to humankind. Researches did in computing systems, Virtuality concepts, and their frequent use towards progression and design allows technology to form more accordingly to required needs. Architecture, Engineering and Construction (AEC) Industry is the first affected system by these technologies and allowed Virtual systems to be implemented in the design processes. This implementation also allowed designers to build virtual environments in virtual realities, that can be traversed and interacted using a

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variety of mixed techniques and virtual systems. According to this, Oxman (2000) remarks that;

> "cycle of research-oriented work in cognition and computation which is helping to formulate our knowledge of design thinking is now becoming the foundation and resource for computational design environments which are responsive to, and can enhance, the cognitive properties of design" (p. 338)

Oxman then continues by saying that "Research into the cognitive properties of the human designer is helping us to formulate means by which the computer can operate to support these properties." (Oxman, 2000, p. 338), which attracts attention to potential support and addition to said mediums, with the expected or imagined technological and virtual merging.

Improvement of the capabilities of the designer using these technological additions allows better and more real virtual creations. These improvements and attention also affected Video Games and Video Game industry, approved the creation of a wide variety of video game genres and titles. These titles are put in tournaments after the late 2000s and are still in ongoing eSports Tournaments (Electronic Sports). This new industry made video game medium a 130$ billion per year global (Nakamura, 2019) economy state in the entertainment industry, the importance of video gaming and virtual realities are undeniable. Over the last decade, virtual reality and mixed reality concepts and technologies are researched and applied in depts. Now virtual reality systems are widespread to the point where the majority of technology users can own virtual reality devices and experiment with virtual environments. This ease of access and further research and development is crucial because of the potential of these concepts being promising for both design cycles and AEC Industry.

With the progression of video gaming evolved, the need for creating adequate environments for the games to be interacted, immersed within also increased. The gaming community could not have achieved this without the help of technological advancements in computing, virtual technology, and Virtual concepts, architecture, engineering, and design mediums. To this end, creating immersive spaces and locations in video games is affected by

architecture and interior architecture mediums, using the same ratios, principles, and rules, trying to generate still-life environments, adaptable and intractable settings that users can familiarize themselves. These atmospheres used to create specific mediums required for game immersion and psychological stimuli representing, era, time, environment. Thinking of a virtual space different than real-life counterpart is not possible if not declared and explained as an alternative universe with various rules. Thus, the majority of video games accepted as a mirror of our reality. In creating such an environment, architecture's position in creating lifelike spatial spaces is very crucial.

Therefore; Gaming Industry and developers for video games work in order to create better environments for video gaming using real-world architectural knowledge and examples. The same effort also used in the real-world architecture; which aims to construct better solutions to housing, working, industry and so on with the help of using adapted virtual technologies used in video gaming to its benefits. The correlation between the two mediums is no longer undeniable. In light of these connections and progression, research on both mediums and their connection points is a vital research subject, closely connected with architecture and design mediums which in turn should be researched more closely.

Problem of the Thesis:

Because of video game developers try to create better immersive architecture, more designers will generate ideas for real-world architecture to be tried or constructed. After designers exposed to virtual creations, this improves real-world developments or real-world locations, history, historical settlements, and events.

Following this improvement, game developers generate newer ideas to be implemented on video games environment or video game backgrounds according to these developments. The correlation of both mediums is undeniable. Thus this thesis will research real-world architecture and interior

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design to that of video game architecture and interior design to prove the hypothesis of both being crucial to another for development on either medium.

In the light of this question, this thesis will focus its research and compare video games on architecture, interior architecture, design, material, form, and immersion in order to achieve a result, comparison and correlation between video game design and virtual environments to of real-world environments. These comparisons will be crucial in proving this hypothesis of video game development is similar and essential for real-world architecture and vice-versa. The question of how video game development can support AEC industries, and AEC industries development can support video game development will be studied, and a conclusion depending on the findings of case studies will be prepared.

Purpose of the Thesis:

Purpose of this thesis is to gather information on both Virtual Reality Concepts and Video Games to correlate with Architecture and their benefits to the AEC industry of real-world. This thesis will be researching and documenting virtual locations in video games to create a basis for comparison.

The comparison criteria are limited to materials, immersion, forms, functions, perception levels, aesthetics, and acoustics according to similar researches done on video games. The comparison of said topics with real-world examples to prove the importance of both virtual reality and real-world design correlation is crucial.

Selected video games for this thesis research purpose also includes specifications that can be read architecturally and form, material, interior design, spatial, immersive factors, acoustics, products, interaction, and functions as opposed to real-world examples. Therefore the purpose of comparing both mediums in order to show development on either medium is crucial and requires further research for improvement for both mediums.

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Extent of the Thesis:

This thesis will be limited to selected games for this thesis purpose which will only include First-Person Shooter (FPS) genre to simulate better correlation in between real-world perspective.

These FPS Video Games are selected from Video Game Journalist's list of best video games existing. Critics of Video Game Journalists highly acclaim selected video games on video game being immersive, realistic, innovative and spatial or architectural use. Selected video games are critical and progressive FPS titles that advanced the video game industry. In the selection process, video games are classified by their popularity and acclamation by video game journalists, and also can be read architecturally which the perception is limited to First-Person view only. However, besides the mentioned video games and their history, the video games studied in this thesis' case study are contemporary titles, fundamentally chosen to reflect the realistic graphics, architecture, design and correlation with real-world.

The extent of the video games is; *BioShock* (2K Games, 2007), *Call of Duty: Modern Warfare* (Infinity Ward, 2019), *Dishonored* (Arkane Studios, 2012), *Doom* (id Software, 2016), *Doom Eternal* (id Software, 2020), *Escape From Tarkov* (Battlestate Games, 2017), *Half-Life* (Valve, 1998), *Half-Life 2* (Valve, 2004), *Kingdom Come: Deliverance* (Warhorse Studios, 2018), *Mirror's Edge* (EA Dice, 2008), *The Elder Scrolls V: Skyrim* (Bethesda Game Studios, 2011), *Wolfenstein: The New Order* (MachineGames, 2014), *Wolfenstein II: The New Colossus* (MachineGames, 2017).

Method of Thesis:

This thesis will be researched in qualitative methods, researching thesis' done about similar subjects or related subjects, literature reviews, Internet sources and researches, articles about video games, including gameplay reviews and screenshots from mentioned video games in this thesis. The historical progression findings will be written in historically chronological order.

Central gameplay reviews will be written by the writer of this thesis via playing the mentioned video games listed in the extent of this thesis and recording screenshots of those said video games. Besides mentioned reviews will be compared to reviews done on the internet by video game critiques and video game journalists, to be able to compare and correlate with real-world examples and similarities to reach a conclusion or findings on the problem of this thesis. Compared results and reviews will be made to a chart to improve the relay of information more effectively.

The PC system used by the researcher in researching the video games in this thesis was built to accommodate every video game in the highest graphical quality, including a 3D surround capable headphones to replicate best audial performance available to document immersion and correlation.

CHAPTER I. VIDEO GAMES

Video games are today known as a popular form of entertainment in modern culture, but, video games' history span over almost forty years of development and progress. As of today, according to *History Newsletter* and *Bloomberg*, which is a financial, software, data, and media company that researches and documents such economies, the video game industry consists more than $130 Billion globally per Year (Nakamura, 2019). However, what is a Video Game? James Newman explains its research importance as;

> "While Scholars identify a range of social, cultural, economic, political and technological factors that suggest the need for a (re)consideration of videogames by students of media, culture, and technology, here, it is useful to briefly examine just three reasons why videogames demand to be treated seriously: the size of the videogames industry; the popularity of videogames; videogames as an example of human-computer interaction" (2004, p. 3)

In that sense, Video Games is a game, Frasca remarks this as "However, even if it sounds obvious, Videogames are, before anything else, games" (Frasca, 2004). And Zimmerman Explains the game activity as;

> "a game is a voluntary interactive activity, in which one or more players follow rules that constrain their behaviour, enacting an artificial conflict that ends in a quantifiable outcome" (2004, p. 160).

Therefore, we can understand from Zimmerman's and Newman's explanations, and videogames are a voluntary entertainment action, counted as a significant activity that is being researched and explored further. While the activity of playing the video game, is same as playing any other game, a voluntary action, which results in a quantifiable outcome; the player of the game is presented with a winner or loser and stimulus. With today's technological advances and opportunities, video games are available to anyone thru a variety of platforms and taking a majority portion in the activity of play in human life. This play started with several experiments and ideas in the early 1950s.

Earliest of video game history goes back to the 1950s, CRT screen attached prototype is to be the entertainment device named *Tennis for Two*, and

in time, become the first electronic interactive device which opened a new road for technology to be used effectively. Much development, both in video games understanding and requirements, consumer's requirements, and technological improvements have been achieved over the past couple of decades. Therefore, this history allows us to observe and document the progress of video game developments, the instruments and interfaces they are being played or experienced on, and how the virtual worlds they have created evolved with the technology they are bound.

In this section, the basic history of video games will be explained, in order to observe the progress of virtual worlds creations evolution, how they are created, rules and their depiction observed by the user and their hyper-realistic graphical progression from earlier games to today's modern video games where the line between reality and Virtuality is blurred.

1.1. Video Games History

Video Games history began at 1947 with a *Cathode Ray Tube Amusement Device*, built by Thomas Goldsmith Jr. and Estle Ray Mann, which was inspired by the radar display technology and it consisted of a CRT Screen with two analogue controllers which allowed users to control the vector drawn dot on the CRT Screen to simulate attacks directed at shapes printed on the screen. (Wolf, 2007, p. 25)

This design, however, took the interest of several enthusiasts to design and develop their machines. The most innovative and indispensable of them is *Tic Tac Toe* Computer Game by Alexander S. Douglas, who was a British Professor of Computer sciences, programmed the *Tic Tac Toe* video game in 1952 by using the Cambridge's EDSAC (Electronic Delay Storage Automatic Calculator) computer in the process of his research on human-computer interactions. (Winter, 2018)

Following *Tic Tac Toe*, *Tennis for Two* was made in 1958 by William A. Higinbotham. Higinbotham was an American Physicist who worked on atomic

energy researches in 1945s later started working on Brookhaven to focus researches on peaceful atomic energy usage in 1947. Whist working in Brookhaven, Higinbotham read a manual of one of the computers existed in Brookhaven and found out the documents explained how the computer could simulate the trajectory of a bullet, a missile or a bouncing ball and came up with the idea of using an oscilloscope to simulate a path of a ball between two courts to create a game of tennis. (Lambert, 2008)

Image 1.1: Tennis for Two computer game on a DuMont Lab Oscilloscope.
Source: Brookhaven National Laboratory (BNL), image by Pietro Dipalma.

One of the twenty-one video games being displayed at the Museum of the Moving Image in New York is *Spacewar!*. It is a significant game in video game

history, and it was developed by MIT students Martin Graetz, Steve Russell, and Wayne Wiitanen in 1961, as a video game of two spaceships battling each other in a black background screen. After the release of the *Spacewar!*, Graetz presented a paper to the newly formed DECUS (Digital Equipment Computer User's Society) explaining the video game they have created. Following the paper on Graetz*, Spacewar!* spread over the globe, as being the first video game able to be played over different computers, as it was the first video game written for the PCP-1 computer system, but not a complete system itself. Therefore, any community with a PCP-1 computer was able to play the *Spacewar!* video game. Alex Smith's research on the history of *Spacewar!* and its effects explain the spread of *Spacewar!*;

> "How quickly this spread occurred has recently been the subject of some debate. The traditional narrative, borrowed from Graetz's article, posits a fairly rapid and widespread adoption of the game…Nevertheless, it is fair to say that in an era when most game programs were one-offs that remained confined to a specific system, or at the very least a particular geographic area, *Spacewar!* penetrated computer labs from Cambridge to California, inspiring would-be programmers to follow the hacker ethic by creating their own variations on the game or even creating their own original programs. This activity culminated in the early 1970s in the creation of the first arcade video games — which were directly inspired by *Spacewar!* — and the subsequent launch of a new video game industry." (Smith, 2014)

Image 1.2: Spacewar! running on the Computer History Museum's PDP-1.

Source: Image by Joi Ito.

Another noteworthy mention would be *Space Travel* by Ken Thompson in 1969. The creation of this video game birthed from Thompson's work in Bell Labs, while working on creating programming languages, but resulted in something more massive than expected. Bell Labs was working on a computer project that Thompson also used to write his *Space Travel* video game into, but Bell Lab's withdrawal from the project forced Thompson to revert to an old PDP-7 computer he found and rewrote *Space Travel* on it. This process made Thompson create some tools to write the video game program on the computer, which the tools then were used by Thompson and Dennis Ritchie to create *Unix* Operating System (OS) (Ritchie, 2001). The *Unix* OS was first intended to be used in Bell Labs. However, it was later licensed to be used outside parties in the 1970s, leading to the system to be used on several successor OS' and OS variants, such as *Linux* OS, *Microsoft Windows* OS, *Apple macOS* (Ritchie, 1993).

These early computers or machines were built only for a single purpose, and that was to run the written program in the machine's RAM or ROM – Random Access Memory and Read-Only Memory, respectively –. However, as the computer and electronics technology evolved, these single-purpose built machines evolved into either console machines that are meant to connect to a home television or computers of their own. Explaining the systems these video games used to run is a topic of its own which is not covered by this thesis, the interface and machines history will be not be explored further. Instead, the topic will be limited to PC's, PC peripherals and HIDs as VR systems and VR's HMD systems in primary because of the widespread use of PC platform which is accessible by almost anyone on this decade and also because the thesis' extent of video game examples has been tested and viewed on the PC platform.

However, with the spread of PC systems, which are systematically the same machines with better integral components such as RAMs, CPUs, and GPUs able to perform such complex and intricate tasks, more comprehensive interface arrays and connections, was an opportunity for video games to jump into PC. With development and advancement, video games were no longer only limited to specific machines or required consoles to be played, instead were able to be

played from any PC. During its inception, PC consisted of a case that housed the essential electronic equipment in it, a monitor screen, a keyboard, and a mouse to be operated, and these peripherals also allowed video game controls to evolve. However, with today's modularity and variety, a computer system is no longer limited to a monitor-keyboard-mouse triangle, which was the essential interaction and interfaces with the system, but almost limitless to the creativity. 21st centuries systems computers include a Universal Serial Bus (USB), which allows any interface system or peripheral to be attached to the computer via its connection port. More commonly named HID's, include almost anything the user interacts with to control or use the computer systems, from mouse, keyboard, keypad, joysticks to virtual reality headsets or mixed reality controllers, are now able to be connected to any computer via these USB ports.

The interface between computers and use is limited to interface devices attached to the computer. The first examples consisted of a keyboard and screen interface, which the physical input was done by keyboard, and the visual response was observed from the screen. The addition of the mouse to the interface system created a triangle where movement and selection abilities were given to the mouse. Mouse could also be used to draw or pinpoint select. Command inputs given to keyboard and mouse is visually observed over the screen of the computer. This system created an adequate and successful video game platform. The eras improvement in technology and reduced costs of the computer parts required to build or own a personal computer allowed the improvement and rise of the 3D graphics, which were perceived as groundbreaking and revolutionary.

One example of this is the 1984 Video game *Elite* (Braben, Bell), which also is one of the longest-running video game franchises according to Video Game Journalists –which is a branch of journalism concerned with reporting, discussion and evaluation of Video Games– that must have seen regular releases for at least twenty-five years, from franchises first release to its most recent. *Elite* is a video game that puts the user in the captain's chair of a spaceship, where the user can travel in interstellar space, which consisted of eight galaxies with their star systems and layouts, each star systems and planets of those star

systems having different properties. The game mechanics and systems consisted of a lot of different factors combined, such as travel and fuel consumption, money earning ways, docking to stations on the orbits of planets, fighting aliens or marauding trading posts, being a part of the navy, or just plain scavenging. Developers of the game explain the gameplay as;

> "From the start, there were no tutorials no obvious path and no helpful assistant; the player as delivered into an unforgiving universe and allowed to reach the ultimate goal of being ranked "Elite" through whatever means; moral and physical; he deemed appropriate" (Byrne, 2007, p. 104).

This kind of gameplay also created a new form of game genres where the video game is declared innovative. The *Elite* player was given a basic ship with a small number of credits and given no introduction, training, or objectives to be directed, instead of leaving the choices to be given to the players will. Finding the players-choosing way of progression and rising above the ranks required time investment to the video game where the progression system and investment system was not something built into video games at that time (Gazzard, 2013). The release earned its name as a classic of its time, and as a result, the video game has been ported to every home computer of its time. Spreading of *Elite* also inspired as an influential model for a lot of future coming video games on its image (LaMosca, 2006).
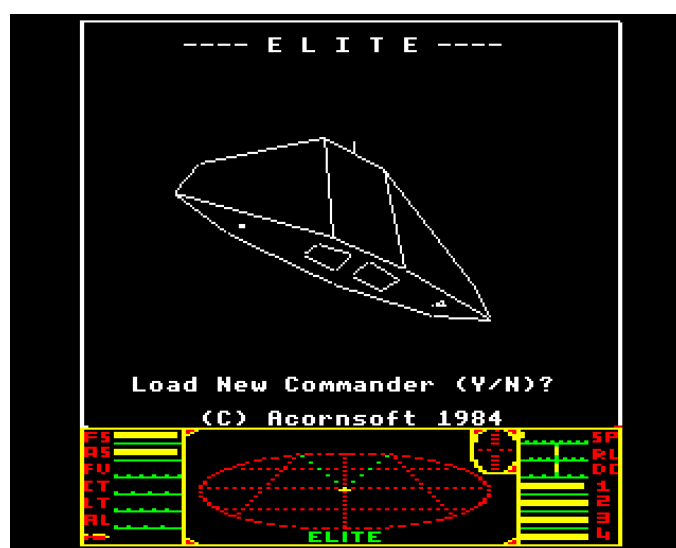
Image 1.3: Elite (Braben, Bell, 1984) video game screenshot.
Source: http://bbcmicro.co.uk/game.php?id=366.

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The history of technological development, decade's cultural popular topics and genres, and development, this research can also track how architecture, spatial understanding and replicating the reality humankind lives in the virtual space also connected. Earlier before the 80's the video games mainly based on space and science-fiction, which is also following the atomic era and global space race. After the '80s, first Role-Playing Games (RPG) or Fantastic games started to come out with more realistic sense, at the peak of global Cold War tensions, such as the *Wasteland* (Interplay Productions 1988), *Fallout* (Interplay Productions, 1997), and motion pictures such as *Mad Max* (Warner Brothers, 1979) as a dystopian action movie, creating a new post-disaster world series of genre and fantasy based on the global cold war tensions and nuclear war possibilities of the global powers. With the technological advances in the '90s and following updating of computer systems that are able to generate 3D imagery, video games also evolved to the first-person perspective and further used architecture, spatial understanding and real-world references to create more embodiment and immersion.

With the improved technology, new generation computers equipped with affordable 3D graphic chips, which allowed computers to generate more detailed 3D textured graphics and faster computing power, allowed video games to evolve further. The First-Person Shooter (FPS) type of video games was the first one to take advantage of this technology. FPS genre video game is when the video game is played through the perspective of the player-controlled avatar and seen through the eyes of the main character.

With the improvement of investment and progression in order to create an immersive and realistic story, the characters of the video games stories have also become more personalized or able to be sympathetic, psychologically. Several video game titles offered a specific avatar to the player that the player can control and experience the video game. In contrast, other video game titles offered a variety of avatars to be chosen by the player to be controlled throughout the video game. The ability to chose the avatar the player wanted then further developed the player-controlled avatars in video games, allowing the player to personally customize the avatar in the video game to resemble the

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player further, therefore, increase the immersion and embodiment to the video game, or the player's ideal customizations. The FPS type video games and several other related video games are always perceived from the eyes of the avatar the player controls. The avatars vision could be centred on a weapon to survive in the combat story is being placed, and gameplay usually consists of fighting, however, not only bound to fighting. In 1992 *Wolfenstein 3D* (id Software), and then in 1993 *Doom* (id Software) video game, used these 3D graphics to create environments where the user is required to input movements and actions thru keyboard to traverse or fight, and each level consisted of a labyrinth with an exit, where the user is required to fight and survive the level and reach the exit to complete the level. *Doom*, unlike id Softwares previous release, *Wolfenstein 3D*, used its eras advantage to present the levels in 3D perspective and allowed the user to traverse in the levels of labyrinths freely, which was very useful on an FPS video game. In turn, *Doom* helped define the FPS genre, inspired many similar games, and known as one of the most influential and significant games in the video game history.

Image 1.4: Doom (id Software, 1993) video game screenshot.
Source: Screenshot by Efecan Büyükbaykal.

With *Doom*, and now defined FPS genre, a lot of developers and designers started working on this new opportunity, because a lot of other genres at the era was not presenting the game on the user's perspective, FPS genre had much potential to affect users with the immersion levels of a first-person perspective. In 1996, id Software's new release *Quake* changed the video gaming and first-person shooter genre yet again, with better graphical rendering engine provided by the technology and its successor, *Quake II* in 1997. In *Quake II*, developers included OpenGL support –a technological addition which allows further graphical computing power, allowing coloured lighting and rendering accurately tested the eras hardware capacities– and pushed them further.

However, the controls and interface with the video game were still limited to the keyboard. The user of the video game has to use keyboard inputs to change the perspective of the vision of the Avatar and aim, but in 1994 *Marathon* by Bungie interactive, the first time allowed the users to use the mouse to freely look in the created 3D environment, which in turn allowed other developers to use and implement the same option to their titles.

This change, most visibly observed and historically holds significance, is seen on Valve's 1998 release of *Half-Life*, which like *Doom*, achieved a lot of groundbreaking developments, received many awards, and took its place among the 'Greatest Video Games of All Time' of the video game journalists lists. *Half-Life* introduced a new set of 3D rendered graphics and a seamlessly immersive world, where the Avatar is the protagonist of the story, and the game is not just Shoot them all type of First-person shooter. Instead, a story-driven, narrative, immersive game, where the protagonist is trying to escape a facility he was working in after an experiment goes wrong.

In the *Half-Life*, the user always has uninterrupted control of the protagonist, able to freely look in the 3D environment, move freely in the levels, and the story is always perceived through the protagonist's eyes, unlike any other games of that time. In addition to the evolved 3D graphics, the architecture use and spatial understanding were also improved with the technology of the time. With this change, *Half-Life* became the base model for

every new FPS genre video game afterwards of its release because of its immersive capabilities, freedom, spatial use and ratio, LOD, and of course 3D quality. *Half-Life*'s second instalment in its series *Half-Life 2* (Valve, 2004) brought with it more quality, LOD and immersion into the video gaming industry. Such as the new *Half-Life 2* included all the new generation graphics while adding motion capture facial movement and expressions to NPC's and much more realistic visual effects, a physics engine powered by *Havok Physics Engine* (Havok, 2003) which simulates real-world physics to increases the sense and presence, movement and motion in the video game. Since a Physics Engine is installed a prototype Gravity Gun is included in-game where the player could use the gravity gun to manipulate objects according to physics, pull or push almost anything in-game, create alternative and avantgarde gameplay interaction and puzzle-solving that was never done before. In the end, *Half-Life 2* received thirty-nine game of the year awards including awards for physics, animation, acoustics, artificial intelligence, graphics and narrative, and cited as one of the greatest games of all time. It is also crucial to mention that a research conducted by Frans Mäyrä and Laura Ermi in the University of Tampere by preparing a questionnaire with several video games as to specify immersive qualities of the video games resulted in researchers finding the *Half-Life 2* as the overall the most influential game in immersing its players at its time (2005, p. 11).

Image 1.5: Half-Life (Valve, 1998) video game – Office Complex.
Source: Screenshot by Efecan Büyükbaykal.

Image 1.6: Half-Life 2 (Valve, 2004) video game – City 17.
Source: Screenshot by Efecan Büyükbaykal.

After this change and development in the genre, freedom of movement in a 3D environment and ability to freely look, different approaches on storytelling, immersion ways, further improvement of 3D graphics and graphical quality of the video games and enhanced LODs, the next improvement was focused on the virtual environments and their realism, story and the experience presented to the player. This requirement was fulfilled by the 2K

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Games' release, *BioShock*, in 2007 just three years after *Half-Life 2*. *BioShock* used a lot of 20th centuries dystopian, utopian thinkers and historical figures on its story materials which player could relate, environmental designs which player is familiar, and used different approaches on its narrative just like *Half-Life* series, allowing the user to choose how to approach to individual encounters in the video game. Players ability to choose how to act, which had different story progressions and repercussions on end, therefore incorporating role-playing elements and choices that mattered into the FPS genre. Currently, *BioShock* is one of the most acclaimed and researched video game in its sense of philosophy and psychology in video games, and how it manipulates the player in specific ways. *BioShock* also incorporates such as story based on Walt Disney's persona and philosophy and includes many real-world architectural influences in its created virtual reality, as the story is placed in 1960s era, the video games virtual environment uses the art deco movement in every fashionable and visible way to give the sense of the era.

Image 1.7: BioShock (2K Games, 2007) video game – Rapture City.
Source: Screenshot by Efecan Büyükbaykal.

With today's technological opportunities, where the 3D graphics have become hyper-realistic and video game industry becoming one of the

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entertainment industries major division, improvements to said elements are almost never-ending. These improvements allowed many game developers companies to develop their graphics, gameplay, immersion, story, interaction, experience criteria. This progress also allowed several reboots of old titles that are regarded as classics and important titles. One example is *Elite* which was first released in 1984, rebooted itself with contemporary immersive graphics, game style, more in-depth and complex gameplay, in 2014 as *Elite: Dangerous* (Frontier Developments) under the same leadership. Another example is *Doom* which was released in 1993 by id Software rebooted itself in same fast-paced gameplay with contemporary graphics and effects in 2016 as *Doom* (from now on referred to as Doom 2016 to eliminate confusion with 1993 Doom title) and released a sequel to first title, *Doom Eternal* on 2020. While several titles such as previously mentioned rebooted, other relevant classic game titles rights being sold to other companies for the revival of the said titles. Couple outstanding examples are *Fallout* (Interplay Productions) series and *Wolfenstein* (id Software) series which are obtained by Bethesda Softworks in order to be continued or rebooted, are also highly acclaimed according to Video Game Journalists.

Image 1.8: Rebooted Elite Dangerous (Frontier Development, 2014) video game with contemporary graphics and gameplay.
Source: Steam video game store picture,
https://store.steampowered.com/app/359320/Elite_Dangerous/.

One crucial mention of video game history would be the *Grand Theft Auto* (GTA), created by Mike Dailly and David Jones, developed and published by Rockstar Games. First title *GTA* released in 1997, and last title in 2013 as *GTA V*. The *GTA* franchise achieved its success via recreating a fictional universe almost copied same from real-world immersive and known cities – such as Manhattan New York, California; United States– and offered a living city. While the first two instalments of the series were top-down perspective gameplay, third release, *GTA III* switched to advanced graphic and third person-person perspective to the last instalment *GTA V* which is also in third-person perspective. However, *GTA IV* and *GTA V* offered an optional FPS perspective of choice compared to *GTA III*, and *GTA V* is the most immersive, contains most LODs and its virtual world is almost equal to real-world scale size of New York Manhattan city recreated in virtual reality. *GTA* franchise created living cities, where every people in the city –while the story being script-driven– had a story and their agendas, where the player's Avatar had to find a place in the

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city, meet new people or employers, grow amongst the ranks, and earn money to purchase better homes, cars, weapons, clothing and so on. *GTA* video games offered realistic architecture and interior design use, that is mimicked from real-world and portrayed as such. Persistent, living city concept in *GTA* franchises could be delved further into and is considered a study of its own.

Therefore a linear evolution of video games history exponentially grew, and outbursted after its economic and cultural importance were seated, and collaborations with other mediums established. Several relevant titles explained above gave the designers, developers and game creators pursuit in creating what has not been done before, or trying to relay experience that has not been offered before. This pursuit also has been followed by technological development. While technologies main contractor and improver is military powers, the economic side of technological improvements also has to cope with the video game community to create better systems for the market in order for their economic stability and sustainability while providing services, otherwise risk a gap in the provided services. It is also important to mention that with every technological outbreak, game developers instantly implemented that new technology to their creations in order to produce a better product while helping technology market to be in demand by the user's developers products. John Carmack can give an excellent example of this progression. Carmack is one of the founding members of id Software which developed the *Wolfenstein 3D* and *Doom* video game series and helped define the video games and FPS genre, outstanding graphics and new software to develop games on. After finishing Doom III video game, Carmack focused on new technologies which resulted in him moving from id Software's position to Oculus VR's development team to switch focus from developing games to improving VR systems.

Currently, with the addition of the VR technology and immersive graphics to the video game culture and video game industry, additional human interface devices, immersive controls, actions, acoustics, and sound effects, video games are almost blurring the line between the Virtuality-Reality continuum. The future of the video game industry and video game products, however, are open to debate, while the industry is working to provide more

material that is commercialized as realistic and immersive for the consumer market. Currently, with the spread of VR among PC users and the video gaming industry, new ways of immersion, interaction is worked on by the video game developers, and engineers are also working to make the technology offered by VR much more accessible to produce and obtain.

This development in technology and the addition of VR systems and Virtual Reality concepts being developed also took the interest of several researchers and allowed them further to study the effects and possibilities of the VR systems. These studies also include integration tests of VR to everyday activities, design mediums collaborative work cycles and possible new ways to allow designing with the 3D capabilities and instant realization of design with the help of VR and HMD's.

1.1.1. Video Game Development Process

Video game development process is a lengthy design and production cycle, just as any AEC industry cycle. However, the majority of the development process divides into two categories as Creative Process and Production Process which results as the Alpha Version, the first testable product, which then proceeds to user testing phases to perfect the video game of problems and glitches. The resulting final product is then released into the gaming industries distribution network for consumers, which can obtain the video games as hardcopies or obtain digital copies available for download to PC.

This process is first started with brainstorming with the creative group, which leads to a prototype creating, which are created by the production group consists of software engineers and 3D designers, only after that prototype is tested, in which prototype testers provide the iterative additions and provide solution implementations to problems encountered. A final product is achieved at the end of this process. The main two processes are separated in the creative and production process.

The creative process in a Video Game development starts with an idea, which it is brainstormed according to possibilities of creation and conveying the game story and mechanics to the users. After creating the general idea and how will be the game story, progress and which elements it would include, concept artists and 3D artists start working on the concept art of the game, defining the characters, player-controlled avatar, locations and LOD in the video game. With the continuation of concept art development, a storyboard is established where the story flow, events, and decisions are made for the scenario of the video game. After this process of designing these said elements, software engineers start to work on the video game systems to build the game.

Therefore, the creative process of video game development is a collaborative work, including many industries and design mediums to work together to create a contemporary and producible work of art, system, and concept that is supported by a narrative story and elements for entertainment. In the creative process of a video game collaborative work, important segments include landscape design, architecture design, interior and spatial design, material design, 3D artistry, folklore or history elements play a significant role on creating a contemporary, intellectual product.

The creative process of a video game is the most crucial part of a video game title because the production process of the video games could be classified as a technicality limited to the producer's capabilities. 21st centuries relevant video game titles generally rely on the creative process to create engaging, fashionable, immersive and attractive content than could be converted to a video game for the consumer economy. Otherwise, risk failure due to lack of interest or popularity and in the commercial industry of video games which also disrupts the developers and producers ability to continue producing video games. It is crucial to inform that the most successful video games are called AAA titles, which is backed by larger development studios or publishing agencies. Developing a AAA title is directly connected with the budget supplied to the video game's development team. A larger budget allows more designers and personnel working on the creative process, allowing faster

progression and better synchronization between teams working on the video game.

The next process after concept design and process of the game development comes to the production process, which is the area of software engineers, coders, and 3D artists' jobs. This process is divided as the 3D artists creating 3D models of the environments created in concept process and characters in an adequate format required for the game, software engineers, programmers and coders working on the game system, creating an adequate and working platform for the game code to be able to run on conventional consumer systems, integrate and implement game mechanic systems via coding equations defining actions and reactions or results to the program.

This process is mainly a production cycle where the concept process products are realized via means of computer programming, coding, and mapping the created 3D environments and characters with required textures to visualize the video game. The budget of the developer's studio is also a contributing factor on the LOD provided in the product. A significant development company, studio or publisher providing budget and equipment for the development of video game results as a AAA title. After this process, the video game prototype is tested to find problems and fix the found problems or implement any further additions to the program.

1.1.2. Level and Location Design in Video Games

Video Games of our era are always taking place in environments one way or another, either a replication from real-world example or a fictionally created environment. There are few exclusions, however, where the environment is vast or unlimited like *Elite: Dangerous* video game, the player is a ship captain that can travel between star systems and the environments in the universe. The Elite: Dangerous' levels and location depends on the ship the player is using, where the cockpit of the ship is the first location player can observe, and secondly, the stations player docks at or interstellar space player travel at becomes

another location player can observe. However, while being a first-person perspective video game, the player can only control the spaceship provided to the player, and cannot move off the captains' chair. The perspective is limited to the cockpit, and where the player's ship is in the video game.

Location is vital in a video game, where the players' avatar traverses in. Early video games such as *Wolfenstein 3D* and *Doom* consisted of labyrinthine design. The first examples used low-resolution images that had low LOD to create boundaries to visualize a spatial environment. These textures used in early video games low resolutions; therefore from the close perspective they were obscure, however, from a distance and the first-person perspective, they were able to resemble objects, materials and types of materials. In *Doom*, the environment is made to resemble a research complex invaded by hellish aliens. In that created 3D labyrinths, the player had to fight and survive those enemies while traversing the labyrinth-like locations to find the exit to get to the next level of the video game.

Image 1.9: Doom (id Software, 1993) video games labyrinthine level designs.
Source: Screenshot by Efecan Büyükbaykal.

Some other later games like *GTA* series consisted of cities and districts of cities, where the progress of the game's story took the avatar from one district to another while allowing the player to go back to the previous districts if chosen so. Location is a sense where the surrounding environment gives its inhabitants the sense of where one is, in a closed or open environment, in urban areas or a forest, near the sea or a cliff, and as every entertainment industry media used in this sense to the fullest advantage. An avatar in a video game, thus directly player of the video game, cannot make sense of the story or setting without understanding the location. Ermi and Mäyrä's (2005) studies confirm that the cognition and understanding of video games and therefore immersion start from observation of the environment. Currently, Video Game Genres consists of several world types to control locations in-game, and the most important of them is the Open World type of Video game and Linear Story type of Video Games. FPS type of video games can take advantage of both types of locations, while linear story type of FPS video games focusing on narrative, action and progression, open-world type of FPS games are more bent towards players choices, and how the player decides the virtual world of the video game would change.

The linear story type video games take the player from one location to another depending on the story, and that frame of the story is limited to the level avatar is currently experiencing. The avatar cannot go back to the previous level because the story is progressed, and the only way to continue progress is to go forward, hence the linear story definition. This type of video games development is much more straightforward, primarily due to technical requirements and development is much easier to produce. However, Open World type Video games offer a created location sets connecting to make a virtual world or a complete virtual world continually living in the background. In open-world video games, the avatar of the video game and the player controlling the avatar has to make sense of the world or location avatar is in, and decide where to go, in order to initiate story progression or game progression. Therefore the avatar of the video game and the player controlling avatar are embodied and immersed into the virtual world. This information is

gathered via the means video game is offering players in the setting video game is made and planned, where this information retrieval could be talking or interacting with the NPC characters, where these NPC's are controlled by the games logic engine or scripts, or read any in-game information supplied to the avatar in games created virtual world.

Level and location design are crucial in video games to help player immerse with the video games virtual world, traversing in the created world and gathering information required to beat the game. Where the first examples of 3D perspective FPS games included basic geometrical shapes to create locations, current technological advances in computing power and graphical visualization allows video game designers to create more immersive locations. These video game locations and levels, being more realistic and relatable, increase the ability of the player of the video game to be more immersed with the game's story and setting. Bonner explains the player's emotional side as "gamers bear emotions intrinsic in-game space and thus, create an atmosphere in connection with the game world by affective consternation" (2014, p. 3). In order to increase this immersion, video game developers are known to use real-world location examples, or architectural movement similarities in video games to create a psychological stimulus, where the buildings, bridges, streets, interior spaces, equipment used in those spaces resemble the real-world counterparts. There are also secondary psychological stimuli induced by the story and narrative. However, the environment is found to be much more appealing factor. It is not surprising that real-world examples influence video game designers.

To this end, an essential designer in the video game world, Viktor Antonov, who created the *Half-Life 2*'s dystopic City, is interviewed to explain his ways of creating video game worlds. In *Half-Life 2*, City 17 is the environment story progresses, where the city is subjected by interdimensional beings called Combine, almost like assimilated to a point where futuristic alien constructions and towers mixed with early soviet era concrete architecture already residing in City 17. Creator of this fictional city, Antonov explains his motive as "Often I play these two against each other: the high-polished

industrial design philosophy versus craftsmanship that no longer exists." (Zeller, 2012, p. 175). The game world of *Half-Life 2* is explained as a fictitious country, possibly former warsaw pact country that also resembles shorelines of the northern Black Sea. Bonner explains that;

> "Antonov selected the image of Eastern European cities as their communist and in parts, stately architecture represents historically attuned places which transfer the idealist and unfulfilled communism…Antonov also models his designs on cities of his childhood like Sofia, Budapest and Odessa, which are shaped by the Stalinist architecture of the 1930s and 1950s, neoclassical representative architecture and precast concrete buildings. The central station of City 17 for example, where the players arrive at the beginning of *Half-Life 2* is a simplified adaptation of the central station in Budapest, *Budapést Nyugati palyaudvar*, built between 1874 and 1877 by the world-famous engineer Gustave Eiffel. This station concourse is made of a clear glass and steel skeleton and flanked by neoclassical shaped structures whose palace-like Opulence is lacking in the game intrinsic polygonal structure." (2014, pp. 6-7).
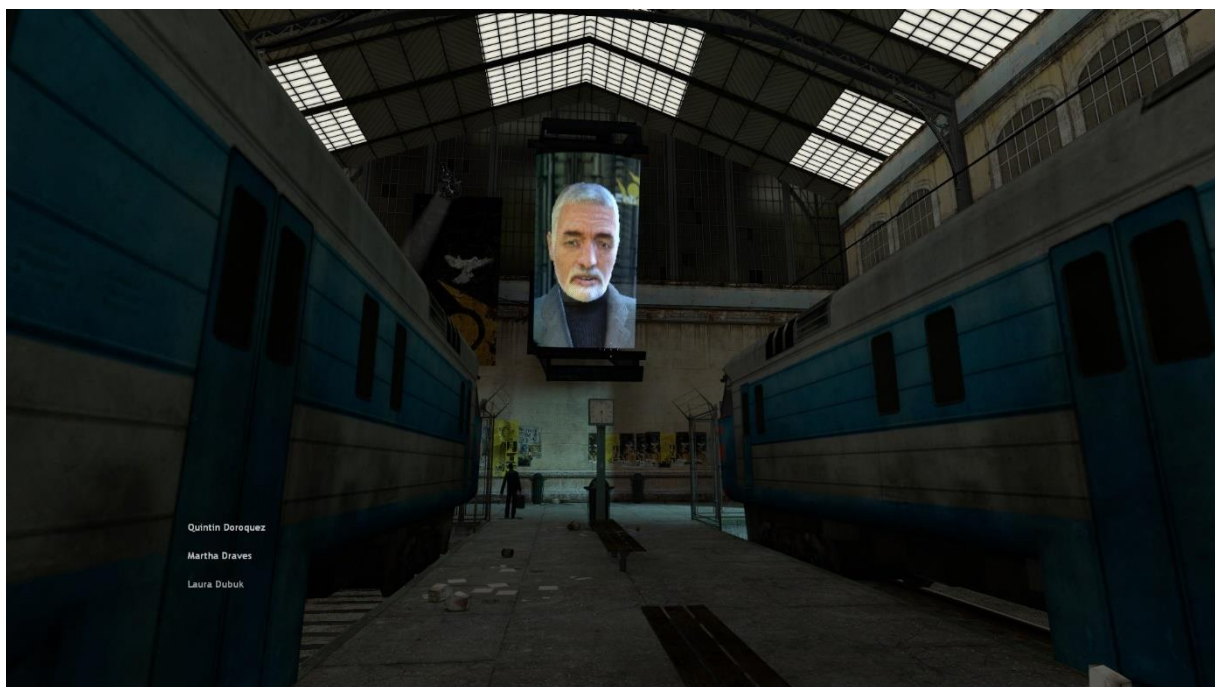
Image 1.10: Half-Life 2's (Valve, 2004) train station, adapted from *Budapést Nyugati palyaudvar* train station built by Gustave Eiffel in 1877.
Source: Screenshot by Efecan Büyükbaykal.

In the *Half-Life 2*'s City 17, Combine structures and systems are housed in a former politically important building of City 17. This architectural observation is done by researches and explained as "a cinematically condensed image of America cities like Washington, the neoclassical domed structure with wide frontage, high tambours and temple portico evokes the idea of a government building." (Bonner, 2014, p. 7). Therefore we can see how developers of video game worlds are using real-world examples and references to invoke a sense of surroundings and environments to the players.

This similarity is a psychological trick to fool the player to get immersed with the virtual world created, as the players of the video games are used to be in similar interior spaces or urban spaces. Mike Gust remarks about location in video games as "Architecture is the art form closest to the gaming experience, not film or fiction, not painting, photography or sculpture. Only architecture completely enfolds us as thoroughly as gaming." (Gust, 2009). Gust explains his experience on a level of *Half-Life 2* with these words, which shows the importance of level design in video games and effects on the player of the video game as;

> "The Ravenholm level of *Half Life 2*. "We don't go to Ravenholm" I was told earlier in the game and now I know why. There is nothing else like it in the entire game. I'm creeping down ill lit passages, sprinting down blood-stained streets and up stairs clogged with shambling zombies. I jump out onto catwalks of rotten boards as the zombies moan below me. I scramble over rooftops my heart beating, my skin crawling. It's all so tight, dark, and closed in. Everywhere you turn there is nowhere to turn. An entire city transformed by the Combine into monsters. If *Half Life 2* is a house of horrors then Ravenholm is its deepest, most frightening room, its dark heart. It's at once slow and fast. Dread-filled and bristling with sudden death, Ravenholm leaves me wrung out but excited. It's one of the most compelling gaming experiences ever" (Gust, 2009).

With Gust's remark on his experience of a level on a video game, this thesis can quote from Steen Eiler Rasmussen's book titled *Experiencing Architecture* (1962) which explains the experience of location as;

> "It is not enough to see architecture; you must experience it. You must observe how it was designed for a special purpose and how it was attuned to the entire concept and rhythm of a specific era. You must dwell in the rooms, feel how they close around you, observe how you are naturally

led from one to the other. You must be aware of the textural effects, discover why just those colours were used, how the choice depended on the orientation of rooms in relation to windows and sun…You must experience the great difference acoustics make in your conception of space: the way sound acts in an enormous cathedral, with its echoes and long-toned reverberations, as compared to a small paneled room well-padded with hangings, rugs and cushions." (Rasmussen, 1962, p. 33)

The environments properties, qualities, styles are also used in Bioware's *BioShock* video game. *BioShock*'s story is told in an underwater city called Rapture, the city is placed and built at the bottom of the Atlantic Ocean and has originally intended to be a perfect utopian hideaway for American elites to live out their lives. The concept of the city can be referenced back to Ayn Rand's *Atlas Shurgged* (1957) novel and can be called a heterotopia by Michel Foucault's terms. Bonner explains the first sequence of the video game and the introduction to the Rapture city as;

> "the player sinks down in a diving bell and look at the diegetic Rapture built-in 1946. With its Art Deco skyscrapers, it looks like a sunken New York. In addition, the outside lighting of the architecture, the searchlights and lit windows are reminiscent of night views and photographs of New York of the 1920s and 1930s just as the ones were taken in 1929 by the German architect Erich Mendelsohn. Unlike any other city, the cityscape of New York has been intertwined with its cinematically abbreviated representations over genres and decades. Consequently, it is deeply rooted in our pop-cultural memory. Everyone can quickly recognize the iconic buildings and their vertical structures, feels familiar or even at home." (2014, p. 9).

Image 1.11: Underwater city of Rapture in BioShock (2K Games, 2007) video game.
Source: Screenshot by Efecan Büyükbaykal.

With the evolution and progression of video games and their hyper-realistic imagery capabilities, bringing reflections from real-world into a video game is quite beneficial for the developers as mentioned above by Bonner, it can create an emotional connection or a pop-cultural connection with the player of the video game, instantly creating an immersion element. The example Bonner reflects can also be seen in popular video games such as *GTA IV*, where the time's squares resemblance and its neon lighting, constant traffic and populated streets are immediately recognized as the iconic New York City. Several other mentionable examples include the *S.T.A.L.K.E.R.: Call of Pripyat* (GSC Game World, 2009) video game where the *Pripyat city* and its iconic yellow Ferris wheel is virtually created and traversable, or the *Kingdom Come: Deliverance*'s (Warhorse Studios, 2018) accurate reconstruction of the Bohemian Kingdom of the 1400s according to historical information can be given as examples. *Assassin's Creed* series video games developed by Ubisoft is also an essential example of this topic where the historical architectural constructions and landmarks recreation creates an immediate connection and understanding with the player.

Image 1.12: GTA IV (Rockstar Games, 2008) Star Junction, archetyped after Times Square of New York, Manhattan, US.

Source: Image by Rockstar Games, https://gtwfilesie.grandtheftwiki.com/StarJunction-GTAIV-southwards.jpg?_ga=2.94026778.627308589.1595423506-944033922.1595423506.

A mentionable example about this topic could be given from Battlestate Game's production *Escape From Tarkov* (2017) video game, which created a fictional city of *Tarkov* and fictional region of *Norvinsk*, considered to be near the Russian city of *St. Petersburg*, for its virtual world. While the virtual creation of *Tarkov* city and *Norvinsk* region is not real, it is influenced by Russian cityscape texture, building materials and architectural systems. The virtual reality of *Tarkov* includes an economic zone containing tall skyscrapers, shopping malls and storage areas, a seaport on the coastline with resorts on the hills, and industrial zones including factories and train stations which are created in the virtual world from real-world references and similarities to

resemble Russian cities and zones. While not existing in real-world and completely being fictional this resemblance to the real-world, and similarities provided in architectural texture and cityscape successfully immerses the player into the video game and virtual world of *Escape From Tarkov*.

Image 1.13: Escape From Tarkov's (Battlestate Games, 2017) environment.
Source: Screenshot by Efecan Büyükbaykal.

Without sufficient environmental information provided to the player of the video game, the environmental cognition and understanding cannot be achieved in the video game. Therefore, we can collect and conclude on bringing out the importance of level and location design in video games is very important to relay the experience and immersion to the player of the video game.

1.2. Spatial Design in Video Games

Video games, as mentioned above, almost always take place in a virtually created space or location, where locations and spaces intermingle with each other. Marc Bonner uses Greg J. Smith's remark on "how architects place

graphics or 3D models of their designs into photographic or virtual copy of the respective city to illustrate completions, contrasts or extensions of the urban structure caused by the new building" (Bonner, 2014, p. 2). According to Smith;

> "Video game designers simulating an urban world face similar challenges: They need to convey the complexity of a city to digital space in order to create an immersive, multilayer and reflexive gameplay. Both fields create a user oriented, architectural depiction which communicates social and spatial characteristics." (2010)

In the text, Smith uses the Bernard Tschumi's architecture theory of Manhattan Transcripts and *Mirror's Edge* (EA Dice, 2008), and outlines the readability of a city, thus he sees the image of the city as a transdisciplinary matter. (Bonner 2014, p. 2). To support this theory, we can look into Louis H. Sullivan, explained the principle of "Form Follows Function" in 1896 with his sentence:

> "It is the pervading law of all things organic and inorganic, of all thing physical and metaphysical, of all things human and all things superhuman, of all true manifestations of the head, of heart, of the soul, that the life is recognizable in its expression, that form ever follows function." (Sullivan, 1896, p. 408)

Therefore, "the adaptation of this principle to the game intrinsic, digital space seems coherent and legitimate for now." (Bonner 2014, p. 2).

According to these, the most immersive of video games is the Open World type video games where the video game consists of a virtually created world with no physical boundaries or limited with some in-game mechanics to keep the player in the created virtual world, and the virtually created world consists of these intermingled architectural and circulatory layers with buildings. Urban spaces create spatial spaces where the player of the video game can perceive and observe the living virtual world.

Image 1.14: City of Mirror's Edge (EA Dice, 2008) video game.
Source: Screenshot by Efecan Büyükbaykal.

These created virtual worlds generally consist of an urban layout where the buildings are placed strategically or according to a real-world example and connected with streets between the buildings. The player is given the freedom to choose how to traverse in the virtual world, -if vehicles are included and permitted- a player can drive the vehicle in the video game in streets to approach to the location player wants to go, walk, or use transportation means that is not controllable by the player. These open worlds also include interior spaces, if the player enters a building or construction, and in those interior spaces, connections between other interior spaces of the building creating a circulatory layer, therefore creating a spatial understanding of architecture from urban level to the spaces within buildings, interior spaces and circulation spaces connecting those interior spaces, just like the real-world counterpart. These spatial spaces in video games could be used to alter the approach to specific events in video games according to the story of video games or limitations of the game mechanics. For example, if a player is requested to enter a building's specific floor via any means, the player is free to choose the approach via spatial means. The player can walk into the building and use the

escalator to reach to that specific floor, or choose to use the stairs for a silent approach, or find the service areas of the building and use mechanical shafts integrated to the gameplay to use a more stealth style approach if required or chosen so. This type of freedom and use of landscape and architecture is prominently seen in *Dishonored* (Arkane Studios, 2012) video game. *Dishonored* offers a Victorian-style architecture composed of steampunk influences, and successfully creates multiple approaches to objective zones. The player of the video game can control the avatar to directly approach to zone for a more direct approach and combat, or use the architecture and its spatial connections for advantage for stealth and remain hidden while approaching objectives.

These spatial spaces allow a video game to be more flexible on specific events and give the player of the video game a certain degree of freedom of choice on how to progress the game. It also increases the immersion, as the player is not forced to follow a scripted or a linear approach to the event directed but given control of the situation where the player can choose, and this freedom of choice is accepted as an immersive factor in video game settings. This freedom also gives the developers of video games to implement role-playing elements into the video game, allowing choices that matter in the video game that affects the results, which can be considered as a score received at the end of any play.

1.3. Video Games and Virtual Reality

When we look at the Video game concept, it is almost impossible to think about it without the situation of its Virtual and virtual boundaries. Virtual reality is one of the significant components of the video games, where the video game is designed, placed, and played is entirely virtual. Because of its relationship with Virtuality, and video games residing in virtual boundaries created in digital space, cannot exist outside the digital space. This interaction of the physical realm with the digital realm creates a correlation and, therefore,

Virtual reality and its technologies are found very crucial for video games and their improvement.

Over the last decade, improvements achieved in virtual reality technology is almost all of the time supported with video game medium and its benefactors or helped develop in one way or another, which in turn is almost all the time, being supported by the other industries such as architecture, engineering, and urban planning. In order to create a virtual location, video game designers often collaborated with architects, urban planners, and engineers in order to achieve their purposes and get help to create an immersive, realistic, or realistically explainable concept. To this end, virtual reality systems and technologies and Virtuality-reality continuum are intermingled with the video game industry, where the technology is used to its fullest to achieve a desired effect or quality. When studied further, the virtual realities first term was coined in 1989 by Jaron Lanier, who later worked in significant developments that allowed VR technologies to evolve (Krueger, 1991). The technological possibility of a computer generating real-time 3D animations and graphics with the use of HMD's is a very crucial benefit for both video gaming immersion and collaborative design work in AEC industry and interior design.

Virtuality and the Virtual reality questions and concepts were also being questioned and researched upon over the last two decades, while the media is also producing similar products to question and create consciousness. Movies such as *The Thirteenth Floor* (1999) which is based upon the 1964 novel, *Simulacrum-3* by Daniel Galouye, *The Matrix* (1999) which depicts a dystopian future where humanity is living in artificial intelligence created virtual simulation, and *Existenz* (1999) which tells the story of a game designer who is trapped and hunted by her own virtual reality game, was produced in 1999 and was not the last ones to question and introduce virtual reality and simulation concepts to the media.

At the start of the 2000s, with the aid of the technology and Virtuality, video games almost had no limit, Gust remarks the advancement of graphics as;

"As game technology advanced, the push toward ever more realistic graphics, or eye candy if you will, became, for better or worse, the standard by which games were measured. You can easily trace a line from *Zork* (1982) to *Wasteland* (1988) to *Doom* (1993) to *Grim Fandango* (1998) to *Deus Ex* (2003) to *Bioshock* (2007) or any half dozen games of your choice and the one thing that remains constant is the increasing sophistication of graphics. Through the years, the quality of story and gameplay mechanics rises and falls but the quality of the graphics continually evolve. And hand in hand with graphics, came realistic, nearly photo realistic, depictions of game space" (Gust, 2009).

With this realistic graphics, everything could be converted to a video game, every story, event, or theory could be worked in virtual reality as a game or simulation. Previous two decades from that point was the commercial success of the video games. Since the 1980s the video games become an essential part of the entertainment industry. The system of video games usually works with an interface between the player and the computer system, where the players' inputs are converted to actions in the computer system that runs the video game. Now with the aid of the Virtuality-reality continuum and its technological benefits, the interface between the computer systems that are running the video games and its user became much more interfaceable, where the system can provide and generate haptic feedback to its user via interface equipment attached to the computer depending on the video game's setting, or the interaction between the system is reduced to motions or gestures thanks to the mixed reality systems and the optical reception of the user is often manipulated by the mixed reality systems depending on the video games setting to achieve required immersion and perception.

The futuristic questions of the early 1980s are now a reality where the technological barriers are lifted, and the designer's question of how reduced to a simple line technological process, video games are ever-increasing their importance in the entertainment industry and its economic influence over the globe.

As of this decade's combined use of virtual systems and video games getting more consistent and interfaced, the effects of its mixed-use generate also increases exponentially. These effects include hyper-realistic graphics

provided in stereoscopic 3D depth, acoustic realism, immersive locations and story, haptic feedbacks, or players' ability to interact with the virtual reality game without the means of HIDs.

1.4. Perception in Video Games

Perception in video games is considered one of the significant importance because the physical realization, immersion and observation of the video game are achieved through perceptive means. The interaction between the video game and the player is primarily achieved physically via both audial and visual perceptive means which is called the audiovisual media, both subjects physically and virtually crucial immersion factors and focus points in video games. Both on the Virtual Reality systems that user uses to play the game or conventional screens, actions are done in the video game via inputting commands via keyboard or virtual reality systems apparatuses, are observed by the user via perceptive means. Therefore, perception in video games is crucial to increase immersion, response, and the graphical quality of the perceived image.

However, the perceptive quality of a video game is consistent with the hardware the video game is being played primarily, and this is a technical issue and dependent on the players PC. Secondly, the graphical quality and audiovisual media in the video game are developed by the video game developers, which are correlated with their development budget. However, all of the AAA video games pursue to provide the players with the latest graphical quality and hyperrealistic graphics for their releases. The technological advances in CPU and GPU capabilities allowed manufacturers to create several types of the CPU's and GPU's being commercially sold in order to reach a more comprehensive user variety of different consumer parties with varying economies for PC budgets. While this is another topic not related to this thesis, higher-end CPUs and GPUs allow computers to generate more realistic and better quality 3D graphics and effects fluently, which then is observed by the player of the video game. The quality of the video game's visual renderings are

also managed by the video game engine developed or used by the video game's developers to achieve intended visual quality; however the optimization and delivery of the game engine and its potential are always relative to the hardware used in the user's platform.

Image 1.15: Call of Duty: Modern Warfare (Infinity Ward, 2019) video game's Clean House mission.
Source: Screenshot by Efecan Büyükbaykal

This thesis considers the perceived qualities of the video games on the recommended hardware specifications of the video game titles released by the developers and publishers of the said video games as the standard, which are recommended by the developers and publishers of the video games in order to achieve smooth gameplay and fluent graphics. Therefore the PC system used in this thesis research is built in order to achieve recommended graphical settings in the case study video games, for optimal perception observation and documentation.

1.4.1. Virtual Reality Benefits to Perception in Video Games

Virtual Reality systems increased the perception of video games in a significant upgrade. Before virtual reality technologies implementation to the video games, first 3D video games used arrow keys on the keyboard to change the perspective of the player or aim the weapon player uses in the video game, the next step was to implementation of the mice/mouse HID to allow the player to free-look and aim the weapon player uses in the video game. However, Virtual Reality technologies VR Headsets uses a technological motion sensor integrated with the headset to allow the user to free-look by moving users' head and allow the player a six DOF (Degrees of Freedom) in video games perceptive boundaries. Six DOF movement ability of VR HMD's allow the player to move with the HMD, which is translated in the video game the player is playing as movements on each axis. Changing the free-look ability from the mouse HID to VR headsets motion sensors allows users to look freely to any point, just as in the real world, utilizing movement, rotation, and canting the head of the user. Also, the perceived quality of the VR headsets include the use of stereoscopic screens in each eye socket adjusted for the users own eyes in distance and width between two eyes of the user to give a 3D depth in the visuals generated in the headset to increase the perception of the surrounding environment, video games details and allow the user to immerse in the video game. This quality of 3D depth combined with hyperrealistic graphics allows almost realistic sensation when observed from a VR HMD. Coates explains the VR's definition as "Virtual Reality is electronic simulations of environments experience via head-mounted eye goggles and wired clothing, enabling the end-user to interact in realistic three-dimensional situations" (Coates, 1992).

Recent developments and releases in the video game industry, including VR style gameplay, also improved how perception and the possibilities of VR are being used in the settings of video games. The latest release of Valve's *Half-Life: Alyx* (2020) is developed as a VR-only video game where the users have to play the game via a VR headset recommended in the system specs of the video game to include perception and freedom of movement in the video game. The video game's many puzzles include the use of VR HMD's motion

tracker sensors attached to the user's hands to manipulate objects in-game to solve puzzles or players specific positioning in the virtual environment to observe an event from particular viewpoint to see what each input of puzzle-solving action results. Movement in *Half-Life: Alyx* is also achieved by physically standing up, crouching down, or moving in real-world while using the VR HMD in pre-defined safe zones before gameplay activity. The success of Valve's latest video game release, and commercializing their own six DOF VR HMD that includes motion sensors able to simulate five finger movement in virtual space, will increase the research on developing more in-depth virtual reality games, with a possible switch of focus from the conventional way of video games to VR video games for better experience and perception.

1.5. Experience in Video Games

Video Games, while being in the entertainment industry, always includes different experiences. At the same time, many are increasing the experience of fingers, and eye coordination, some variants of the video games offer real-life experiences, such as driving vehicles, flying planes, sailing ships. It is also known that video games are not just limited with just motor coordination skills and real-life experiences, but the experiences video game offers to increase mental awareness and capabilities, memory capabilities, and problem-solving experiences and reflexes. According to studies, experience in video games can be classified by two main topics; experience in-game and experience achieved by the player in real-world. In-game experience in video games is primarily used to give a reward sensation to the player as a result of specific actions or accomplishment that can be used to develop and progress the avatar of the video game. However, the experience achieved by the player of the video game in real-world requires a more in-depth study, because this experience involves the thought process, problem-solving, motor skills coordination and reflexes.

First examples of these experiences could be seen in the *Tomb Raider* (Eidos Interactive, 1996) video game, where the player takes on the role of the protagonist Lara Croft, who is a highly intelligent archaeologist and a treasure

hunter, searching for ancient and forgotten ruins of ancient civilizations to find the treasures hidden from the surface of the world. In her adventures, the player has to control Lara Croft in the dangerous mazes and traps of the ruins player is searching and solve puzzles left by the builders of those ancient ruins to keep unwanted people outside. These problem-solving activities offered by the *Tomb Raider* series is known to use many of the players' mental abilities, in which rewards the player upon solving with Lara Croft opening another unopened section the ruins she is surveying, and mental memory experience and mental problem-solving abilities to the player.

Perhaps one of the reasons the video game industry is booming in this era is because video game developers are able almost to create any experience via the means of video games. This availability of difference in the experience provided in video game according to the broad consumer range of video games is the primary reason why video games are successful in the entertainment industry. This experience progression is best seen in the simulators where the video game uses the real-world physics and rules; the simulation event includes an activity, where the activity can be considered too dangerous for the well-being of the player without proper licensing and training. This activity could also be that unavailable to everyone besides selected few, and such examples are flying a military jet plane, landing a space shuttle, racing on tracks with world-class racing cars or driving a world war two era battle tank amidst a warzone. Researchers such as Laura Ermi and Frans Mäyrä, have explained the action of playing video games and experience correlation as "people play games for the experience that can only be achieved by engaging in the gameplay" (2005, p. 3).

Simulator genre video games considered to be less rewarding compared to the other video games genres because the player is rewarded usually just by staying alive and the option to continue simulating certain events more in-depth. However, this is a considerably valuable experience on account of the simulation's seriousness. Torben Grodal (2003) explains the video games as a distinguishing factor of experience and entertainment because they allow the experience flow and embodiment by linking perception, emotion and cognition

with first-person actions. Grodal's suggestion is the video game as an action that requires both motor skills and cognitive functions of the player to develop to a certain point in order to be engaged in gameplay. Ermi and Mäyrä contributes to the Grodal's observation of experience in videogames as;

> "When playing games, it is not enough to just sit and watch and possibly activate some cognitive schemas. Instead, the player must become an active participant. When successful, this type of participation leads to strong gameplay experiences that can have particularly powerful hold on the player's actions and attention" (Ermi, Mäyrä, 2005, p. 3).

Other mentionable video games reward players with in-game money, in-game fame, or good relations with other NPC's, achieving objectives and completing missions usually result in a scripted cutscene where the player learns more about the setting or story of the video games virtual world or receives further objectives and missions. Upon completing those given objectives and missions, video game ends, and the end of the video game is usually rewarding the player with particular in-game objects, titles, and so on. Only real experience, as mentioned above, is mental abilities provided to the player, such as motor coordination skills, memory skills, and problem-solving skills.

With these in mind, video games, as mentioned before, is only an act of playing a game, voluntary and rewarded with psychological stimuli. The primary purpose of playing the video game is as same as playing any game, achieve psychological stimuli and enjoy the time passed in the voluntary action of playing the video game, the play activity. Therefore the developers of video games, whether the video game in context a narrative video game, strategical video game, FPS video game or a puzzle-solving video game, is aimed to relay the most comforting and rewarding experiences to the players of video games.

Because of this objective in mind, the video game genres have been multiplied into multiple branches in order for them to each focus on a bracketed of experiences relayed in video games. A single genre cannot relay the focused experience; therefore, the separated genres focus on specific experiences aimed in the video game title. Such as that diversity in current video game titles is so

broad that players of the video game can choose the video games beforehand according to the experience offered to the player in-game. Several video games also offer what kind of experience the player seeks in-game from adventure to combat, or just story of the video game could be selected to adjust the video games difficulties and tendency on a single aspect. Therefore it is possible to say the experience offered in video games are also flexible to the player.

1.5.1. Virtual Reality Benefits to Experience in Video Games

Virtual Reality Headsets are now a shared option in video gaming. With the reduced costs of the VR headsets, and fluent graphics provided by the headset allowed a general spread of the usage of these mentioned headsets. This spread also resulted in a variety of video games where a video game could only be perceived from the screen, only from VR headset, or from both options depending on the user having a VR headset or not.

A typical example of including both VR and non-VR versions of a video game are Simulations, where these simulations could range from military to civilian simulations, and these simulations can range from using a vehicle, flying a vehicle or sailing a vehicle to driving a vehicle or controlling only one avatar from the first-person perspective. According to the user's choice, these video games could be run with or without a VR headset, while using a VR headset will give better immersion and feeling compared to using a conventional screen setup. Many video games are also able to be controlled and played with conventional keyboard and mouse HID's, or specific gamepads or controllers, or equipment built for ultimate experience and immersion. Therefore, the experience of the video game is specifically dependant of how the player's setup is. However, the technological benefits of VR HMD's and VR's motion tracker controllers can allow the player to hold, control, grasp, use almost anything in the virtual space, therefore eliminating the requirement for special HID's or controllers for the video game, becoming the ultimate equipment for video gaming.

Another example of the Virtual reality technologies addition to video games is the usage of motion sensors. These can fully experience in VR-only video games where the VR headset is not just limited to use the motion sensors integrated to the headset but includes the addition of the VR apparatuses included in the VR headsets retail packaging. In these VR-only video games, the player can look around and having six DOF freely, and besides, use the VR apparatuses which also includes motion sensors in the devices which gives the player ability to control anthropological hand-shaped control organs in video games with full hand rotation, movement, and finger flexibility. This freedom gives the player the ability to grab or hold the objects provided in video games or the ability to manipulate the surroundings in the video game environment.

With the current speed of progression of Virtual Reality technology and widespread, precise usage of motion sensors, it is considered the future games would be entirely in virtual reality context and be played with VR headset and motion sensor systems to integrate the user to the video game setting fully. This integration is already being one of the critical topics in debates concerning the technologies and humanities combined future and made its way to the motion picture media like a movie, considering the heavy use of VR. The movie *Ready Player One* (Spielberg, 2018), takes place in later times, where users of VR systems use virtual reality to escape from the dread of real life. The movie gives a subtle warning as with every technological progression, and contribution to human life, adaptation and regulation are advised instead of abusement.

Furthermore, perhaps with further developments, an ability to generate sensory feedback to the user in the physical world could also be implemented in VR HID's. The most recent release of Valve's new *Half-Life: Alyx* is a VR-only video game title that uses the VR technology to its fullest for the first time in video gaming history. In *Half-Life: Alyx*, the player is expected to move around the virtual environment with the use of VR headset and motion trackers which allows video game's avatars hands to be controlled by the user to manipulate objects around it and can even collide with other objects in the virtual environment if chosen so. Including the option to use virtual hands in

the video game, to aim and shoot, collect objects, store the found objects or combine objects found in the world in order to proceed in the video game or defeat enemies of the protagonist.

Image 1.16: Half-Life Alyx's (Valve, 2020) use of VR HMD's controllers to allow players to control Avatars hands in the game, real-time.
Source: Valve shows off how you'll fight and move in Half-Life: Alyx, by Adi Robertson, at https://www.theverge.com/2020/3/2/21161780/valve-half-life-alyx-gameplay-trailer-videos-teleportation-combat-puzzles

Half-Life: Alyx, proved that the experience in VR video games could be more entertaining and creative than a standard non-VR video game, the spatial and environmental experience offered, and the physical ability to manipulate game world while receiving the feedback from the virtual environment of those actions consequences is highly acclaimed after its release. This improvement and release also offer the video game developers to work even more on creating more VR titles that relay more entertaining experiences to the players in order to enhance the experience and joy obtained from playing the video game.

This type of gameplay also brings out the repetition to gain mastery over the video game elements and actions required to beat the game, which directly

correlates with the player's pleasure received from playing the video game. Because of the new movement capability and DOF provided by the VR systems, new types of experiences and pleasures could be simulated in VR and MR. Torben Grodal explains gameplay experiences as;

> "Video games provide personalized experiences that are based on playing (that is: pleasurable *repetitive learning processes),* backed up by emotions that change over time not only because of the events but also due to the development of the learning processes" (Grodal, 2003, p. 153)

Therefore, the experience mentioned in video game gameplay is extensively enriched with the addition of VR system, enhancing the experience earned by the player.

1.6. Physics and World Laws in Video Games

The real-world humans are living is considered reality, as opposed to virtual reality, where everything created in Virtuality is considered to be a computer-aided or generated. The real world consists of several physical laws, and the community's humans are living also consists of several laws in order to increase wellbeing and peace. Compared to the reality, or real-world, Virtuality, and VR systems virtual space, virtual space is generated in the boundaries on a computer system and bound to the Virtuality, which cannot exist outside its boundaries in the real-world. However, since virtual reality can be programmed and adjusted, its laws, physics and settings can be changed if chosen so.

Physics laws in our reality are considered to be absolute in the earth, and can be explained physically and mathematically, and observable. There are no options or ways to change those absolute rules without affecting the physical environment. For example, the gravitational pull of the Earth will always be the same until the planet's core extinguishes, or the mass of the Earth changes. Therefore, the gravity pull of the earth is considered absolute for the Earth, until any other effect disrupts or changes the physics. A human cannot defy the gravitational pull of the earth by any means besides achieving terminal velocity

in opposing vector, which is greater than the gravitational force otherwise cannot leave the surface of the Earth by any means. There is also a specific physical effect of action and reaction, where a certain amount of force is equal to the same amount of opposite reaction. This effect can be observed via objects crashing into each other such as vehicles or objects getting crushed by trash compactors. Every object will have a specific physical resistance to some aspects of the physics, such as being malleable or durable, brittle or sturdy bonded, and reactions to change of temperature. Every physical action, in reality, is explainable by physics, and every action is known to react in an opposing force.

Constitutional Laws of the planet Earth or countries in the Earth are also a set of rules put forth with the convening of rulers, in the hopes of increasing the wellbeing of living humans and keeping the peace, and there are specific penalties for breaking the laws of living, from minor incursions to significant punishments.

However, in video games and virtuality, both of these laws can be changed or altered, depending on the scenario and setting of the video games story, or the universe created for the video game. For example, if a video game is set on an undefined universe with no specific set of physics laws declared, a video game can surprise the players with a different set of physics laws by letting the player experience the laws themselves, or could also include a briefing before gameplay about the new laws included in the system because of the new setting. For example, a video game could take place on the surface on the Mars, such as *Doom 2016* where the research installation has a greater gravitational pull such as Earth for the comport of the employees working in the installations, and the surface levels outside of the research installation let the player feel a lower gravitational pull different than Earth's. The physical rules in video games are achieved by physics engines integrated into the video games and by entering specific scientific pieces of information already provided by scientists and generally known. Also, according to the video games setting of stories, the avatar of the video game that the player controls could inhabit supernatural abilities, magical abilities or superhuman strength,

durability, endurance, or speed otherwise impossible to obtain or achieve in real-world because of how humans physically are. Therefore, the physics laws in the video game can change accordingly to the video games scenario, setting and created an alternate universe.

This law is not the case for real-world like video games where the video games story and gameplay take place in the earth, or Simulations, where the video game developers try to mimic real-world physic laws as close as possible, in order to create a realistic simulation of defined action. This pursuit of mimicking real-world physics in simulation type video games is to achieve the closest quality and effects happening in real-life. This integration is best seen on racing and flying simulator video games, where the tyre traction of racing cars or the pressure difference on wings of a plane is calculated and reflected the player accordingly to the real-world occurrences.

Several games, outside of fantastic or science fiction genre and simulation genre, offer real-world physics and real-world laws, and create the video game accordingly to the real-world counterparts, where every action feels realistic, while not being a simulation itself, but instead focuses on another genre and topic. One example of this is *Half-Life 2* where the video games story progression takes the avatar thru several areas in which the player is needed to solve a puzzle using physics by pushing or pulling objects with different weights in order to proceed. *Half-Life 2*, while using a cutting edge physics engine of its time, also introduced a Gravity Gun in-game to the players that can pull and push objects with a great force beyond human strength, which is also used to manipulate the world of *Half-Life 2* and solve several puzzles.

Image 1.17: Half-Life 2 (Valve, 2004) incorporates the physics engine with puzzles that the player must creatively think, interact and solve to progress thru the levels.
Source: Screenshot by Efecan Büyükbaykal.

Another mention of the physics and its importance would be *Mirror's Edge*, where the user takes control of avatar, Faith, a free runner whose occupation is being a courier. The setting is the real world like, while the ruling system being more digitally dystopia-like, heavily inspecting, and surveillance of information is restricting any sensitive information from being shared. Because of these settings, the information couriering is the job of these free runners; where the courier takes a piece of information from the client and runs on top of buildings using free-running sport. Using athletic feats such as swinging, sliding, rolling, jumping, and physics like conservation of energy or action-reaction equation and rebounding from edges, evading any authorities or spying eyes from observing and reach to a destination to deliver the information given. In *Mirror's Edge*, physics laws mirror the real-world physic laws where the player has to abide by the rules otherwise fall to their death. Of course, several limitations of physical world laws have to be removed from video games or increased in video games, because such actions described above

requires sharp physical wits and endurance, where a regular human is unable to perform mentioned tasks or not able to be performed at all.

Another mentionable example of physics and world laws could be given from *GTA* series of video games, where the player controls the avatar in the video game can do almost anything the player chooses to. *GTA* video games offer an open world where the player of the video game is free to do anything and known to commercialize on its options of customization and freedom. These actions also include felonies, crimes, theft and murder according to the video games set, and these heinous actions also have a repercussion, where the *GTA* world consists of artificial intelligence controlled law enforcement units, like NPC's, which respond accordingly to the disturbances the avatar causes if the crime is reported. The laws example given in *GTA* series is the closest to the real-world setting where the traffic laws, collisions, or crimes are responded similarly in a real-world setting.

CHAPTER II. VIRTUALITY AND REALITY

Almost every medium and industry in the 21st century is technology-based, and the change or adaptation with these technological advances is inevitable at this point. Recent emergence and advancement of virtual realities and its techniques are providing substantial improvements in design and AEC industries. The improvements in AEC industries technological side and new concepts of looking at design procedure is researched extensively by Marc Aurel Schnabel. Schnabel is a professor of architecture, a leading researcher on Reality-Virtuality Continuum, and one of the researchers experimenting on adapted use of MR, VR, AR, and social media to universities design studio's work and design cycle and CAD programs. This improvement is explained by Schnabel as;

> "Various new developments in computing, visualization, and modelling technologies allow Architecture, Engineering, and Construction Industries to make use of novel techniques that merge real-life situations with computer-generated visual information to combine real and virtual spaces" (Schnabel, 2009, p. 3).

To be more precise; the past decade has improved the ability to combine virtual space and real space in a variety of reality concepts. These concepts are known as Virtual Reality (VR), Mixed Reality (MR), Augmented Reality (AR), Augmented Virtuality (AV), Amplified Reality, Virtualized Reality, as schematized in the Reality-Virtuality Continuum created by Milgram and Colquhoun in late 90ies. (Milgram and Colquhoun, 1999, p. 1177). Reality-Virtuality Continuum concept is first created and introduced by Paul Milgram in 1994 (Milgram, 1994, p. 2351).
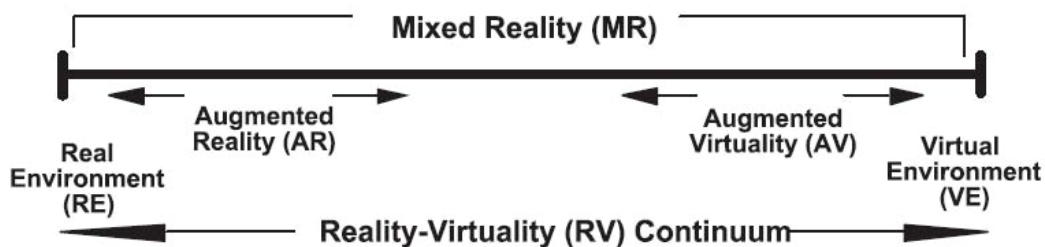
Image 2.1: Reality-Virtuality Continuum presented by Milgram and Colquhoun in 1999.

Such technologies and researches also brought fort advancements in computing and design, construction, engineering, several professions that use the precision and simulation benefits of the virtual reality technology and the most widely known video games, using their potential in improvement.

The common point in these concepts is to include computers and computer-generated imagery in everyday human activity, to increase the perception and interaction further is required or described activity. However the experience of that is virtual is commented by Rennan Raffaele, on his thesis of virtual reality for digital game design and development as "Virtual Reality means experiencing things through our computers that do not really exist." (Raffaele, 2017, p. 26). Greenbaum also defines virtual reality as; "Virtual reality is an alternate world filled with computer-generated images that respond to human movements" (Greenbaum, 1992, p. 58). Although the definitions of Virtuality and virtual reality has changed throughout its inception to development and today integration with everyday life activities to collaborative work cycles, Virtual reality is a reality created in the confines of digital space.

Moreover, usage of these mentioned reality concepts and implement them on possible mediums is mentioned by Kvan and Schnabel as "specifically tailored to enhance comprehension, interaction and collaboration for specific activities along a design cycle" (Kvan, 2000, p. 410; Schnabel, 2009, p. 4). These researches asserted the requirement in that medium in order to improve what can be done with physical and analogue terms with digital or merge both realities in mixed reality terms.

The improvements and reality concepts as with their implementation and enhancements on a larger scale will be explained in this section to create a foundation for comparison and correlation in between realities. Real-world information will be used to compare video games' realities correlation with real-world realities in terms of architecture, design, and perception. Currently applied mixed reality technologies explained in the "Virtuality-Reality Continuum" (Schnabel, 2007, p. 8), where the virtual, real, and the real concepts in between are laid on a scale to understand their standings better.

This research is using Schnabel's research summaries classification on Virtuality-Reality Continuum, a scale adapted from Milgram and Colquhoun's scale done in 1999. Reason for Schnabel's Virtuality Reality Continuum scale (Schnabel, Wang, Seichter, Kvan, 2007, p. 8) is chosen because it is much more updated and extended version of the Milgram and Colquhoun's (Milgram and Colquhoun, 1999, p. 1177) previous scale.
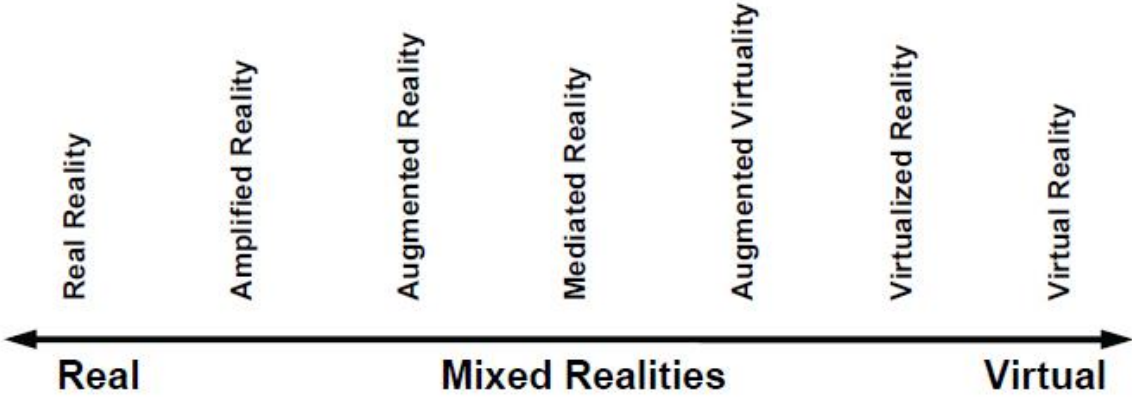
Image 2.2: Schnabel's Virtuality Reality Continuum scale presenting the order of reality concepts by Schnabel, Wang, Seichter and Kvan at 2007.

2.1. Virtuality

Virtuality, as a reality concept, changed how previous realities are perceived. Since then, our reality has found itself a way to adapt to these new reality concepts as technology improved them. Virtuality, as defined by Schnabel, "is a realm that presents an entirely computer-simulated environment." (Schnabel, 2009, p. 9). In this concept, Virtuality as reality merges with or replaces sections of the real, physical world in terms of creating new realities that humans can perceive. Husserl and Gibson discussed this in their book published in 1931, titled Ideas: General Introduction to Pure Phenomenology, as "how artificial interacts with the physical world of everyday human activities in order to enrich the experience of perception,

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affordance, and engagement" (Schnabel, 2009, p. 4), and phrased by Schnabel as "merging of realities" and their common point as "all mixed realities share a common philosophy." (Schnabel, 2009, p. 4).

In our current 21st century state, the physical world without the addition of digital is unthinkable, where digital systems control even our basic requirements, and all of the human economics digital. Subsequently, virtual technologies and the advanced graphics of virtualization were bound to enter human life, in one way or another. In a common philosophy, everything digital humans' day-to-day activities control and use, creates an overlapping layer of physical and virtual realities, thus, in a way putting the user in a mixed environment where the definition changes depending on how the mixed reality is used. However, the use of Virtuality and its increased hyperrealistic graphics rendered in 3D perspective and depth, and the use of VR HMD's increases the virtualities importance as a digital space in real space.

In the past decade, with the advancement of technological capacities and production capabilities, VR technology is researched, prototyped, and looked into in-depth. Nevertheless, in order to explain virtual reality and mixed reality concepts, real environment and virtual environments also need to be explained. Currently, Virtuality consists of Virtual Reality, Virtualized Reality, Augmented Virtuality, Mediated Reality, Augmented Reality, Amplified Reality, which in between real and virtual, creating mixed-realities or mixed-environments. Schnabel classified order of reality to Virtuality in 2007 to a table and currently being used as such in order to classify Virtual Reality types and their positions according to perceived reality. In order to understand Virtuality and Reality in the sense of ME topics, the differences between these realities must be laid out. Otherwise, the vague definitions of different realities would not be sufficient to use the Virtuality-Reality Continuum to correlate in between the Real-world and Virtual world.

2.1.1. Virtual Reality

Virtual Reality Technology, abbreviated as 'VR,' is a type of reality system that generates a whole computer-generated virtual environment, which then can be perceived and looked into from angles that the viewer chooses, experienced, and could be traversed. This system is previously suggested and looked into by Designers and Architects to be used in concept presentations. Technological advances also improved the computer-generated graphics to a realistic level, "computing has also advanced, as they have supported more sophisticated computer-generated graphics" (Hendrickson and Rehak, 1993; Schnabel, 2007) is how other researchers and collaborators describe the improvement. These advances, suggestions and implementations now combined in the VR concept for immersion and freedom of movement in Virtuality.

Virtual Reality concepts currently developed to a point where it is a widespread technological option for the home, recreational use, office, design and among many other human activities. This technology can even be achieved by using the use of smartphones with a VR headset device, instead of obtaining the standalone product, which allows every user with a smartphone to experience VR in six DOF. In between those sections, Schnabel explains that VR's strong use fields also include

> "a wide range of interest in diverse fields, with the typical application being web-based design review, Computer Supported Cooperative Work, as well as 3D-type thinking with desktop-PC and headset based VE" (Schnabel, 2007, p. 3).

Schnabel then goes on to quote from his previous research; "and for the first time, immersive virtual environments were successfully deployed to be used on creation of an architectural design in larger context." (Schnabel, 2002; 2007: 3). Therefore, the current researches and the researcher's opinions on the VR systems and Virtual Reality Concepts are very positive. Positive being tremendous support, new ideas, and concepts are uninterruptedly generated, and it is well-thought-out to be the next technological evolution.

However, current usage of VR requires the user to wear a headset that is housing Head-Mounted Display (HMD) which is connected to the user's PC

in order to show the computer-generated VE in 3D depth to the user and immerse the user to that VE. Separating users perception and consciousness from the real environment also removing any physical expression, visible emotion or personal interactions from the user and these expressions are required for Human to Human contact. Therefore VR and VE usage limit the user to the limitation of the generated VE (Schnabel, 2007). While being the most widely used technology of ME, it is still limited to the user and the user's VE of choosing. Currently, because of this limitation, a new generation of virtual reality headsets and virtual reality concepts also include headset cameras to allow the user to perceive the real world if required. This addition is also opening a doorway, and development for virtual reality headsets to not only be a VR HMD but also work as an MR HMD, including more than one reality concepts in the system, offering more flexibility to both user and developer.

Image 2.3: A VR HMD by Oculus.
Source: https://www.oculus.com/rift-s/

2.1.2. Virtualized Reality

Virtualized Reality concept is defined as a concept that "virtualizes real world-scenery by capturing scene descriptions from a number of transcription angles, and aligns the 3D structure of the scene with the image." (Kanade, Narayanan and Rander, 1995; Schnabel, 2007, p. 7) by Schnabel. In order to generate a scene for Virtualized Reality system, the object, location, or the event has to be recorded from every angle, using camera systems. The recorded project is then generated in the computer system for it to be virtualized and then rendered to be projected to the planned area. This concept is the same as the Virtual Reality concept. However, the difference in between is, Virtual Reality User has to use an HMD headset covering eyes which each eye socket has a high fidelity screen projecting the desired image to create an image perceived as in 3D depth. On the other hand, Virtualized Reality does the same without the use of an HMD. Without an HMD headset or any constraints, because the location, event or the object is recorded digitally, visualized and then rendered to the scene digitally, with the aid of cameras and projectors or viewing glasses and allow the user to traverse in the scene and look from different perspectives.

2.1.3. Augmented Virtuality

Augmented Virtuality is a more expansive form of the VR concept, where the user can manipulate the computer-generated imagery. Besides, Augmented Virtuality is defined by Milgram and Colquhoun (1999) as the augmentation of VE with real objects, while Schnabel (2009) defines it merely as looking into reality from a virtual world perspective. Whereas in the video game concept, the Augmented Virtuality implies the real objects surrounding the user, and the users themselves can be projected into Virtual Reality.

More frequent usage of this technology is via Smart Devices with screens and cameras integrated to the device, where the user can place virtual objects in the imagery camera captures from the real space, instantaneously. Therefore,

the user can modify the real space via virtual means and plan or design the real space with the help of virtual tools provided in the application used to achieve Augmented Reality.

However, the design industry is working for more progress in Augmented Virtuality (Oxman, 2000), Schnabel reports that Augmented Virtuality has not received significant attention, like AR or VR did (Schnabel, 2007). According to Schnabel, he reported that "the recognized research efforts towards AV applications in the design domain is fairly limited" (Schnabel, 2007, p. 5). However, later added that "according to Oxman (2000) the only commercial design and gaming industries are creating incentives for research in Augmented Virtuality" (Schnabel, 2009, p. 8) in his later research which implies that Augmented Virtuality requires further development and study for this concept to be much more available in widespread common usage.

2.1.4. Mediated Reality

Mediated Reality term is a mix of Virtual reality and Real-world throughout the usage of computer-generated information to modify human perception. This concept is achieved by devices that block the sensory input to humans and transit it thru the camera the user wears to achieve Mediated Reality. The blocked sensory input compiles with the computer-generated information and only after then is relayed to the user's eyes, including more information and data than a regular sensory input would carry. Schnabel, explains this process with;

> "Mediated reality describes the general concept of the artificial modification of human perception by re-synthesizing the light that reaches the eye of a user. Information is added or removed from the scene before it is 'seen'" (Schnabel, 2009, p. 8).

This type of reality concept, the primary purpose, is to alter sensory input with requested information or enhance the sensory input. While its potential to be used on AEC industries are many, such as "this method can aid urban designers to envision a landscape where a building is proposed, removed, or

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replaced" (Schnabel, 2009, p. 8). However, the primary usage of it is to enhance vision and information gathered by the user or achieve the Diminished Reality concept, where the sensory input is altered in a way so that user's perception of reality is deliberately diminished to only show the filtered or altered vision thru the HMD.

2.1.5. Augmented Reality

Augmented Reality is another concept in the Virtuality-Reality Continuum that works in real space while visually inserting computer-generated imagery or visuals into the real space perceived by the user, to support and enhance the objective that is interacted. Milgram and Colquhoun's (1999) definitions classify AR as a sub-realm of MR. According to Seichter and Schnabel (2005), "AR can project virtual elements into the real world as visuals to which designers can associate with tangible interfaces and provide great benefits for architecture and urban design" (Seichter and Schnabel, 2005; Schnabel, 2007, p. 4).

AR concept allows users to work in real space while not being separated from the real world and the perception user has while receiving computer-generated imagery projected on the task at hand, therefore assisting the user on the required task. AR concept is previously used on entertainment medium and video games, but with the developing technology and improved visualization systems, Augmented Reality systems are now working with Goal-Oriented systems, such as training, surgery, and collaborative work (Schnabel, 2007; Kvan, 2007; Schnabel, 2009).

There are extensive works and prototypes created with AR concept for engineering, design, and urban planning to be worked collaboratively while mixing the computer-generated imagery with real-world locations or space. However, compared to the VR Concept, AR is hardly getting out of development or seeing further use because of the unpractical solutions and low resolution to capture imagery and project imagery thru user's HMD headset and

apparatus in between Collaborators group. Schnabel remarks this by his mention of the situation;

> "The state-of-the-art in AR today is comparable to the early years of VR in that many systems have been demonstrated, but few have matured beyond laboratory-based prototypes… …Some technological problems like low-resolution video capture devices and low-resolution head-mounted displays have prevented the widespread adoption of AR in various fields of applications, including design" (Schnabel, 2007, p. 5).

2.1.6. Amplified Reality

Amplified Reality is an amplified version of the AR concept, where the information is enriched for user's perception through the superposition of digital projections over real space. According to Schnabel's definition;

> "Amplified Reality amplifies the expressions of objects in the real world and emphasizes the importance of the shared experiences that result from publicly available properties of objects. AR is about how the user perceives reality, while the amplified reality is based on how the perceived might control how information is made available" (Schnabel, 2007, p. 6).

Amplified Reality can be used in very strategic and different situations where the user is always provided with amplified information and serves to enhance and increase the information given to specific professions. This concept also considered being able to use in the home environment because it is the amplified version of the AR concept that includes the same properties, which has been explained previously.

2.1.7. Mixed Reality

Schnabel describes the Mixed Reality concept as "a more expansive state and form of Virtual Reality, Mixed Reality is considered as where the computer-generated imagery is intermingled with real-world" (Milgram and Colquhoun, 1999; Schnabel, 2007, p. 3). Therefore, the term MR includes all of the real concepts in between Real and Virtual Continuum. Depending on the method of augmentation, MR provides numerous options for both

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communication and collaboration in many professions. The focus of the researchers for this technology's further development for the past decade has incrementally increased. While the MR term extends over both Real and Virtual sides of the Virtuality-Reality Continuum, it also narrows down to two significant sub-modes, Augmented Virtuality and Augmented Reality, which is explained in the previous sub-topics.

MR technologies offer the potential for interaction between design information distribution and collaboration for the entire design cycle or construction cycle for AEC industries. In this context, Schnabel explains that "MR merges both realms, real and virtual, into a new environment. Virtual Reality (VR) technologies create an intersection wherein real and virtual-world objects are presented together in a unique experience." (Schnabel, 2009, p. 4). Xiangyu Wang and Schnabel as also mention this technology as;

> "a potential for the mixed reality that by merging a range of digital and physical media, the design and construction process can be enriched by different perceptions, comprehensions of spatial volumes within both physical and virtual environments" (Wang et al., 2003; Schnabel, 2009, p. 6).

Schnabel continues to explain this as "developing computer support for collaboration in design or construction means creating systems that can amplify the effectiveness of the collaborating team as a whole" (Schnabel, 2009, p. 6), then includes that "MEs were originally embraced for design concept presentations, the advancement of computing allowed designers to interact within the Virtuality-Reality Continuum at a more sophisticated level" (Schnabel, 2009, p. 10). According to this, technological implementation of mixed realities in design, architecture, engineering, and construction industries, among many others like piloting, driving, simulations, and surgeries professions are prioritized before any other implementation.

2.2. Virtuality in Reality

Explaining the Virtuality-Reality Continuum and VR concepts without explaining the reality is almost impossible. Reality is the definition of the real

physical world, where Schnabel explains in his studies as the real world is consisting of physical laws and consists of elements that can be intermingled with, or manipulated toward use, which exists, in comparison to Virtual reality where the elements created or manipulated in that realm are just computer-generated information (Schnabel, 2009, p. 6). In terms of architecture, Schnabel defines reality as;

> "the term reality covers all, that is, whether or not it is created, designed, observable, or comprehensible. The reality, in this sense, may include terms like void, space, solid, building, built, dynamic, and stable. There are many philosophical, phenomenological, historical, and social categories and definitions of reality that go beyond the framework of this section. It is how-ever interesting to note that, with the emergence of MR, reality redefines itself anew and stands as one realm, among others" (2009, p. 6).

The reality, in terms of definition, is physical world humans are in, includes what is real and what is perceivable or observable, robust, built, dynamic or static, or void, otherwise include many epistemological, philosophical, and phenomenological categories which exceed the contents and purpose of this thesis. Jim Blascovich's, a professor of psychological and brain sciences, and focuses on virtual reality research, virtuality and the reality understanding compared to virtuality in his book, *Infinite Reality: The Hidden Blueprint of our lives* (2012), and can be summed by his later interview as;

> "Pragmatically, nearly everyone considers the physical world as grounded, or "real." Any other environment, whether created via a bedtime story, novel, cartoon, television, or game platforms such as Nintendo's Wii, Sony's Move, or Microsoft's Kinect, is considered virtual reality. Hence, we conceptualize virtual reality in a relativistic way; that is, in contrast to what is considered grounded" (Blascovich, Ehre, 2019).

Because of this vast extent of reality, this thesis will evaluate the correlation of Real and Virtual as Reality to be considered as the physical world, as opposed to the virtual world generated by computers in said reality concepts and its side products. Spaces on this matter of Virtuality and reality will be considered as the space occupied or existing in real-world, and space created in digital space which is only achievable by digital means and exists in real-world in digital space provided by PCs.

2.2.1. Virtuality as a Supporting Factor

VR technologies are a vast supporter in several technology branches and a very major technological improvement in the Architecture, Engineering, and Construction industry. This improvement has brought with it a majority of improvements and advancements in production technologies, computing systems, visualization technologies and systems, feedback systems, design systems and methods, Building Information Systems (BIMs), and engineering systems. With the support of virtual technology, many of the mentioned professions now can take advantage of planning before building, or perceive, observe, test, simulate and try the planned design or action with the help of virtual technologies.

These virtual technologies, combined with reality and several supporting systems of AEC, such as CAD programs, simulations, or visual media creation programs, shows visible and promising results and potentials. A prototype created to implement multi-touch capabilities to the virtual designing system allows significant benefits to the design cycle, and the case studies benefits are explained as;

> "In design activities, people create an external representation of information, often of their ideas and understanding. (our) System provides a common ground for multiple users to express their ideas with immediate correspondence from the representation showing on the multi-touch tabletop. It aids users to make their ideas more concrete and explicit, and once externalized; they can reflect how well their work sits within real context or situation or communicate and collaborate with stakeholders" (Chen; Schnabel, 2011, pp. 566-567).

As everything is associated together in these industries, lone production and evaluation in an industry are unthinkable. Every profession is either intermingled with one another or a support provider for another, development requests and requirements, further researches brought with it a series of development which in turn supported each other and created a significant upgrade in said industries and mediums. For example, if virtual technology requirements and improvements have not dictated that they required better visualization agents, computer-generated imagery, computer systems would not

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have improved in a way that supported VR systems efficiently. Todays VR systems compared to first examples of the early 2000s required better graphics and better hardware and faster systems, which also was answered by electronic engineers and material engineers, producing better materials for conductivity and better electronic systems for management of those said systems. We can see a linear and booming progress in the past decade on every technology integrated medium.

When looked into VR, because just by researching and developing virtual reality systems and technology, all of it sub-systems were also improved vastly; we can see how microprocessors integrated into computers got smaller and better. After being tested in computers and smart devices, these improvements have been put into virtual systems devices for their size convenience. Another observation of how the graphical quality of computer-generated imagery in the last decade improved tremendously, to achieve a real-life quality visually. These technologies quickly got themselves integrated into the AEC Industry, improving the quality of products, and hastening the design process, helping the whole design cycle by providing better systems and better computer-aided programs. This progress is improving the quality and connection of collaborating mediums in design. Because of these improvements and spreading between mediums, VR technology is being able to be used by home-activities for recreational purposes, or professional systems without having to be a member of the mentioned industries too. Improving the virtual technology and VR concepts opened a new door and a new doorway in the majority of the industries, not just for corporate business, but also for small third-party developers and testers too, helping in the outcome of the progression of the technology and spreading of the technology. The VR technologies widespread use, test and progression, its systems and programming allowing open-source sharing, also creates a platform for development provided by other collaborators outside the industry.

Because of this, the supporting factor of Virtual technology is essential, and it is to be explained in the following sections to create a better

understanding of how the improvements have taken hold in several industries and how it was used to improve the said mediums.

2.2.1.1. Virtual Technology in Computing

In the past decade, a further inclination of development for Virtual Reality Concepts, could not be achieved without the improvements in computing. While so, the computing industry also got affected by virtual technology while it was helping it to develop. The most critical system for computing in virtual systems is the virtualization technique, where the concept is to create one or more virtual machines in a single physical machine, while its purpose is to divide the workload and processes into several of the created virtual machines. This term is first explained and mentioned by Ted Holm Nelson, in his 1965 paper for Association for Computing Machinery Conference in 1965, Virtuality is perhaps, first time used in the digital context and considered as a revolutionary progression in computing. As of today, virtual systems progression is used as creating virtual machines and cores, with faster calculation power and more effective use of the hardware, subsequently effectively dividing the calculation load exerted on a PC.

Virtualization in computing technology allows the physical computer to divide itself into sub-cores, where each core can run a virtual system that can be tasked with different priorities, calculations or simulations, or run different OS' and perform a multitude of functions and options at once without the requirement of installing multiple physical computers and controlling them one by one. Many Research Centers are using these major systems divided into smaller virtual systems offered to their scientists and researchers to be substituted for larger computers occupying more volume in the workspace. This division is also allowing real-time control of the system where the required capacity and performance options can be adjusted.

The same virtualization concept in computing resulted as a creation of Virtual Computing Cores in the CPU's, acting as the brain of the computer,

making the processes and calculations required for the user's preference of programs, instructions, and requests. This virtualization technology allowed computers and CPUs to improve vastly, which in turn improved the processor technology. CPU's are the central element in the generation of computer-generated imagery where the computer-generated image is calculated and put in order by the CPU and then rendered with the Graphical Process Unit (GPU). There are constant communication and planning between the CPU and GPU units of a computer when generating computer-generated imagery. Therefore, the advance of this technology, resulted in a mass improvement on both computer-generated imageries becoming more realistic and being able to be rendered faster, containing more LOD and easy to produce and procure. This improved abilities and reduced cost combined with ease of production resulted in technologies spread over every electronic device now, from smartphones to computers, which in turn, lead an improvement in the computing industry.

Virtualization technologies in PC's and computing is an important research aspect and development topic in computing, considering how important and essential computers and computing systems are in human lives contemporary use. Virtuality, virtual reality and their contributing systems, therefore increase the adaptation, development in these studies, while also receiving vast amounts of development for their implementations, creates a linear evolution in both mediums.

2.2.1.2. Virtual Technology in Design

The design industry is one of the many industries which took the full-scale of the improvements provided by the development of Virtuality technology. Oxman who also researches virtuality and design, explains this as a process of visual reasoning;

> "Among the fundamental cognitive processes in design is that of the exploitation of visual representations of design states as a medium for the exploration and development of designs. This is a well-known interactive and exploratory process. Exploration in design has been postulated as a process of perception, conception, and presentation. This

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sequential, serial process of presentation and re-representation results in a series of transformations on externalized presentations" (2000, p. 339).

Therefore, advances in qualities of computer-generated imagery and virtual technology allowed an increase in the variety of design processes via perception, providing designers with more visual information and freedom of exploration, ease of presentation, and production.

The design medium uses many of the improved virtual systems offerings, and several of them are used in creating virtual replicas of volumes, spaces or objects in order to showcase it in the world wide web as virtual museums. Creating 3D imagery from 2D imagery with the help of virtual technology, and use the virtual technology to achieve quick and efficient 3D designing with tools that are impossible to create in reality. Altered and simplified versions of this technology, integrated with design and commercial use, is also being used on 3D online shopping where the user can see the object in 3D perspective. The user can alter its appearance, or even use it as an augmented reality version of it to place a virtual placeholder for the item to a reallocation provided by the user's smart device to see it as how it would look and occupy a volume in physical space.

Virtual developments another benefit on design medium is providing Virtual Reality, Augmented Reality, or Amplified Reality systems to the designers to be used to work on real space and virtual space at the same time, work on holographic projections cast by the virtual systems and collaborate on the design cycle, or to another end of this benefit, create adequate, hyper-realistic and hyper-immersive graphics and designs for video game medium to be used commercially via the help of mixed reality technologies. While the next significant improvement and era of technology are named Virtual Technologies, the design industry is prearranged to take full advantage of these new virtual technologies, as in using them to increase the creation and planning of required project or design, or in any way, the designers equipped with virtual technologies are needed on that matter.

2.2.1.3. Virtual Technology in Engineering

The virtual advancement of technologies, as explained in the previous sections, increased the capacities of the computers and the power of computing, which in turn supported designers and design tools. This improvement also benefited the Engineering industry, as engineers are now able to use the virtual technology provided by the computing to create better systems for designing such elements, and use the virtual technology provided by designers to use new design tools to approach the required task from different angles. This process allowed engineers to work on required designs on levels and approaches previously thought impossible. Ability to use virtualization techniques and technologies and new tools provided by these technologies allows an engineer to work on new materials and elements to create new compounds or composites, shapes or constructions, work on the projects required tests, simulations and foresee the problems that would hinder the project and eliminate them beforehand. Nobuyoshi Yabuki and Hiroki Machinaka explained their researches conclusion on using VR and AR technologies to plan steel bridges as;

> "In this research, we developed a product model for steel girder bridges for representing 3D geometry and attributed data of all the members of the structure so that interoperability of the data should be realized. Then, we developed a VR-CAD system for detailed design of steel girder bridges by using the developed product model, … Although the VR-CAD system demonstrated its feasibility and effectiveness, better user interface than a mouse was necessary to capture, move, and control objects in the virtual world on the display monitor… This system can be used for interference checking among girders and surrounding objects such as buildings, trees, poles, and other structures" (2006, p. 1292).

On a larger scale, the engineering industry is now using these systems intensively on every physical product, virtually testing and intricately inspecting every angle, before physical construction or production, creating simulations accordingly that is needed for the constructions or productions requirements, such as bridges, or skyscrapers or mechanical systems. In the advanced state of computing, designing and engineering, supported by the vast virtual technologies, computers simulating any test required on any design can

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pinpoint the problems beforehand, that is entered before simulation, which in turn can be observed and solved by the engineers equipped with virtual technologies.

2.2.2. Combining Virtuality with Reality

Over the last decade, improvements made on the computing, designing and construction technologies, and integration of virtual capabilities to said industries allowed a visible and documented improvement. Schnabel explains this improvement as;

> "As the AEC industries integrate increasingly digitally managed information and BIMs more intuitive visualization platforms are necessary for efficient use of such information. Recent advances in computer interfaces and hardware instruments have fostered MR prototypes to improve current architectural visualization, design communication and processes, development of building construction, and engineering management and maintenance systems. The combination of real with virtual entities creates mixed environments that could enhance and aid these processes" (Schnabel, 2009, p. 5).

In this section, the combination of virtual technologies to real-world industries and the improvements of the virtual technologies combinations with those industries such as Design, Engineering, and Architecture will be laid out.

2.2.2.1. Virtual Technologies Benefits on Design Medium

With the implementation of virtual technologies and advancements done in computing technologies, allowing computers and their CPUs, GPUs, and RAMs further abilities, provides users with new features on computing, calculating, visualization, and design tools, created almost infinite ways and possibilities on design systems for designers to use. Previously without the improved systems of today, the lack of computing power and capacity of these hardware issues bottlenecked the benefits provided by the programs or systems allowed design in virtual systems or platforms. However, currently,

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contemporary programs can work faster than anything imagined before, and perform tasks previously considered not possible.

These systems and programs created with those technologies, allows designers to instantly convert 2D designs to 3D designs, using the VR technologies to their benefits to create MR environments to work collaboratively with other design cycle contributors, projecting the design on real-world via VR systems, change and evaluate the design accordingly to the design cycle required.

These improvements and benefits allow user's and designers to work faster, more conscious of the design and the process, communicate with other collaborators in a much-uncomplicated manner, and an ability to perceive and inspect the design from any angle thanks to the virtual systems benefits implemented to the process. Thanks to this benefit, designers, in the last decade, we can design more complicated designs and systems with the help of virtual technologies.

2.2.2.2. Virtual Technologies Benefits on Construction Medium

Over the last decade, improvement and integration of MR concepts to construction medium proved a powerful instrument to bridge the gap between the idea of design and its representation over its construction process. Merging VR concept with the real world reality throughout construction is crucial for the finished project and its construction cycle, as in virtual technologies ability to virtually project and visualize the project with the help of mixed reality concepts and tackle the problems that could occur over the construction process.

Almost the same approach over-engineering medium, construction medium is using virtual technologies to render and observe the finished construction project via the technological means MR offers. To this end, this technology can offer complex angles of observation and detail otherwise impossible before construction, and therefore helping construction systems to

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solve problems, try different approaches or work with other collaborators in the project to better layout the system that is wanted to be built.

As of today, MR is one of the necessary and irreplaceable parts on the construction medium and its industries. Due to its virtual ability to create architectural visualization and engineering visualization, MR allows design communication between collaborating industries and systems. The communication between mediums also reduces the load projected on construction systems as in building management and maintenance systems, increase the efficiency of BIMs to help them further ease the construction on said systems by allowing digital solutions, therefore enhances the design and construction cycle.

2.2.2.3. Virtual Technologies Benefits on Architecture Medium

Over the many other industries in the AEC group, architecture could be considered to be the most affected medium by virtual reality technology. Because of the improved computers and their designs are allowing better computer-generated visualizations and virtual reality concepts allowing virtualization of the designed project beforehand, communications with other collaborating design cycle industries, further improving the subdivisions of the design cycle process to the tiniest detail, visualization and immersion.

MR technologies allowed architecture to use computers and the VR systems to their full potential, projecting considered projects to real-world locations to generate the visual of how it would be after the completion of the project, or generate the visuals for any enhancements or additions to the original design in a hyper-realistic quality. This progression also allowed designers to use the same technology to be presented to the client in virtual reality or augmented reality systems in order to immerse the client with the projects full design cycle over the process. This implementation is explained by Wang and then Schnabel as;

"By merging the virtual systems with the analogue systems, design and construction process can be enriched by different perceptions, and understandings of spatial volumes within both physical and virtual environments" (Wang et al., 2003; Schnabel, 2009, p. 6).

The use of purely digital media is a limiting factor on the creative process of the design, which in turn also limits the design process to the boundaries of the digital realm, however compiling both digital and analogue media on design process enhances the design cycle, allows designers and architects to design more freely with their new tools allowed by this Virtuality. Therefore, using both sides of the Virtuality-reality Continuum, allows an interchangeable communication over design environments, dismantling the limits of design. Schnabel then expresses his findings using MR completely as: "These realms are subsequently linked together into an overall process leading to alternative form-findings and design-outcomes." (2005; 2009, p. 7). Therefore the function and addition of virtual technologies benefits to architecture medium can be observed and proved by the researches aiming to improve the implementation of both said mediums.

It is also observable that over the decade's CAD programs like AutoCAD and among many others, improved and changed the way architecture and design elements have been made and planned. Tiamersma mentions that;

"The rapid rise of Computer-Aided Manufacturing is helping to change the architectural practice as well. Using 3D printing and lasering, progressive architects are able to create new building processes and results that are flexible and beyond anything that people can make with conventional techniques" (2014, p. 57).

Tiamersma also talks about the gamification of the architectural design process by giving examples from urban design and strategies applied to the design in a brainstorming session, including neighbourhoods, cities and towns (Tiamersma, 2014). This process among others, including virtual reality systems and technological addition to the architecture medium resulting in a broader variety of design outcomes and ease of production, planning and construction, proving that architecture and games are containing a direct relationship with each other, which can be improved further by focusing on either medium.ss

2.2.2.4. Virtual Benefits Addition to Video Games

The advancement of virtual technologies and all of its benefits allowed video games and video game design process to bear all of its technological fruits. Video games existed almost since the time computers first emerged, and its industry is on a booming state for the past two decades because of its regular consumption.

Technology is a subject that cannot be slowed down because it is only limited to the imagination of humankind. For the last two decades, designers, engineers, mathematicians, are working on better computer equipment, better CPUs, and more powerful GPUs, in order to achieve more realistic computer-generated imagery and virtual possibilities. One side of this virtual request was the architecture medium, requesting and researching further on the use of virtual technologies on the representation of the architectural project both on physical and virtual media. The other side was the video game industry, requiring such technology in order to design and develop better games with better visuals and immersion.

Currently, today's virtual technology is on a level where hyperrealistic computer-generated imagery is enough to fool the human eye on detail and realism levels. This benefit is used on video game design medium to create hyper-realistic locations, avatars, characters and immerse the player on many levels, stimulating the player, engrossing them to the activity of video gameplay.

The continuing growth of technological improvements allowed more developers to create more video games. Moreover, frequent use of worldwide web over the last decade allowed video game medium and its industry to grow. Further growth is allowed when the digital technology and world wide web's spread over the globe, made hardcopies obsolete. Now the video game medium is accessible from any location on the globe as long as the user has an internet connection. This ease of access also allows the video game industry to be widespread and broad in the sense of consumption, utilizing more factors of technology and Virtuality in every aspect the industry could. One mentionable

example of this use and ease of access is the latest release of Google's *Stadia* (2019). *Stadia* that is developed by Google is a multiplatform gaming system that uses internet connection to play video games from a variety of devices, without actually having a PC system that is required to play the video game on.

Also, the Video game design medium included interchangeability over different disciplines and mediums, allowing many different professions to work under a project to create a virtual product. Video game design, which is focused on the conceptual side of the video game, includes mostly designers, while the game development, it focuses on the virtual systems where the designer's concepts are brought to life. As a whole, the video game design process is almost like an Architecture, Engineering, and Construction industry-wise.

However, the speed of the video game developments, improving visual quality and immersive qualities, is a technological problem, where the technology of that time limits the designer. Currently, this industry and the medium can be counted as one of the biggest economies in the globe, provides countless jobs, and responsible for many both technological and virtual improvements on both Virtuality-Reality Continuum and its uses. Therefore, the improvement of this medium is highly visible and correlative with the advancement of virtual technologies. As the virtual technologies advanced, it also allowed the video game industry to create better graphics, faster and smoother gameplay, more immersive video games, and without the virtual technologies advancement, this improvement is almost impossible on this medium.

CHAPTER III. CORRELATION BETWEEN ARCHITECTURE AND VIDEO GAMES

In the previous sections, the virtual reality concepts and video games practical importance and history have been explained. This section is aimed to convey both previous sections pieces of information in order to compare and create graphs showing the correlation in between with real-world architecture compared to video games, and in between video games own architectural use. Current technological advances and its benefits on design mediums are collaboratively used in order to advance and create the most profound products possible. It is also known that the same techniques used in creating an architectural design or model are used on creating video games virtual worlds, therefore, contributing the architecture's importance and virtual reality technologies and continuums factors into creating an adequate video game world similar to real-world cannot be denied. On this chapter, the influences of real-world architecture on video games, and video games influence on real-world interior spaces and architecture will be researched.

This correlation is essential for the hypothesis of this thesis, because in order to bring out the importance of virtual reality for real-world mediums and industries, and video games meaningful connection to real-world architectural and interior architectural concepts. In order to achieve this correlation, the virtual worlds will be compared to that of real-world examples and uses, and the differences and alignments of the comparison will be laid out. Inevitably, these comparisons will also allow a clear picture of how architecture, environment and interior architectural elements are used in virtual worlds compared to real-world in order to relay the best experience. Furthermore, these comparisons and charts are fundamentally relevant at showing how successful the virtual world can depict real-world setting, and how real-world architecture and design mediums are affecting the progression in virtual reality systems, therefore, pointing out the importance of both mediums for one another.

3.1. Virtual World of Video Games and Real-World

Video games are limited to specific boundaries, just as the game concept is always bound to its rules. A concept of the game is a voluntary action requiring its players or attendees to take part in actions according to games rules and achieve a result. Video games are nothing different than the real game concept, where the video game offers the players the same result by voluntary participation to achieve a result. However, video games are created in a virtual system where the information and experience are relayed via HIDs and a screen projecting information according to the virtual world. The virtual space can be considered as an abstract; however, with the current technological developments and researches, it is accepted as a real space that exists in digital form and considered as a volume that occupies the real space.

The factors allowing the virtual spaces and worlds to be accepted as a real space is because it is three dimensional, it can be manipulated or changed, and could be experienced and discovered through time. Compared to other entertainment elements, it is explained as;

> "game space is manoeuvrable, and it contains perspective. Because the position of the observer can be changed, space is just as much a space as a physical space. It is, therefore, that game space can learn a lot from physical space and architectural design" (Tiemersma, 2014, p. 67).

It is highly possible that, in the future of technology, architecture, virtuality and video games, that the separating line between real and virtual will be blurred and the differentiation between what is real and what is virtual will be debated even further.

However, studies in social sciences and its correlation with teaching via the action of playing a video game proved that using this approach in education allowed students to learn more efficiently compared to the conventional methods. This approach is, therefore, is further being developed in order to increase the education provided in schooling and also implemented as serious video game playing in order to teach a specific set of skills and practice prewritten scenarios in order to simulate specific experiences.

Serious video gaming is a specific virtual experience created in a virtual world in order to educate and train the user in specific ways. These objectives could be educational, business, management, advancement in information and production and experience of specific tasks. Tiamersma explains serious video games as a factor that relies on game techniques and entertainment but an action that needs a clear meaning and relevance to the reality to make them work (2014, p. 46). Furthermore, he remarks that "the meaning refers to the purpose of the serious game; teaching teamwork for example. The relevance to reality is needed to really make people apply their experiences in real life" (Tiamersma, 2014, p. 46). This importance alone can show how the virtual world of technology can be used for serious education, improvement and development in real-world.

Several compelling serious video gaming experiences and examples could be given as simulators and specific video games developed in order to enhance and develop communication in a particular group of workers that require experience beforehand. A specific example of VR and video games use in virtual reality that includes real-world education and skills is medicine training examples. The VR systems that are used to convey a pre-created virtual world that copies the rules and systems of the real-world is known to be used by both medical practitioners to treat patients with phobias, anxieties and disorders (Raffaele, 2017, p. 19). Military use of virtual reality systems is also known to be used to train military personnel in order to familiarize them to the mission zones, military equipment and communication skills. This training, compared to regular briefings given and theoretical lessons provided with hard copy regulation texts is much more effective in training specific personnel to be compliant and effective in required timeframes.

Virtual reality and serious video gaming systems are also being used by schools and licensing of plane pilots, ship captains and train conductors among many others, because with the use of creating a virtual world that is mimicking precisely like the real-world counterpart. These schools and training systems equipped with virtual systems can educate candidates accordingly and to the fullest, providing critical scenarios and problems to solve and train for

emergencies to prepare them for real-world experiences. One other notable mention of serious gaming is to teach medicine practitioners such as surgeons to train them on specific scenarios, emergencies and familiarization of new technological equipment via the usage of virtual reality systems and augmented reality systems.

Therefore the virtual world is continuously used in similar examples and professions such as these to train and familiarize or relay particular experiences to the users, which can be encountered in the real-world. Such training allows doctors, pilots, captains or other transportation or dangerous equipment operators to know their assigned systems better and respond efficiently in times of emergencies to prevent loss of life, equipment damage, public discomfort or disruption of city life. With these pieces of information relayed, it is impossible to disregard the importance of the benefits and possibilities of the virtual realities, created virtual worlds for specific purposes and their connection to real-life situations. With 21st centuries technological benefits, production capabilities and virtual systems, almost any profession or experience can be simulated with a virtual creation.

Besides serious gaming, virtual technologies also improved the ability to create and design better systems which were not possible to create or calculate with conventional methods. Researchers such as Schnabel is known to implement these mentioned virtual technologies to the construction cycles or design cycles to improve further the collaboration between the AEC industries and education systems of said systems and professions. Schnabel explains that;

> "architects, designers and engineers use a variety of instruments to bridge the gap between the idea of a design and its representation hence linking an idea, its communication and realization. Any tool demands different responses from of the designer, and each instrument introduces different reinterpretations of the design" (2009, p. 3).

Such new instruments and abilities to look into a design process would not be possible without the addition of virtual technologies and the benefits of the virtual world of ability to construct the planned design in its created virtual environment.

Therefore, when the virtual worlds of virtual technologies are inspected, all of the mentioned facts are a beneficial factor in developing further improvements on the virtual worlds, which also improve the video game mediums. Video games are, however mainly a part of the entertainment industry, even if they use the same tools used in serious gaming, simulations or designing. With the social and cultural developments in 21st century, efficient use of technology and internet, social media and commercialization, video games are now an essential part of the entertainment industry and a part of humankind's lives. Video games provide an essential stimulus to its players to convey specific emotions, psychological achievements and activities. Therefore, the virtual worlds created for video gaming are a vital research subject to compare with the real-world counterpart, because of the activity of playing and spending time in that virtual world which results in achieving experiences, pieces of information, familiarities to establish immersion in the created virtual world compared to the real-world of the player. Most of the achievements earned in a virtual world are limited only to the user of the video game and the user's psychological consciousness.

Therefore, video games and the virtual worlds of the video games primary purpose is divided into two. The first objective is to create a virtual world where the story of the video game or the objectives of the video game is placed and operated by the player. The second objective is to create an adequate connection with the player of the video game. This connection is often created with immersing the player with the virtual world of the video game with individual elements that are already in that player's life, besides with the expositions provided in the video game, compelling story elements and gameplay mechanics.

Specific relevant video game titles that are mentioned in the list of best video games ever made are known to use these factors and familiarities to establish such connection and create immersion for the player to conjure a connection with the virtual world and real-world. Such examples are *Half-Life* and *Half-Life 2,* which provided a fluent and narrative gameplay without restricting the player and always allowed the player to experience the story

from the first perspective of the protagonist of the story. The first *Half-Life* title and its use of new graphics of its time, players were first time introduced to such elements in a video game title. *Half-Life* video games story is placed in a research lab created in the middle of a desert, and the research lab and its complexes are created adequately from examples of real-world. Players could traverse in this complexes, visit almost every part of the building, from meeting halls to personnel rooms to toilets, in which player is introduced to NPC's that are already there and attending their own duties, which implies the player that the virtual world of *Half-Life* and its inhabitants are life-like, and the player is now a part of that virtual world with specific duties of their own.

An important memorable part of the *Half-Life*'s introduction section is when the player is told to go to personnel quarters to get dressed and equipped for the experiment he is going to conduct. When the player arrives at the personnel quarters, the player is introduced to several characters in quarters that are talking about the experiment that is going to take place that day, who are mentioning their concerns. Also when the player arrives at the personal locker in the quarter, the player can see the college diploma and a picture of the player's avatar in the locker among a lab coat belonging to the player. In *Half-Life 2*, when the video game begins and the player is left at the train station, the player is given no information or an exposition about the whereabout or objective and left to discover the location. The player then can traverse the train station, talk with NPC's already in the station, directed by the controlling Combine forces, and exit the station via its main gates. After exiting the station, the player arrives in a city centre that is looking like a warsaw pact Baltic city with neo-Stalinist concrete architecture, Orwellian dystopian like similar clothes on every citizen and cameras and control systems on every corner of the city streets (Bonner, 2014). Along the path of the player, the player can listen to the conversations of other NPC's to learn about the situation and problems of living in such city, and how oppressive control is used against citizens. The video game journalists consider both examples as a historic entry to a video game story, that immediately immerses the player to

the virtual world of *Half-Life*, how it is related to the real-world counterpart and conveys the experience of living in that virtually created world is.

Such examples and the freedom to create almost anything in the virtual worlds provided with 21st centuries technological capabilities allows both a direct relation with the real-world for familiarization and freedom to achieve what could not be achieved in real-world. Such examples could be given as video games specifically created to reflect a dystopian concept to relay particular concerns and problems already encountered in real-world to create consciousness against such future or to allow experiencing different rules besides what is already set in real-world.

Abilities and capacities of the virtual worlds are almost limitless, combined with several VR systems and add-ons, haptic feedback and orientation, created virtual worlds and participant of that virtual world could experience almost anything nowadays. It is therefore imperative that the further development of Virtual systems and virtual worlds is needed to further improve the immersion capabilities of virtual worlds compared to real-world. It should also be noted that every design and production system can be further improved with the implementation of VR systems to the production and design cycles.

3.2. Architecture, Environment, and Interior Design in Video Games

Video games as an entertainment industry one of the top developed product is widely used in 21st-century human everyday life. A crucial reason for video games to become an essential pillar in the entertainment industry can be observed as video games are almost all the time reflecting an alternate version of perceived human life with intriguing stories and locations, allowing the players to experience different senses and feelings that are unavailable in real-life without any consequences.

If observed further, with the addition of technological advances allowing video games to become more realistic with gameplay mechanics, more lifelike with interactions and conversations, and visually striking just as real-world

allowed video games to almost completely mimic the real-world. The mimicking of real-world properties in video games to create immersion and create a connection with the virtual world of video games also increases psychological rewards.

In order to understand the relation of virtual worlds of video games to real-world, researching the critically acclaimed FPS video games, the most crucial relationship between real-world and virtual worlds can be narrowed down to architecture use, environment use and interior architecture use in video games to mimic real-world settings or properties. Even in early FPS video games such as *Half-Life* and *Counter-Strike* (Valve, 2000), video game designers used architecture and interior architecture placed in video game environment strategically to force players to reach from one point to another or use the architectural elements or interior architectural spatial zones strategically to defeat enemies. Of course, this strategical use of interior spaces and architecture is not achieved by just placing placeholders or rigid boxes or volumes, but achieved by creating similar representations from real-world examples in order to allow the player to feel and understand psychologically that the created virtual world resembles the real-world. This use of realistic architecture, spatial design and interior design use is a significant example of video game developers mimicking real-world properties and environment in virtual space, that specifically resembles the real-world, in order to create an immersive environment for video game player to immerse into the virtual reality and embody themselves into the video game.

Relevant video game titles that have won several best-game awards are known to use architecture, interior architecture and environmental designs to the fullest to achieve better gameplay mechanics, immersion and offer different strategies of approach to the objective. *Dishonored* could give one such example (Arkane Studios, 2012) and its use of interior architecture, architecture and architectural elements, and environmental design on strategic routes and options of encounters. *Dishonored* is an FPS RPG game which uses a fictional setting of a dystopian city heavily based on industry and reflected in a Victorian architecture of 19th century London, mixed with steampunk

aesthetics. The story of the *Dishonored* places the player in the protagonist Corvo's perspective, who is a bodyguard to the Empress of the city of *Dishonored*. In the gameplay, the player controls Corvo and given a multitude of choices on how to act towards an objective, and created virtual world allows the player significant freedom in methods of progression, both spatially and ethically (Zonaga, Carter, 2019, p. 4), such as choices to kill or spare, whether to infiltrate the culprit's hideouts staying out of sight or approach directly with combat. Actions of the player have direct consequences on the districts of the city Dunwall, which is already a failing dystopian industrialized city, and the usurper of the Empresses throne exerts further authoritarian control. Therefore each violent action player turns city rulers more desperate in exerting control, while the population of Dunwall city is affected more negatively. If the authoritarian control organs are rendered inoperable, however, then a plague takes hold of the city districts because there are no more authorities to control the spread of the plague.

Therefore the player is forced to make crucial decisions accordingly to how to affect the city of Dunwall while progressing the story, and every action is considered to have a consequence, even while at the moment the decision is considered logical, on long term could create adverse effects. Zonaga and Carter (2019) explain a section of the video game that player is given the objective of assassinating a target in a fortified complex and stealing his journal. Players are then given several options of how they can navigate the environment to achieve this objective, such as infiltrating from underground infrastructure, scaling the walls, climbing thru windows or simply walking thru the complex engaging and killing guards in combat (Zonaga, Carter, 2019, p. 5). According to these examples, the *Dishonored* video game can be classified as a video game that uses architectural elements such as roofs, windows, walls and infrastructures, and interior architectural elements. This kind of spatial understanding actively allows players to choose the way of approach to individual objectives freely. This kind of video game play also introduces a stronger choices-matter type of virtual world that was first comprised on *BioShock* FPS video game.

Zonaga and Carter (2019) also analyzed the playstyle of *Dishonored,* by playing through the video game twice wholly, in order to achieve both opposite ways of completing the video game. Their results showed the good playstyle required more infiltration, stealth and less action or killing, and remain undetected, while bad playstyle required more action, reckless and aggressive gameplay. Zonaga and Carter's research determined that architecture played a very prominent role when playing stealthily as opposed to confrontationally (2019, p. 14). They explain their findings as;

> "While the focus of our visual analysis was on the design of buildings and streetscapes, we found that during stealthy play, greater attention was paid towards architectural features such as ledges, fenestration, balconies, exposed structures and undercrofts as they facilitated alternate pathways to the goal which were unseen by patrolling enemies" (Zonaga, Carter; 2019, p.15).

In addition to Zonaga and Carter, Bonner also notes that "stealth gameplay means sneaking around the enemies, using architecture and environment as cover, but during action gameplay architecture is reduced to a system of cover possibilities" (2015, p. 7) which implies the importance of architecture and environment design, planning and created virtual worlds spatial uses importance in video games. Therefore Zonaga and Carter express that "not only does the architecture of the gameworld become an extension of the player's expertise and prowess, but it makes possible the very experience of becoming embodied in the gameworld" (2019, p. 15).

Image 3.1: Dishonored (Arkane Studios, 2012) video game and its variable gameplay allowed by its architectural use.
Source: Screenshot by Efecan Büyükbaykal.

This architectural, interior architectural and environmental use in video games is, therefore, an undeniable factor in creating a better virtual world of video games where the embodiment and relationship with the player and players immersion to video games virtual world is required to achieve in a real-world manner.

3.2.1. Video Game Architecture

Video games evolved so much since their inception that the concept of the video game or the production cycles of the video game can now be considered an art form. Tavinor explains the consideration of video games are counted as an art as;

> "when viewed under a number of recent cluster theories of art in virtue of their display of a core of characteristic properties. At the same time, videogames have their own distinctive features, meaning that as a form of art they should be treated on their own terms and not simply seen as derivative forms of pre-existing types" (2009, p. 172).

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Therefore, video games relation with art and architecture and its use cannot be denied nor the examples of exceptional use of architecture in video games denied being counted as such. Many contemporary video games have to use architecture and architectural elements to form a virtual world that the player could embody themselves into or immerse into, and the main reason when looked further is that it reflects the real-world properties and similarities when done so. Otherwise, without the use of architecture in the video game, the player cannot make sense of the surrounding without relevant references, similarities or ratios provided with architectural elements. 21st-century real-world life consists in living spaces and office spaces created in architectural constructions which lay in accordance and compliance with infrastructure and environmental connections that houses the human lives in cities. Therefore when a video game narrative and playstyle is placed in a city, the player subconsciously expects to find similar settings that of to known examples around the world for creating relevance and improve the participative and voluntary gameplay action and immerse in the virtual world. Zonaga and Carter both imply the importance of architectural use in this sense of gameplay and virtual worlds art while Bonner is laying out how architecture is used in video games and how it should be used in order to enhance the gameplay.

Several notable titles like *GTA* or *Assassin's Creed* (Ubisoft) uses realistic backgrounds to immerse the player with architectural surrounding, and *Assassin's Creed* latest instalment in series also recreates historical architecture such as 18th century France or Ancient Greece to immerse the player in the timeframe story of the videogame is told. Usually, this kind of use is mainly used as a visual effect and complete the background; however as video game understanding progresses, the architecture created in a video game also becomes interactable just as in real-world. While this type of architectural usage and the placement of architecture in video game mostly environmental, architectural systems use in video games also exist and categorized as labyrinth types.

Earliest games such as *Wolfenstein 3D* and *Doom* have used this kind of labyrinthine designs to keep player progress throughout the game while being

in continuously similar spatial surroundings. This concept could be referenced back to the *Minotaur's labyrinth* Daedalus built for King Minos of Crete in Ancient Greek mythology. Video games using this type of architectural reference is created in the virtual world of looping layers of floors and connections, forks and passages can be taken to extremes to align with the narrative and story fo the video game planned on it. In light of these classifications, according to gameplay styles video games such as *Wolfenstein 3D, Doom 2016* and *BioShock* could be named as labyrinthine while still having realistic architectural references and background. Video games such as *Mirror's Edge, GTA, Assassin's Creed, S.T.A.L.K.E.R.: Call of Pripyat, Escape From Tarkov, Half-Life* series, *Kingdom Come: Deliverance* and *Doom Eternal* is considered to have practical architectural use and background and on open environments connected, instead of having a connected labyrinthine system.
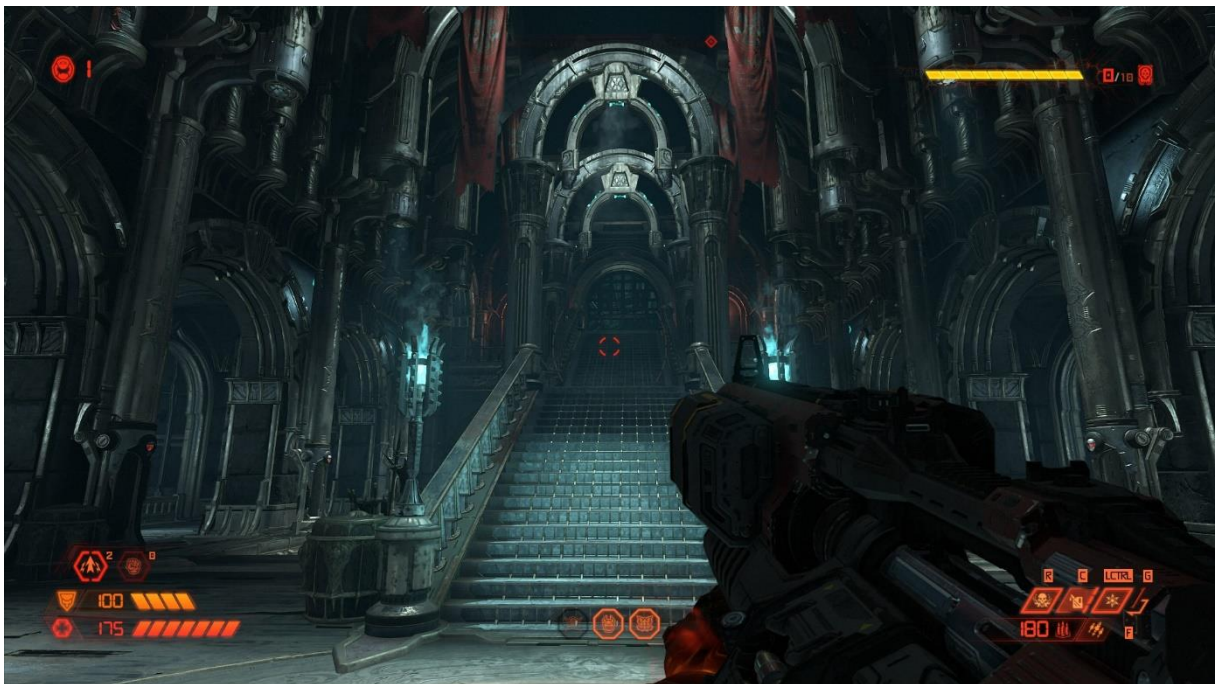
Image 3.2: Doom Eternal (id Software, 2020)'s use of Gothic architecture with contemporary materials.

Source: Screenshot by Efecan Büyükbaykal.

3.2.1.1. Architectural Depiction in Video Games

As every entertainment industries mediums, video games are a very efficient way to form and convey alternate realities, stories and historical progressions in their virtual world compared to real-world. Therefore, even when recreating a historical era in a virtual world of video games or creating an alternate timeline of events for another video game, architectural depiction holds fundamental value in portraying environment.

Such examples are also recorded in human history, just as ancient kings erecting monuments for victories, temples built for religion, government buildings built for order, public areas for populations use, and artworks of sculptures or installations. Such architecture also always used by the rulers to impose the ruling systems views and instil fear, freedom or control over populations. Many of these architectures political use was observed during World War II's Nazi-occupied countries, where the occupying forces built sturdy concrete buildings, and monuments to portray authoritarian and fascistic ways, supported with flags and lighting instilled fear to the occupants while gave pride to the occupiers of the land. Therefore architecture, is just like artworks, that can inspire and modify human psychology and affect the way of lives in real-world.

It is by this knowledge and information that video games also use architectural depictions in virtual worlds to create similar psychological feelings and information about surroundings. Such example could be seen in rebooted video game series *Wolfenstein: The New Order* (MachineGames, 2014), where the story is seen from the eyes of a soldier who falls into the vegetative state at the end times of World War II. When he is awoken from his vegetative state, fourteen years have passed, and Germans have won the World War, dropped the atom bomb on Manhattan destroying New York, and achieved total world domination. Therefore the whole continents, infrastructures and cities are reshaped and reformed accordingly to Nazi propaganda, reflects totalitarian authority and enormity of strength, supported with grey and red colour schemes and dramatic lighting. By knowing real-worlds history, and

compared to *Wolfenstein: The New Order*'s alternate timeline, the player can understand and observe how the alternate timeline affected architecture and cities, and how the architectural depiction is used for political and propaganda purposes, how the world became a dystopian setting compared to real-world events. With this information supplied to the player by just architectural background and styles, and can be observed and understood without any audial clues or exposition provided to the player, the player then can embody themselves into the virtual world of this alternate timeline and immerse with the avatar of the story which also implies how successful architecture is in depicting situations of surroundings.

Image 3.3: Screenshot from Wolfenstein: The New Order (MachineGames, 2014) cutscene. Source: Screenshot by Efecan Büyükbaykal.

Therefore, the use of architectural depiction in video games could be classified as an informative agent that gives the setting, mood and surrounding awareness of the virtual world to the video game. This informative system is a crucial setting for video games and their story settings to produce desired immersion and can be divided into three segments as dystopia based settings,

utopia based settings and real-world based settings and serves the primary function of environmental storytelling and immersion. Therefore, the following subtopics will look into utopia environments, dystopia environments and real-world based environments in video games and their purposes.

3.2.1.1.1. Utopia Environments

Utopia concept is defined as an imaginative system that is desired and highly progressed and considered perfect for human living conditions. Video games consisting of a utopic story and virtual world are therefore bound to create a virtual world that is made in utopian perfection. Compared to how imaginative utopia based concepts are and how its trials in real-world results, utopia is almost always impossible to achieve. Kathleen Spencer emphasizes science fiction's use of realist techniques to create its non-realist worlds considered as utopias (1984), and Moylan explains the utopic manifestations as a "concrete agency looked through and beyond the structural logic and limits of hegemonic exploitation and interpellation" (Moylan, 2000, p. 69). Therefore, according to Moylan and Spencer, assumption utopic and science fictive based worlds can be categorized in either cognitive and naturalistic or noncognitive and estranged topics.

According to Moylan's and Spencer's emphasises on utopic factors are an excellent platform for video game developers to brainstorm and create an adequate utopia based video game. Therefore this categorization allows the video games and their virtual world to use these categories for advantages of the virtuality further to enhance the cognitive experience and reduce noncognitive and estranged topics for the exploitation of curiosity of the player of the video game as a psychological factor.

However, several video games and their story elements have previously used utopia based stories to start of the narration, where the story of the video game reveals in later stages of the video game that the surface utopian concept hid more dark and ugly dystopian setting beneath the scenario of the video game for theatric purposes. This approach is used for the player to tackle

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problems of dystopian nature beneath utopic setting serves the purpose of creating curiosity, the joy of the unknown and the positive stimulus of investigation are typically dystopia based video games with a utopic narrative cover for storytelling purposes, continuity and immersion to the video game. These video games with this specific approach, however, does not fall under utopia based video games, instead are classified as dystopia based video games.

The primary problem of utopia based video games is, that the utopian concepts and stories bearing no problems that could be transformed into a story that a video game could be formed. Thus, video games are mostly focused on real-world based scenarios or dystopian concepts to create better settings for the video game itself. Therefore, most of the development of video games on utopia basis is focused on science-fiction, rather than real-world basis. However, construction, management and creative video games such as *Sim City* (Maxis, 2014) where the player is building a city to manage, or *The Sims 4* (Maxis, 2014) where the player controls the virtual humans created in the sims virtual world as chosen or *Black & White* (Lionhead Studios, 2001) where the player controls a god to manage its populates, fall under utopia based video games and environments.

3.2.1.1.2. Dystopia Environments

Dystopia based video games and environments are a common subject in video games and its entertainment industry. Dystopian settings are precisely opposite of utopian settings where everything is frightening, undesirable and human lives are in constant danger. Because of these factors, creating a dystopia based video game virtual world is easy, just because of the human condition and basic morality understanding allows the player to realize the setting is a wrong place, and the player's avatar is in that virtual world to make changes to that problems.

A dystopian setting in the video game could protest and inform a lot of real-world opinions as well, just as *Wolfenstein: The New Order* and *Wolfenstein II: The New Colossus* (MachineGames, 2017) looks into a

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tyrannical dystopia forced by the alternate timeline where the Nazis won the world war II. The *Deus Ex: Human Revolution* (Eidos Montreal, 2011) title focuses on a dystopian future where augmentation with artificial organs and implants creates a transhumanist division, discrimination and segregation between augmented humans and normal humans. *Half-Life* video games especially the second instalment in series reflects a tyrannical rule in a dystopian setting again instilled by the Combine to the residents of City 17. Furthermore, *BioShock* video games virtual world depicts a city named Rapture, built with utopic intentions for the upper class to escape from the ordinary lives to live on but fall on each other to turn in to a terrifying dystopic husk of its former glory. The dystopic elements of the media are, therefore, a crucial instrument at storytelling and pointing out flaws and problems in the experienced real-world or potential future times.
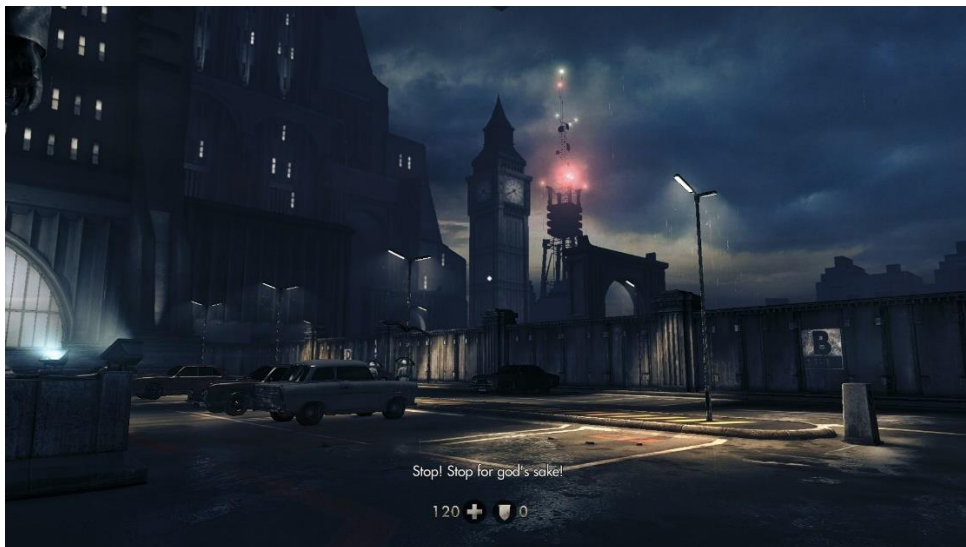
Image 3.4 : Wolfenstein: The New Order (MachineGames, 2014), where Nazi's dystopic regime rules the globe.
Source: Screenshot by Efecan Büyükbaykal.

Image 3.5: Wolfenstein II: The New Colossus (MachineGames, 2017) Nazi-controlled 'New America' in the 1960s.

Source: Screenshot by Efecan Büyükbaykal.
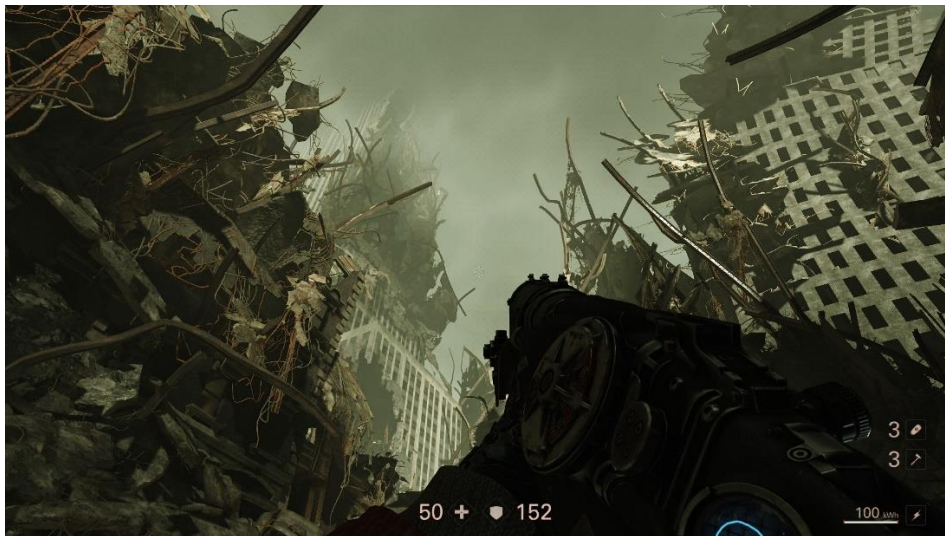
Image 3.6: Wolfenstein II: The New Colossus (MachineGames, 2017)' destroyed Manhattan city.

Source: Screenshot by Efecan Büyükbaykal.

Frasca, explains the dystopia based video games relevance to real-world with the video game *The Stanley Parable* as;

"The video game dystopia follows a similar strategy, yet grants the player a far more involved role than a reader or viewer could ever dream of.

Having the player enact dystopia, in a direct feedback loop to her or his actions, games such as Galactic Cafe's *The Stanley Parable* (2013) allow for a far more intimate experience of the dystopian genre" (Frasca, 2015, p. 1).

Compared to other mentioned video games, *The Stanley Parable* uses a different method to relay this experience, by the use of implied player and empirical player in the video gameplay. This experience, according to Frasca, pushes the player towards a better understanding of the virtual world, the dystopian nature of the players empirical status in the real world, and possibly a subversive response, which Frasca hopes that will allow the players of the video game to take action in real-world to prevent such occurrences and experiences (Frasca, 2015, p. 2). Frasca also defends that the dystopic narrative elements in a video game are controllable and manipulatable by the player. Previously Moylan suggested that;

"Structure of narrative and counter-narrative, the potential of dystopian text to achieve an epical, or open, expression lies in the way it negotiates the clash of the official narrative and the oppositional counter-narrative and eventually is realized in a utopian or anti-utopian stance within its own healthy negativity" (Moylan, 2000, p. 152).

Image 3.7: The Stanley Parable (Galactic Cafe, 2013)'s Mind Control Facility level.
Source: Screenshot by Efecan Büyükbaykal.

Therefore, using Moylan's and Frasca's opinions, conclude on dystopia based elements in virtually created spaces or video games are strong narrative elements that are more than literary instruments or media instruments. The

positive advantages of mixed media usage in video games and depicted experience elements in video games, dystopia based video games and environments are a powerful element of virtual experience that can potentially create awareness, subversive questioning, and close the gap between fiction and reality (Frasca, 2015, p. 2). Because of dystopian settings, vast possibilities to suit for video games story to create a thrilling and embodying narrative elements, create awareness and questioning the virtual experience with reality, these video games are considered excellent examples of immersion in said virtual worlds for players to experience the video game media.

3.2.1.1.3. Real-World Environments

Real-world based video games are known to use real-world architectural elements or backgrounds with similar names or same names of the locations or places in the real world to create a connection with the player and the video game to explain the story better and immerse the player. Such video games are known to use historical facts, timelines and information to create the illusion of a virtual world belonging to real-world counterpart. Best examples of these real-world based video games are *Assassin's Creed* series, where the player takes on the role of the protagonist, which uses a VR headset to travel back in time using VR headsets ability to read genetic materials historical background and experience the past time of the ancestors of the user. Since the release of *Assassin's Creed* video games, the story of the individual titles has been placed in ancient Greece, ancient Egypt, Victorian-era France, medieval era Jerusalem, renaissance era Venice and Renaissance-era Rome times. The video games virtual world and the developers of the video game uses historical facts and archaeological knowledge to recreate said locations accordingly to the real-world information to immerse the player to that timeframe.

GTA series also uses real-world locations such as 21st century Manhattan and California cities from the US, almost identical to the real-world counterpart

with the difference of slight changes in the cityscape to suit more accordingly to the video game style and change of names to avoid similarities with real-world. Video games such as *S.T.A.L.K.E.R.* series and *Escape From Tarkov* also uses real-world based recreation of a virtual world, like *GTA*. Because *GTA, S.T.A.L.K.E.R* and *Escape From Tarkov* and several other titles use the similarities to the real world the player of the video game subjected to familiar backgrounds of city and cityscape, with surrounding architectural elements and forms that are all too familiar from everyday exposure to virtual media and motion pictures. This familiarity serves to induce immersion to the player to embody further into the virtual world where every public rule, common sense is a mirror of the real world and allows the player to assume a new identity in the virtual world in the video game.

Image 3.8 : S.T.A.L.K.E.R.: Call of Pripyat (GSC Game World, 2009), is based on the real structures in the deserted Pripyat City.
Source: Screenshot by Efecan Büyükbaykal.

Image 3.9: Escape From Tarkov (Battlestate Games, 2017) uses real-world architecture to immerse the player in its virtual world.

Source: Screenshot by Efecan Büyükbaykal.

A crucial mention of real-world based video game and real-world depiction would be the *Kingdom Come: Deliverance* video game by Warhorse Studios (2018), that revives and recreates the fantastic era of medieval ages. *Kingdom Come: Deliverance* attempts to recreate a realistic video game in medieval Europe with real-world locations according to historical information and records including actual ranged and melee combat elements such as archery and sword fighting. In order to provide an authentic experience, developers worked for a historically accurate environment based on real-world locations, accurate armour and weapons, buildings, interiors, culture and landscape.

Real-world depiction in video games is also much more straightforward than creating a utopic or dystopic version of a virtual world, mainly because there is already available information, knowledge and materials in a digital form able to be used to create video games virtual world. To this end, developers of *Kingdom Come: Deliverance* sought and used the most knowledgable historians, armourers, swordsmen and architects about the period they are depicting in the video game. *Kingdom Come: Deliverance* story is set in the early 1400s in the Kingdom of Bohemia, and the landscape, towns,

architecture of buildings, interior designs, furniture, clothing, were created accordingly to the period depicted in the video game with the help of historical advisors to perfectly imitate and replicate the 1400s Bohemian daily life. Developers of the video game, therefore, used the 21st-century technology to the limit, AEC industries extensive programs and techniques for four years to develop and recreate the Kindom of Bohemia of the 1400s, according to real-world locations, landscape and historical information, recreating a virtual version of *Rataje nad Sazavou*, a town in Central Bohemian region in the Czech Republic.

Image 3.10: Sasau Monastery in Kingdom Come: Deliverance (Warhorse Studios, 2018), replicated accurately from Sázava Monastery in the Czech Republic built in Bohemian Kingdom times.

Source: Screenshot by Efecan Büyükbaykal.

Image 3.11: Sázava Monastery in real-world (Left) with its virtual replication as Sasau Monastery (Right) in Kingdom Come: Deliverance (Warhorse Studios, 2018) video game. Source: Left Image, https://www.destimap.com/index.php?act=place&p=Sazava%2C-Czech-Republic. Right Image, screenshot by Efecan Büyükbaykal.
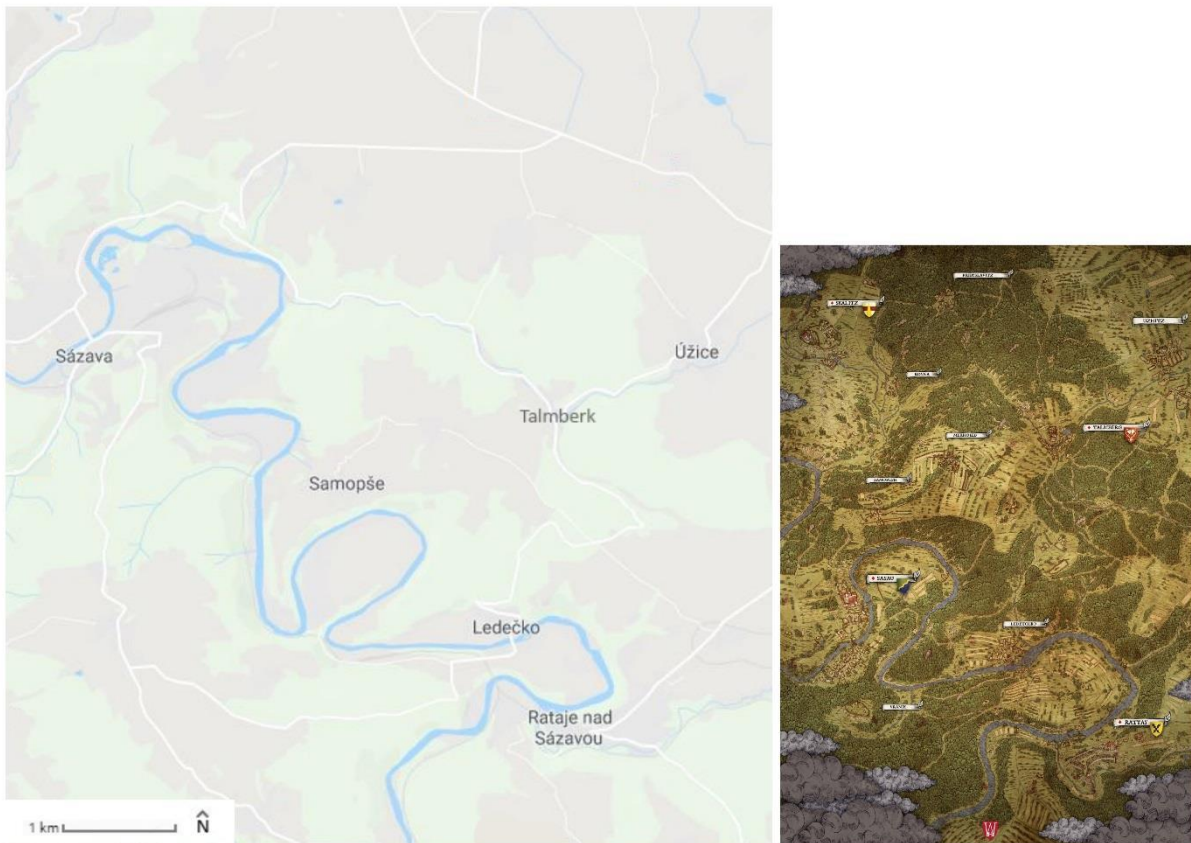
Image 3.12: Rataje nad Sázavou, Central Bohemia and its virtual recreation in Kingdom Come: Deliverance (Warhorse Studios, 2018) video game. Source: Google Maps/Warhorse Studios, Martin Bostal, 2018.

According to Bostal, this realism and real-world replication allow the player and player's avatar to assume a new identity (2018, p. 384). Therefore

allowing a connection between real-world and virtual world create a playground with a new set of rules outside of real-world creating unique play-elements, order, and observed within the boundaries of virtual order that is depicted which can be defined by Johan Huizinga's understanding of order, in his book *Homo Ludens* (1949, p. 10). Huizinga supports this claim with these explanations;

> "Inside the play-ground, an absolute and peculiar order reigns. Here we come across another, very positive feature of play: it creates order, is order. Into an imperfect world and into the confusion of life it brings a temporary, a limited perfection. Play demands order absolute and supreme. The least deviation from it "spoils the game", robs it of its character and makes it worthless" (1949, p. 10).

Therefore these findings can support the notion that the perfect recreation of real-world in virtual spaces containing a sense of order similar to the real-world, to provide a playground for the video game to take place, is the most immersive, cognitive and enjoyable type of video games to experience.

However, Martin Bostal also mentions that while real-world based video games can recreate and reenact a certain period, historical events and stories, such as *Assassin's Creed* series, the accuracy of the story with the correlation of the real-world history can be questioned for the version and order of the history depicted in the virtual world of video games. This deviation from historical order and accuracy of a real-world based recreation is explained by the developers of *Assassin's Creed* to use historical facts to enhance the storytelling elements and play while making required changes to portray better they play-elements in-game and stray from real-world events and orders (Bostal, p. 381). Therefore a real-world based video game can also use a real-world recreation in a virtual space to tell a story based on real-world events. However, the accuracy and truth of the story will be altered to serve the video games purpose positively. On *Kingdom Come: Deliverance*'s case, this level of proper recreation of real-world historical locations, events and culture was not scoped and experimented priorly. Gonzalo Frasca and Martin Bostal mention this improvement as a merging of both narrative, gameplay and historical analysis in video games, and a new culture, potential possible new ways of

reenacting and recreating historical events in virtual worlds to be experienced, studied and benefited in various new ways (Frasca, 1999, pp. 365-371; Bostal, 2018 p. 381).

3.2.2. Urban Design in Video Games

Contemporary video games are known to use real-world architectural and urban design factors in video games virtual world to achieve a close to real-world immersion and create a real-world counterpart that can be familiarized in the virtual world. Many of the video games virtual world aspects are the scenery behind the video games locations and the urban locations that give the player a sense of location and style in these virtual worlds. While the video games primary aspect and events are scaled down to the player's avatar and the objective the player is given, the urban surrounding and the background is a helping factor on immersion surrounding the player.

Many of the modern video games are using advanced technology, allowing the designers to map and create real-world urban locations to be able to be used in the 3D virtual environment created for the video game. Using the same computer programs, systems and approaches used in the real world, video game developers can create life-life, correct to human ratio, and immersive urban designs, that are then used in background scenery or environments video games avatars can traverse. Some notable examples of urban design can be observed in *Assassin's Creed* series video games and *GTA* series, where the urban landscape and urban design is a crucial part of the video game background and scenery, and not just limited to the scenery but usable in many ways benefiting the gameplay required for the video game mechanics.

A specific example of urban designs benefit could be given from *Assassin's Creed* video game series, where the video game story is placed on the player's avatar, an assassin with specific missions to eliminate opposing factions key characters. The video game provides several options to achieve objectives, with the use of urban architecture and design for missions

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advantage. Examples of *Assassin's Creed* video game series developers used real-world data and information to create historical replications of real-world locations in the virtual world for the video game to take place. These examples used real-world landscape data to be replicated adequately with sufficient vegetation, geographical quality and materials to reflect a realistic landscape for the video game to take place. The same approach can be observed in the *GTA* video game series, where the developers of the video game used real-world landscape data to achieve a realistic sub-urban and city landscape. Therefore the purpose in recreating a replica of real-world landscape design and the environment in the virtual world serves the function of embodying the player into the video game story and immerse into the virtual world with familiar elements.

However, the player can also choose a direct approach and initiate combat with the target of the mission and the enemies protecting the objective, while the games own score system, called synchronization, gives more score to stealth and infiltration types of approaches to the mission target. The same approach and freedom are also given to the player in such games as *Dishonored*, *Kingdom Come: Deliverance* and *Mirror's Edge*, allowing the player to move freely, and approach to the objectives of the video game. Therefore the game mechanics, while not denying the player the freedom of choice and path, rewards the player more with different outcomes both strategically and success emotion of achieving something with radical approaches, if the player acts and thinks like avatar player is controlling, inducing role-playing elements. Therefore urban design in video games is somewhat a playground for the player to take advantage of and think outside the box to achieve the goal of the video game.

Kingdom Come: Deliverance video game, uses extensive urban and landscape design and its instruments in the virtual world of the video game. *Kingdom Come: Deliverance* is one of the unique games that accurately recreated the Bohemian Kingdom in the early 1400s to immerse the players to the setting better. Around the central town of *Rataje nad Sazavou*, which is based on the historical information, that also still exists today precisely, the

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landscape is recreated accordingly to the current state of the land, satellite images, and historical pieces of information, with the help of professional advisers in aligned professions. Therefore the virtual world created, as a result, is an accurate historical recreation of an actual real-world location, and allows the players to embody into the avatar they are controlling, even more, to immerse into the virtual world of *Kingdom Come: Deliverance*.

Image 3.13: Accurate historical recreation of Rataje nad Sázavou in Kingdom Come: Deliverance (Warhorse Studios, 2018) and its interactive urban design.
Source: Screenshot by Efecan Büyükbaykal.

These urban designs and architecture is a decisive element in video games, with given freedom to the player to be able to choose an approach to the objective, urban design concept evolves from just being a pathway for circulation or scenery to a video game mechanic, a playground, and becomes strategically essential to tackle the obstacles in the video game and achieve the objectives. It is for this reason that the game developers are using the contemporary computer systems to achieve hyperrealistic graphics and environment quality to enhance further the quality of urban design aspects and

its appealing visuals while being interactable and traversable to increase immersion for the player.

Landscape design in video games, as with architectural design and urban design, is mainly designed in the purpose of creating adequate scenery for the background and surroundings of the video game placement. This concept can be traversed and travelled upon, just observed from specific points of perspective, or left to the players choice of creation such as allowed in several simulators, is a visual aspect and factor in virtual worlds.

However, if the video game is not replicating or recreating a real-world location, is based on an imaginary world or alternative realities where an entirely new landscape and the world is created for the video game. This objective is achieved by video game developers and artists collaborative work. The process of creating an entirely new world with a new landscape is subjectively easy compared to replicating a real-world location. The programs and systems used in creating a video game world and landscape in the virtual world are easily achieved by developer programs with computer aid, where the required and wanted factors entered to the program, the computer can generate a random world with landscape given the tools and materials provided to the program. Therefore, the randomization of computers landscape and world generation is carefully calculated to reflect entered inputs and factors to be sufficient for the video games requirements and story elements, while also providing sufficient realism and immersion to the observer.

3.2.3. Architectural Design in Video Games

Video games and architecture, even when traced back to the earliest 3D video games, always had a significant connection in between mediums. Earliest 3D video games have used the labyrinth systems and basic geometrical structure systems of architecture in order to create a virtual world for video games to take place. The development side of the video game industry, therefore, is highly interested in the progressions achieved and the systems used in

architectural systems in order to implement better creations to the virtual worlds of video games and better use the programs in order to create realistic architectural representations in virtual worlds. However, compared to the real-world architecture, virtual world and video game architecture have the benefits of theoretically ability to exist forever in the digital environment. This flexibility and sustainability allow architectures created in virtual worlds of video games a dynamic existence.

It is also important to note that the creative aspect of video games are known to use specific architectural styles and art movements to generate an era in human history that is used in the video games story. For example, *BioShock* series used the 1960s Art Deco movement and its architectural examples in its virtual world to depict time and era of the video games story taking place. Another example is *Wolfenstein* series are known to use the 1940s and 50s and also in following sequels 1960s era American architectural styles, Art Deco styles with suprematist and brutalist architecture to depict both the timeframe and dystopia depicted in the stories. *Assassin's Creed* series used the latest 3D laser scanning techniques and data collected from records and current state of the locations to recreate fictionally, based on the information gathered, virtual recreations of the ancient cities, such as Ancient Jerusalem to Ancient Greek, to 1800s Carribean's to Renaissance Venice, and French Revolution Paris times. *Assassin's Creed* video game developers, therefore, used a wide variety of historical pieces of information and 3D laser scanning techniques to recreate these old cities in the virtual world, with the help of historians, restoration workers, architects, interior architects, programmers, software developers, and 3D artists. Such examples show how much importance architecture carries in a video game, and how a video game is similarly thought with the real-world relation. Therefore locations and events designed to happen in the virtual world must happen in a virtual city, which then required architectural insight, information, knowledge, and styles to be created. It is also significant to mention the psychological factors of architecture and the materials used in architecture to shape various experiences designed in the video game, whether attract the player's attention or blend in with the surroundings hiding essential

details from the player for later revealing, the material used in architecture also proceeds further than just achieving a realism factor. The virtual city of Tarkov for the video game *Escape From Tarkov* is a fictional city that heavily emphasizes and uses Russian style construction materials, architectural styles and scenery to relay this information. While being a fictional city created in virtual space digitally, developers creating this fictional city have used the references from the existing Russian city of St. Petersburg, and other eastern block countries architectural textures. The player can quickly embody into the virtual reality and understand the characteristic elements of the architectural style and information reflected in the video game, which can translate into the player as a sense of where the player is on the world, according to the surrounding city.
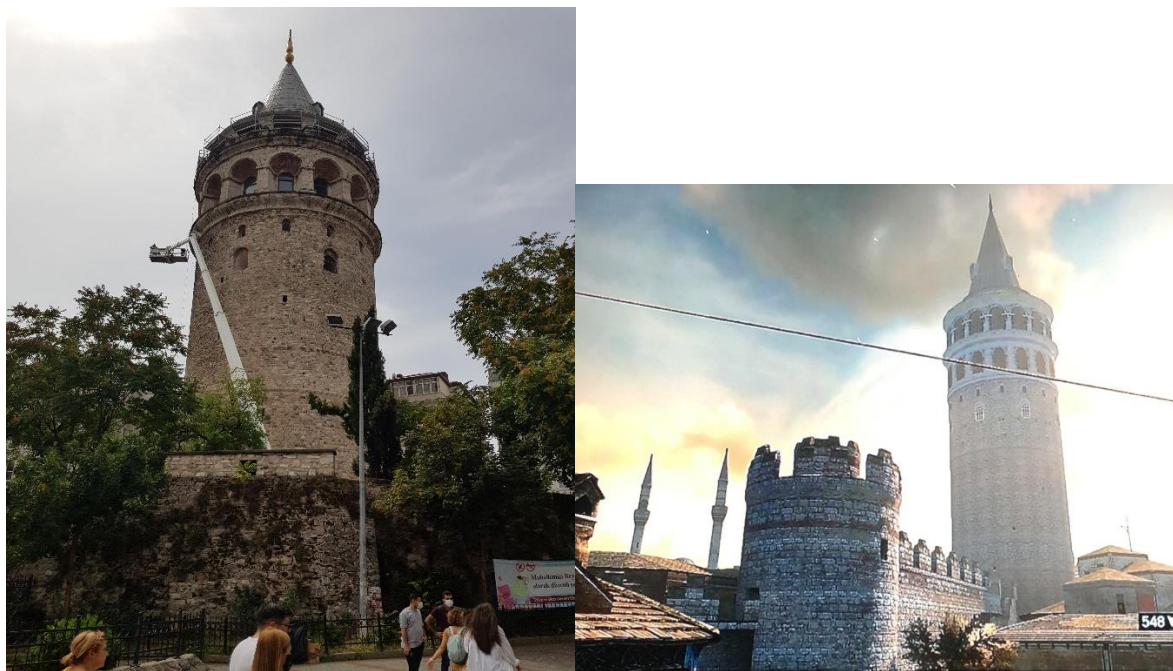
Image 3.14: Image of Galata Tower in Istanbul, Left image original Galata tower in Istanbul, Right image is the recreation of Galata tower in virtual space of Assassin's Creed Video game
Left image source: Photograph taken by Efecan Büyükbaykal
Right image source: https://thriftytraveller.files.wordpress.com/2013/06/129.jpg

Another mention for architectural use in video games can be shown from the Bethesda Softwork's *The Elder Scrolls* series of video games, specifically

Skyrim (2011). *The Elder Scrolls* series are created by Bethesda Softworks in 1994 and still developing contemporary titles in the series to date such as *Elder Scrolls Online* (ZeniMax Online Studios, 2014). *Elder Scrolls* is a fictional alternate world with a very immersive background with historical depth and styles that is mainly focused on Fantastic Role-Playing Game (RPG) elements. The fictional virtual world of *The Elder Scrolls* consists of several magical planes of existence, a wide variety of deities, lots of different anthropomorphic races and humans. *The Elder Scrolls* series are also observed using architecture to the maximum effect creating several different architectural styles for the different races in the video game. Several of these races appearing in *The Elder Scrolls* are different kinds of Elves such as High-Elves, Wood-Elves and Dark-Elves, anthropomorphic lizards and feline races such as Argonians and Khajiit respectively, Orcs and different races of Humans, such as Bretons, Imperials, Nords and Redguards. Further investigated, the player's avatar in the virtual world of *The Elder Scrolls,* encounters each specific race and can visit locations, cities or towns constructed by them, each having their distinctive racial differences, colour and material use, furniture styles and constructions, architecture, different interior space uses and habits. This variety of detail and the intricacies in the LOD also allows the player to be free in choices or portrayal of the fictional character the player is assumed in the video game world.

When inspected *The Elder Scrolls* human races more in-depth, it is found that the design and relation of Imperial Human race are inspired by the ancient Roman Empire, their history, architecture, armour, clothes and furniture. Furthermore, the Breton race is inspired by the Britons and Celtic nations, and the Nords are inspired by the Viking-era northern European culture and Redguards are inspired by the Arabic culture of early Middle-Eastern people. Therefore, each race of human depicted in this fantastic virtual world having their background history and cultural differences that can also be observed by the differences in their architectural use, LOD and style, material use and furniture use. The cultural and historical reference to the real-world

architecture and their variety also creates a LOD that can be further inspected in depth.

Image 3.15: The Elder Scrolls V: Skyrim (Bethesda Game Studios, 2011)'s Whiterun city castle's interior, based on Viking-era European architecture.
Source: Screenshot by Efecan Büyükbaykal.

For example in *Elder Scrolls*, Redguards are seen having more settlements with tents, and domed structures mainly painted in white and gold contours, stable structures containing openings for ventilation against the desert heat, shown in the lavish design and excess use of motifs. Breton architecture and furniture used are observed to have more pattern work and containing austere grandeur in their constructions. More prominent structures of the Bretons contains detailed friezes, stained glass windows and bas reliefs, with heavy use of pointed arches in walls and on interiors. The Nord race is portrayed as masterful woodworkers; their architecture is mainly based on wood and timber construction, buildings constructed partly underground to counter harsh north climate and sustain interior temperature, with buildings load-bearing systems are only made out of wood supports, and straw roofs above wood planks. Imperial race and their architecture are mainly based on

ancient Roman Empire's image and style, cathedral and tower buildings are portrayed as gothic style.

Besides using for scenery, realism or style, architecture plays another significant role, as seen in the *Dishonored* video game example, where the architectural design in the video game, while representing an era and style, is also used to provide styles of gameplay for the player to achieve objectives required. Architectures benefit on play style, and immersion is therefore significant. The player can choose to use the rooftops and architectural elements for a stealthy approach or infiltration, or as cover from enemies, or a strategical element for positioning and combat. Therefore, as Bonner (2015), Zonaga and Carter (2019) suggested, architecture plays a vital storytelling element, contextualizing information to the player, similar to the motion pictures, television series and other visual media is utilizing architecture and provides several aspects of architecture that can be used in video games virtual world.

For the case study on architectural design in video games, video games researched in this thesis are studied to compare different styles from different timeframes, accuracy and realism in architectural depiction.

Video Game Title	Architectural Style	Accuracy	Realism	Architectural Depiction	Material use	Order
BioShock	Art Deco style of the 1960s	Fantastic and utopic elements included	Not realistic due to the setting of video game	Art Deco Style depiction of American City	Heavy use of Stone, Glass and Metal	Order of Architecture is not precise
Call of Duty: Modern Warfare	A real-world representation of the 2020s	Accurate replication of the real world	Realistic representation	Modern Architecture	Modern Materials based on real-world	Accurate Real-world replication

Game						
Dishonored	Accurate architectural order allowing the use of architecture in gameplay as an advantage	Heavy stone and brick use	Victorian-era architectural style	Not realistic due to the setting of video game	Fantastic and dystopic elements included	Victorian-era London references mixed with steampunk additions
Doom	Architectural depiction creates a background order however gameplay areas are created for fluency not order	Futuristic materials based heavily on Metal use	Futuristic science fiction	Not realistic due to the setting of video game	Not accurate due to gameplay setting	Fictional Futuristic world depiction
Doom Eternal	Architectural depiction creates a background order however gameplay areas are created for fluency not order	Futuristic materials based heavily on Metal use	Futuristic science fiction	Not realistic due to the setting of video game	Not accurate due to gameplay setting	Fictional Futuristic world depiction
Escape From Tarkov	Accurate Real-world replication in a fictional creation	Modern Materials based on real-world	Neo-Stalinist and Modern architecture combined	Realistic representation with physics	Accurate replication based on real-world	Neo-Stalinist and modern architecture combined
Half-Life 2	Accurate creation and order in a fictional environment	Realistic use of materials representing in the existing architectural depiction	Based on Neo-Stalinist architecture representing 1950s Balkan states	Realistic representation with physics	Loosely accurate to support gameplay setting	Neo-Stalinist architecture representing 1950s Balkan states
Kingdom Come: Deliverance	Accurate Real-world replication	Realistic use of materials representing the 1400s era of Central Europe architecture	Accurate representation The 1400s Central Europe Architecture	Realistic representation	Accurate to every detail possible	The 1400s Central Europe Architecture
Mirror's Edge	Accurate Real-world replication	Modern Materials based on real-world	High-tech architecture and postmodern architecture	Realistic representation	Accurate cityscape and architectural creation	Fictional Postmodern with realistic elements

The Elder Scrolls V: Skyrim	Fictional fantasy world based on real-world references	Real-world references are accurate in fantasy creation	Not realistic due to the setting of video game	Real-world references are accurate in fantasy creation	Heavy use of Stone, Wood and Metal	Accurate creation and order in a fictional environment
Wolfenstein II: The New Colossus	Fictional Alternate 1960s era representation	Fantastic and dystopic elements included	Not realistic due to the setting of video game	Suprematist and Brutalist Architecture depicting a dystopia	Modern Materials based on real-world	Accurate Real-world replication
Wolfenstein: The New Order	Accurate Real-world replication	Fantastic and dystopic elements included	Not realistic due to the setting of video game	Suprematist and Brutalist Architecture depicting a dystopia	Modern Materials based on real-world	Accurate Real-world replication

Table 1. Case Study of Architectural Design in Video games

3.2.5. Interior Design in Video Games

3D video games have always been placed in a landscape, urban or suburban, or interior spaces. With the current state of hyperrealism and 3D visualization quality provided, the correlation between interior design and video games cannot be denied. Almost every video game storytelling and playing action is happening in interior spaces, or spatially created locations intersecting with each other. Therefore the interior design, interior architecture and space understanding are very crucial in virtual worlds of the video games to achieve an energetic embodiment and immersion with the player as the player's avatar is bound to mentioned spaces. Interior design is a design medium that is mainly focused on arranging and constructing spatial understanding and human psychological factors in order to provide a comfortable space to inhabit and spend time in interiors. Therefore in the video games' aspect, interior architecture and interior design hold profound importance on the quality of the video game and its virtual world. Comparing several video games with extensive and minimal interior design aspects used in

its development, one can quickly see how the little details hidden in interior design and properly designed spatial spaces allow players psychology to immerse in the virtual world, increase the stimulus in the virtual world. On the other hand, minimal use of interior design detaches the player from the created virtual world of video games because of the lack of interior design, its psychological benefits and familiarity.

The Contemporary video game, *Kingdom Come: Deliverance* is one of the accurate reenactment and replications of 1400s Bohemian Kingdom, its architecture, interior designs aspects are advised by historians for actual replication in the virtual reality. Therefore, in an example such as this, which is an accurate replication in virtual reality, every perceived interior space and architecture is remade accordingly to the historical information, also representing an excellent visualization of 1400s era European life. The extent of the video game is therefore just not limited to storytelling elements, but every architecture, construction and interior space can be accessed by the player's avatar and observed. This LOD also implies the importance of computing power, visualization, virtual modelling and virtual reality.

Assassin's Creed series of video games is one of the examples that use interior design in video game's virtual worlds. The video game series explore upon the concept of virtual recreation of memories, that can be achieved by a technological adaptation of VR systems. In the video game series, the player's character uses these VR systems to access the memories embedded in the DNA of the avatar player controls and relive the memories of the player's avatars ancestors. In order to create adequate historical recreation of the past, researches, historians, interior architects and architects worked together with the developers of the *Assassin's Creed* to achieve authenticity. Several examples of the recreation of interior design in the virtual world of *Assassin's Creed* lies at accurately replicating historic buildings and their interiors to provide background and an environment with astonishing LOD to the video games story.

These recreations are done accordingly to the historical facts and records collected by the developers and then used extensively on the recreation of the era that is portrayed in Virtuality. In the video game's scenery and interior spaces, the player can observe the bas reliefs, stained windows, masonry, friezes and details of the interior spaces, resembling the mentioned timeframe of the past. Without the addition of these interior details and immersive detail providing embodying timeframe and status of the virtual recreation, required information could not be supplied to the player to enhance realism, and enhance immersion with interior space use.

Image 3.16: An interior example of contemporary office from Mirror's Edge (EA Dice, 2008).

Source: Screenshot by Efecan Büyükbaykal.

Image 3.17: An interior example of contemporary office from Mirror's Edge (EA Dice, 2008).

Source: Screenshot by Efecan Büyükbaykal.

Image 3.18: An interior example from Deus Ex: Human Revolution (Eidos Montreal, 2011).

Source: Screenshot by Efecan Büyükbaykal.

In order to create a chart to identify interior design use and its accuracy in video games, the case study of video games researched in this thesis is used and documented with accuracy, realism, style, material use and order to classify their ability to replicate real-world properties in virtual space.

Video Game Title	Interior Design	Accuracy	Realism	Style	Material use	Order
BioShock	Art-Deco interiors based on real-world	Fantastic replication reduces accuracy	Not realistic	Art-deco interior spaces	Heavy use of metal and glass	Order sense is present
Call of Duty: Modern Warfare	Replication of real-world	Accurate replication	Realistic representation	Modern interior spaces	Modern material use	Order sense is present
Dishonored	Victorian-era interior spaces	Fantastic replication reduces accuracy	Not realistic	Victorian with steampunk influences	Heavy use of stone wood and metal	Order sense is present
Doom	Science fictive futuristic interiors	Fantastic replication reduces accuracy	Not realistic	High-tech interior spaces	Heavy use of metal and futuristic materials	Order sense is not present
Doom Eternal	Science fictive futuristic interiors	Fantastic replication reduces accuracy	Not realistic	High-tech interior spaces	Heavy use of metal and futuristic materials	Order sense is not present
Escape From Tarkov	Replication of real-world	Accurate replication	Realistic representation	Modern interior spaces	Modern material use	Order sense is present
Half-Life 2	Science fictive futuristic interiors	Accurate replication	Futuristic elements reduce realism	High-tech interior spaces	Modern material use	Order sense is present

Game						
Kingdom Come: Deliverance	Replication of real-world	Accurate replication	Realistic representation	Bohemian kingdom era interior spaces	Accurate historical use of 1400s materials	Order sense is present
Mirror's Edge	Replication of real-world	Accurate replication	Realistic representation	High-tech interior spaces	Modern material use	Order sense is present
The Elder Scrolls V: Skyrim	Based on real-world with fantastic elements	Fantastic replication reduces accuracy	Fantastic elements reduce realism	Fantastic interior spaces based on real-world	Heavy use of stone wood	Order sense is present
Wolfenstein II: The New Colossus	Science fictive futuristic interiors	Accurate replication	Fantastic elements reduce realism	A futuristic representation of the 1960s	Heavy use of metal and concrete	Order sense is present
Wolfenstein: The New Order	Science fictive futuristic interiors	Accurate replication	Fantastic elements reduce realism	A futuristic representation of the 1960s	Heavy use of metal and concrete	Order sense is present

Table 2. Case Study of Interior Design in Video games

3.2.5.1. Furniture in Video Games

Interior design in video games and virtual reality is known to replicate real-world information and locations to use the advantages of familiarity and embodiment of the player to the virtual world. One aspect of this embodiment is to use furniture styles and types in the virtual world to achieve familiarity.

Depending on the timeframe, location and material used in furniture, furniture use can also be used to depict timeframe and condition of the setting created in the video game. Furniture as a form of decorative art and functional constructions to aid human motion and actions thus can be used to enhance immersion criteria in the video game and increase the video games realism.

In humankind's history, earliest humans and in their settlements are known to use natural forms of materials, such as rocks and trees as furniture,

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which followed by humans carving malleable materials in shape to function as furniture or construct furniture with the composition of elements. Nowadays, furniture definition encapsulates an extensive use and function just as working for aesthetic, psychologic, comfort and status criteria as well.

In order to create an adequate virtual world that resembles the real world closely, and allows the player to perceive the created virtual world as a reflection of the real-world the player resides, furniture details are also designed, placed according to historical knowledge to create a setting the player can perceive and relate.

Several video game examples use the furniture addition to their virtual worlds effectively to achieve a stimulus and create immersion. Specific video games allowing the avatar of the video game to use the furniture placed in the video game to enhance the immersion further, otherwise furniture use can be observed by the player of the video game in cutscenes of the video game story exposition the objectives and settings via NPC's scripted conversations, or on background scenery, therefore including the information to the player that the furniture placed in the virtual world is just not a decorative placeholder but used as a piece of functional equipment.

Bethesda Softwork's video game *Skyrim* is one of the contemporary video games that use the effect of furniture successfully. In the video game setting, the player-created avatar is free to roam in the northern lands of the fictional Tamriel continent and able to accomplish quests for the lords of the settlements. With the continuation of providing services to the lords of the settlements and lands increasing reputation, the player can earn the right to purchase a home in the reputable province and furnish the house purchased. In the later developments of the video game, a downloadable content offered in the video game also allowed a house-builder mode for the player to furnish personally, control, align and decorate the houses in the video game, giving the player ultimate control in decorating, designing and furnishing the living spaces in the video game. The furniture in the *Skyrim* is as mentioned above are made by several races of the fictional world of *Elder Scrolls*, each race having particular

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approach and style on furniture, creating a vast difference between locations in the virtual world of *Skyrim*, and allows a wide variety of customization options. *Skyrim* also allows the player-controlled avatar to use particular furniture to increase further the role-playing elements such as sit on benches, chairs and sofas, use the tables, counters and bookshelves for storage. Therefore *Skyrim* is a video game that uses the furniture elements in the video games virtual world successfully to immerse the player into that virtual setting, and embody the player to the role-playing elements.
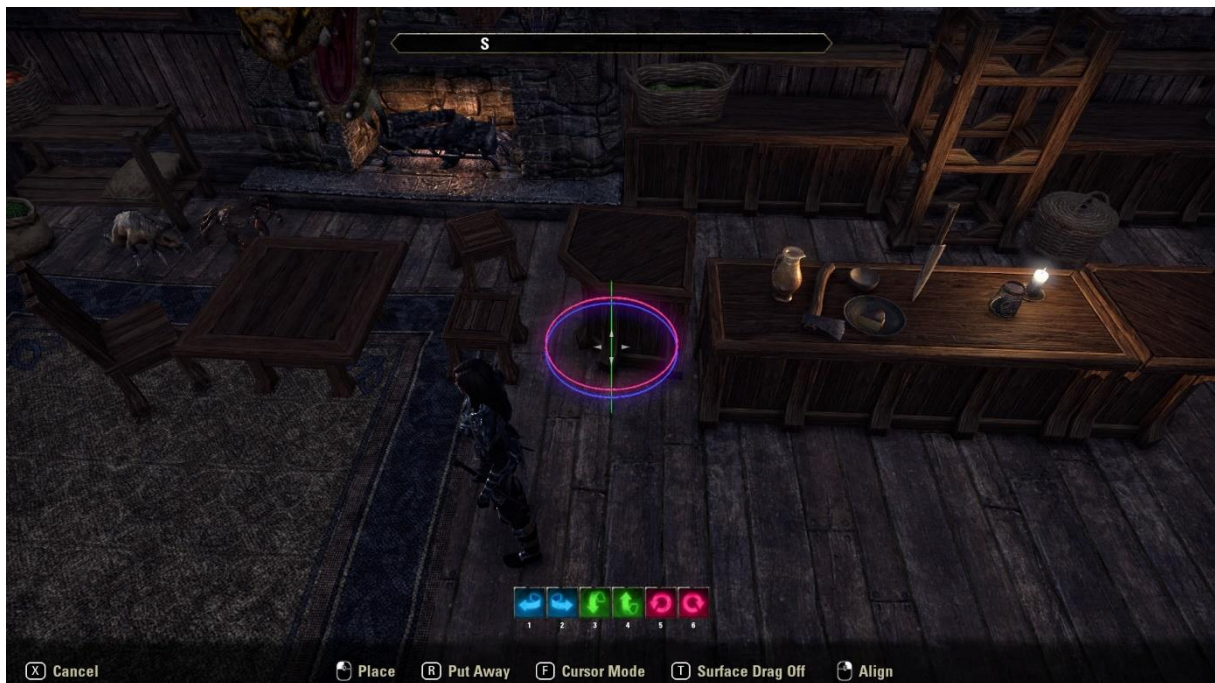
Image 3.19: The Elder Scrolls Online (ZeniMax Online Studios, 2014) housing editor allowing the player to furnish and design the houses the player owns with furniture. Source: Screenshot by Efecan Büyükbaykal.

Further titles in the *Elder Scrolls*, *ESO* is one of the MMORPG video games that is played online with other players, also allows the players to purchase homes, furnish them with decorations, stations, furniture and adornments. *ESO* also allows the players to increase their crafting skills to use crafting to create their furniture with gathered materials across the virtual world of *ESO*, not limiting the player's creativity and furniture choice to in-

game merchants. Such freedom provided in a videogame also allows the player to be more in control of the avatars surroundings and spaces, and more freedom in these virtual locations provides the player with a sense of success, comfort and achievement, while on the other hand also creating a completionist behaviour, urging the player to play for more to achievements.

For the case study of furniture in video games, the video games mentioned in this thesis' extend is studied for furniture use in video games.

Video Game Title	Furniture Style	Accuracy	Realism	Style	Material use	Interaction
BioShock	Art Deco Furniture	Accurate replication	Realistic representation	Art Deco	Wood and Metal	Not interactive
Call of Duty: Modern Warfare	Modern Furniture	Accurate replication	Realistic representation	Modern Contemporary	Modern materials	Not interactive
Dishonored	Victorian Furniture	Includes futuristic elements	Fantastic representation	Victorian-era Classic	Wood	Not interactive
Doom	Futuristic Furniture	Includes futuristic elements	Futuristic representation	Futuristic	Futuristic materials	Not interactive
Doom Eternal	Futuristic Furniture	Includes futuristic elements	Futuristic representation	Futuristic	Futuristic materials	Not interactive
Escape From Tarkov	Modern Furniture	Accurate replication	Realistic representation	Modern	Modern materials	Not interactive

Half-Life 2	Modern Furniture	Includes futuristic elements	Futuristic representation	Futuristic and Modern combined	Modern Materials	Not interactive
Kingdom Come: Deliverance	Bohemian Furniture	Accurate replication	Realistic representation	Bohemian-era Classic	Wood	Interactive
Mirror's Edge	Modern Furniture	Accurate replication	Realistic representation	Modern Contemporary	Modern Materials	Not interactive
The Elder Scrolls V: Skyrim	Based on real-world history	Includes fantastic elements	Fantastic representation	Based on several real-world influences	Wood	Interactive
Wolfenstein II: The New Colossus	1960s furniture	Accurate replication	Realistic representation	The 1960s American Contemporary	Modern materials	Not interactive
Wolfenstein: The New Order	1960s furniture	Accurate replication	Realistic representation	The 1960s European Contemporary	Modern materials	Not interactive

Table 3. Case Study of Furniture in Video games

3.2.5.2. Material in Video Games

Video games and their created virtual reality, is a replication and projection of the reality humans perceive naturally in real-world. Closer the replication of real-world, more realistic and immersive the virtual world becomes. With the advantage of the 21st-century technology, computing power and visualization systems, virtual realities with realistic materials and perception are achievable easily compared to the early history of video games and Virtuality.

Human-made structures and constructions are made from materials composition. Architecture is also defined by the construction materials and surface materials, just as the materials also define interior spaces. Therefore material use and type is a general factor and language in architecture, interior design, product design and representation. Since video games are also a virtual replication and reenactment of real-world, the aspect of materials and conscious use of materials is an essential factor at creating life-like virtual worlds.

The material used in video games virtual environment primarily serves the function of textures of the 3D models and their LOD can vary from model to model, according to the feeling aimed in the video game, or constraints of the video game. Therefore, the understanding of the material in virtual worlds are of a virtual replication of the real-world material digitally, that could not exist outside its virtual boundaries and is just an image texture representing a particular material. With that sense established, anything modelled in 3D environments could be assigned with chosen material to relay specific results, or structure. For example, a cubic interior space designed in a 3D environment virtually can have concrete walls, brick walls, metal walls, or composite materials mixed from different sources to achieve different results. Therefore, this process is first discussed in the creative cycle of the video game production, with support of concept artists and 3D artists to create the required atmosphere, also depicting scales of materials and colours. The following cycle is where the creative productions works are applied to 3D models of the video game and environment to observe results of material choice or decide whether to improve quality or change types of materials further to create the expected result from the video game, its immersion, and realism factors.

Since the material is an essential factor of architecture, and a representation of style, it is imperative in the virtual worlds of the video games to correctly represent its architecture, style, and give the information of material visually to the player. Because of the representative qualities of material used is an excellent investigation source, the player can understand and make sense of the surrounding environment just by materials, or as with several other examples, substantial and intelligent use of materials in specific

locations can also enhance the embodiment of the player further into the video game with intriguing spatial understanding triggering curiosity, and immersion.

The current evolution of 21st-century technology, computing power and design programs capability also improved the quality of materials represented in the video games as well. When looked into video game history, video games released before 2010 did not have the benefits of the graphical engines that current contemporary video games use. Earlier games also did not have realistic lighting capabilities; therefore, light and shadow in the spatial spaces, interior spaces and landscapes, were embedded into the textures of the 3D models. The process of creating or representing material in the virtual world is done by the image-editing software and digital programs that allows attaching texture images to the 3D models. Current technological advances allow the contemporary video game engines and graphical engines to simulate light and shadow different from the 3D model rendered therefore the textures can make use of several 3D texture capabilities such as specular mapping, bump mapping and diffuse mapping in order to enhance the detail of the material further, and the situation of the material. New contemporary texture creating and material creating systems, therefore, allows video games and textures they are using the realistic detail available in real life. These details can range from creating pores in human skin to individual hair modelling and texturing in 3D created human visages, to construction materials quality and surface. Current technological possibilities and use of advanced graphic engines, high definition textures and detailed texture maps, materials used in virtual worlds and video games are considered hyper-realistic.

3.2.5.3. Lighting in Video Games

Lighting is essential to human perception because sight is the primary investigative and perceptive sensory information humans gather from their surroundings. Observation and perception are critical elements in understanding the environment and surroundings and assessment of situations. The sight and lighting are defined by brightness and darkness in space. The

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presence of light, where the intensity defines the brightness in space is illumination in space. On the other hand, darkness, or low intensities of light, creates ambience and depth in the space.

Light and darkness is a very crucial element in human lives. The presence or absence of light can define various topics, from physical events to philosophical. In 21st-century design understanding, lighting is considered a powerful design aspect in architecture, interior design and urban landscape. Besides being a design aspect, lighting is required in human lives for efficient work or display, psychological factors, aesthetics, focusing and creating ambience. One crucial importance could be given in museum displays where the lighting elements, angles, intensities are of significant importance and failure to properly design and adjust such values can damage the artwork or show the artwork with lack of depth with no shadows, or overly bright with reduced surface details. Therefore the from museology and the use of lighting in displaying we can understand how the lighting factor is vital for perception to understand the objects, materials, depth, and surfaces accordingly.

Another essential importance of lighting is that the level of light affects human psychology in different factors. Whether the lack of brightness or overly intensified bright spatial locations can be used to create positive and negative psychological results, just as the usage of light sources, can create a spotlight, point of attention, a circulation pattern, holograms direct attention, while using the lack of brightness or darkness to hide information, detail, create mystery or induce fright.

Current 21st centuries contemporary graphical engines can simulate real-world light characteristics and behave realistically and simulate natural light sources and artificial light sources. Therefore the addition of lighting elements and the importance of lighting in video games and virtual reality is increasing with every day. Since video games are classified under entertainment industry and titled as consumer products, the video game developers are now required to create even more immersive elements and attractive gameplay that stimulates

the player with different and unique experiences, and this stimulation is almost impossible without the use of lighting.

Several video games use the lighting factor very efficiently to both immerse players and give a surrounding awareness. Such examples are known to use the intensity, illumination and brightness for both showing players directions, hiding details for puzzles, creating aesthetics or achieving dramatic effects, attracting attention to specific points. Several open-world type video games use a day-night cycle to simulate day natural lighting and night lighting, both in indoors, and urban landscape and this method allow the player to understand what time it is in the virtual world of the video game. With time understanding and lighting provided, several video games allow the players to choose when to do objectives and missions. Just as well as architecture is considered a significant play element and factor in video games, the light intensity or darkness is also considered a significant element on stealth or combat type approaches, therefore, creating an elaborate system of strategical thinking when to complete objectives in which settings, and allows prior effort on thinking before acting.
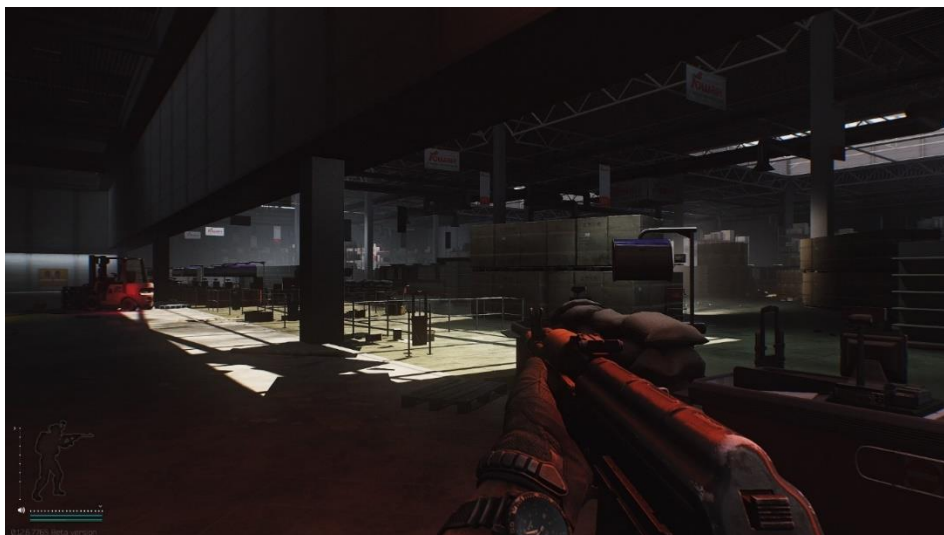
Image 3.20: Escape From Tarkov (Battlestate Games, 2017)'s practical use of light in interior spaces and the time affects the environment.
Source: Screenshot by Efecan Büyükbaykal.

With these pieces of information, a conclusion can be made that lighting in virtual environments, and video games, are considered very crucial, due to importance of creating psychological, aesthetic, dramatic and informative effects, experiencing architecture, interior design, spatial spaces, details and materials, just as well as consciousness about surrounding environment and timeframe.

For the case study of lighting in video games, this thesis' video game lists are studied in order to create a chart comparing the video games immersive use of lighting.

Video Game Title	Lighting Type	Accuracy	Realism	Immersion	Ambience
BioShock	Artificial Lighting	Adjusted for requirements of video game	Realistic representation	Unrealistic	Ambience is established
Call of Duty: Modern Warfare	Real Lighting	Accurate Replication	Realistic representation	Immersive	Ambience is established
Dishonored	Real Lighting	Accurate Replication	Realistic representation	Dark themed	Ambience is established
Doom	Artificial Lighting	Accurate Replication	Realistic representation	Dark themed	Ambience is established
Doom Eternal	Artificial Lighting	Accurate Replication	Realistic representation	Dark themed	Ambience is established
Escape From Tarkov	Real Lighting	Accurate Replication	Realistic representation	Immersive	Ambience is established

Half-Life 2	Real Lighting	Accurate Replication	Realistic representation	Immersive	Ambience is established
Kingdom Come: Deliverance	Real Lighting	Accurate Replication	Realistic representation	Immersive	Ambience is established
Mirror's Edge	Artificial Lighting	Adjusted for requirements of video game	Realistic representation	Artificial themed	Ambience is established
The Elder Scrolls V: Skyrim	Real Lighting	Adjusted for requirements of video game	Unreal representation	Unrealistic	Ambience is subjective
Wolfenstein II: The New Colossus	Artificial Lighting	Accurate Replication	Realistic representation	Immersive	Ambience is established
Wolfenstein: The New Order	Artificial Lighting	Accurate Replication	Realistic representation	Immersive	Ambience is established

Table 4. Case Study of Lighting in Video games

3.2.6. Product Design in Video Games

The product design understanding is a broad concept that includes many aspects of 21st-century human life consumer products and objects. In that scope, product design in video games are limited to the products and objects separate from architectural elements and interior objects, and should not be mixed with industrial design. Product design in video games and virtual worlds are therefore observed as the products, objects and details embedded into the virtual world in order to create immersion and feeling of real-world physicality, detail and sense of living in the spatial surrounding. Due to the broad range of product design, the products mentioned in the video games and virtual

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environments are limited to the range of decoration products and utility products.

Andrew Rollings and Dave Morris, in their book of *Game Architecture and Design* (2004), explain the factors that benefit the development and production of video games, and they explain the visual quality and features as a necessity. However, Rollings and Morris also imply that these features, including products, does not make the game (p. 36). While Rollings' and Morris' explanation of features mainly cover the features and systems of the video games mechanics, this rule also applies to the products placed in a video game. Just like architecture and interior design, randomly placing objects and products would not create an aesthetic sense, but instead, induce a sense of confusion and chaos. Accessories in video games primary purpose is to serve as decoration and resemblance of real-world in order to embody the player into the virtual world as with every other reason of real-world replication or resemblance in virtual world concepts.

When looked into the video games history, the use of products as accessories in video games was limited due to graphical factors and limitations of computing power. However, with the 21st-century improvements and advances in computing power, the advanced graphics, 3D modelling and LOD progressions, accessories in video games also improved. Accessories in video games, therefore, can serve both the decorative purpose of ambience elements or purposeful accessories benefiting the gameplay.

The virtual world created for video games, also narratively and ambiently reflects the era, situation and time of the video game world. Therefore, the use of accessories also plays a vital role in achieving that factor of immersion in video games. Several real-world based video games such as *Assassin's Creed*, *Kingdom Come: Deliverance* is observed to use the accessories in a created virtual word for the video game, accordingly to reflect these factors precisely without breaking immersion. Other video games that created unique alternate worlds resembling real-world but different in their ways, such as *Dishonored*, *BioShock* and *Deus Ex* are, however, is observed to use accessories accordingly

to their own story, setting and language. Considering how accessories are placed and purposed in a video game, implies that accessories and products in the video game are mainly of visual importance and a benefit for immersion criteria, and does not affect the gameplay of the video game for better results. However, psychologically, observation and strategic placement of accessories in the virtual world creates an adequate replication of a virtual place that is being used, and information of space is living. This observation creates embodiment with the player and the avatar, and therefore into the video game.

Therefore, the product placement, products used in a virtual environment, and in a video game must contribute to the virtual world of the video game and video games story. As with all things, the placement and create products in a video game must exist in the sense of order. Positively, the sense of order is understandable, observable and psychologically informative, which is an immersive contribution to the virtual world of the video game. This contribution is an immersive factor and aesthetic pleasure provided to the player to increase further embodiment of the player with the avatar of the video game and virtual environment of the video game.

3.3. Immersion in Video Games

Video games are considered a significant entertainment activity, and a vital part of the entertainment industry in the 21st century. The technological developments and the progression in creating better video games benefits both the consumer market and AEC industries, as well as design industries because of mentioned industries affiliation with digital technology and digital software to achieve results.

To create better video games that serve a wide range of consumer market, preferred by the players of the video game, satisfying individual needs and requests from the video games, video game designers and developers are known to use immersion elements enhanced to increase further the aesthetic appealing of the video game. The psychological enjoyment earned from the video game

is also directly affiliated with the immersion provided by the video game. The immersion is a direct contributive factor of experience earned in video games. This experience is qualitative, that is earned by the player of the video game. Whether the outcome of the video game playing action is positive or negative, the experience earned in the video game is always positive, because the voluntary action of playing a video game is an action taken to induce enjoyment. Therefore, because of immersion is a crucial element on players experience and enjoyment from the video game, video game developers are working to produce more immersive video games, with better visuals, experience, acoustics and narrative. However, because of this pursuit of producing better immersive video games, a wide variety of video games with different aspects of immersive elements being dominant have surfaced and allowed video game researchers and journalists to delve further into immersion elements in video games.

Laura Ermi and Frans Mäyrä (2005) who have studied the fundamental components of the gameplay and analyzed immersion systems have divided the immersion concepts in a video game into three separate concepts on their model. These concepts are sensory immersion, challenge-based immersion and imaginative immersion. According to Ermi and Mäyrä's immersion concepts (p. 8), the sensory immersion is focused under aesthetics, acoustics and sound, while challenge-based immersion is encapsulating the narrative and story elements of the video game, and objective achievements, feeling of success and realism factors of the video game. Imaginative immersion criteria are also conjoined with the challenge-based immersion, primarily narrative and the background information provided to the player to create imaginative thought processes to induce immersion to the virtual world. Therefore according to Ermi and Mäyrä, the immersion is centred on the gameplay experience, players interpretation of playing the video game and creates a bridge between the video game and its structures and player and players motivations.

The immersion according to the correlation of real-world and virtual world of video games are then can be observed as similar, mainly because the player of the video game also experiences the real world with visually

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coordinated information gathering. In addition to Ermi and Mäyrä, Laurie Taylor also states that "immersion is a consequence of inattention to the spatial field, not because the spatial field is given, natural domain of experience" (Taylor, 2002, p.13), and Ermi and Mäyrä's research suggest that audial and visual pieces of information have a significant impact on immersions. Alison McMahan also states that "immersion is not totally dependant on the physical dimensions of technology" (McMahan, 2003, p.68). Therefore immersion is a complicated and broad sensory perception that affects the players not physically, but also mentally, provided with aesthetical visuals that stimulate enjoyment. Another different study conducted by Emily Brown and Paul Cairns in 2004, unlike Ermi and Mäyrä's, uses a three-stepped model of immersion and breaks up the immersion concepts rather than unifies or merges them. According to Browns and Cairns, immersion is a progressive stimulus, and the player attains levels of immersion step by step; engagement, engrossment, then total immersion (2004). However, Brown and Cairns' suggestion of immersion, compared to the how immersion is provided in 2020, is not sequential, rather like Ermi and Mäyrä's concept, engages the player in a whole immersive concept, with subcriteria focusing on different aspects of immersion. This engagement of immersion is developed jointly to the real-world counterpart of immersion, with the benefit of evolved and powerful computers, pursues the immersion elements widely in total engagement, rather than steppes or sections of immersion provided partially. Obviously, in real-world, humans perceive and immerse themselves into the surroundings according to the character they embody, and this process is naturally occurring. However, considering the artificial existence of virtual realities and video games, the embodiment to the character and immersion is induced by the aesthetic, audial and narrative elements provided to the player.

While immersion is an obvious selling point of the video games, the experience earned from video games is also a potential correlation between the real-world and virtual world example. Therefore, in order to specify experience under a classification, previous researches and categorization done by researchers, are not sufficient enough to categorize experience under a concept.

For example, Ermi and Mäyrä's dimensional categorization of immersion and experience factors (2005), does not comply with the Brown and Cairns' sequential immersion progression (2004). In addition, Laurie Taylor's study claims that immersion can only occur when the player of the video games perception and realization from the real-world is separated, and the player accepts the virtual world as a reality (2002). Taylor then explains the immersion as a diegetic and situated, where "the player is immersed in playing the game and in the experience of the game space as a spatial and narrated space" (2002, p. 12). Henri Lefebvre, a french philosopher, uses space definitions as represented and representational, which then proceeds to classify space understanding under three categories; spatial practice, represented space and representative space (Soja, *Thirdspace*, 1997, pp. 26-32). Taylor, explains Lefebvre's spatial understandings as the spatial practice being the perceived reality, represented space as the mentally conceived space and representative space as the combination of spatial and represented space (2002, p. 18). However, with this definition, Taylor also divides the immersion, perception and experience from the total experience of playing video games into segments and the players as a medium. This segregation while sufficiently helpful on defining some aspects of the virtual space, VR and video games, are not capable of relaying the experience elements in the video game, according to Mäyrä and Ermi's explanation of immersion and experience.

Therefore both Taylor's (2002) and McMahan's (2003) studies work to separate immersion and experience understanding to sequential segments, while Mäyrä's and Ermi's model of immersion and experience (2005) work better to explain the relationship of the player with the game, and while connecting the bridge with the video game to the player, explain the relation of experience to immersion. However, Ermi and Mäyrä's (2005) research on immersion of video games resulted in more question that it answered, sociologically. Using Ermi and Mäyrä's immersion model, "in which the game offers the player a chance to use imagination, empathise with the characters, or just enjoy the fantasy of the game" (2005, p. 8). Thus the correlation with the real-world and the virtual world of video games in experience and immersion aspects is a crucial factor

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that directly impacts the action of playing a video game and using the virtual world as an entertainment choice in the real-world. Brown explains this as "immersion is designer with the player's disembodiment and absorption into the textual story and world; we see a trend of immersion systems designer to make the player feel rewarded instead of valued" (2011, p. 32). Brown's findings include that immersion is a designed action and experience factor. Nick Yee, also, theorises that there are four significant actions for player's immersion. Yee classifies these actions as discovery, role-playing, customization and escapism (2006, p. 773). Just as in real-world, humankind's need for discovery and customization, can be justified, video games and virtual worlds also supply these experiences, besides with role-playing elements that are unable to be achieved in real-world, and escapism from real life, avoiding real-world problems and relaxation. It is because of these factors, and immersive capacities that video games have successfully anchored itself into the entertainment industry for so long and continues to be one of the primary entertainment mediums.

According to these researchers, it is possible to look for immersion elements in aesthetics provided by the video game, the audial performance and sounds of the video game, narrative and story elements in the video game, realism and experience levels in the video game to better narrow down the strong correlation between the virtual world of video games and the real-world on the context of the architecture and spatial understanding.

3.3.1. Aesthetics

Aesthetics is a comprehensive and subjective concept in human cognition. Because every human being psychologically develops different according to location, education and zeitgeist of the era, aesthetic taste and understanding are also developed differently. Therefore it is almost impossible to talk about a single aspect of aesthetics or aesthetic use in video games. However, looking at the previous researches done about video games and their aesthetics, important surfacing topics could be found. A search previously made

for the key elements of game aesthetics resulted in three main topics, which are classified as;

> "1- Game aesthetics refers to sensory phenomena that the player encounters in the game (visual, aural, haptic, embodied)
> 2- Game aesthetics refers to those aspects of digital games that are shared with other art forms (and thus provides a means of generalizing about art)
> 3- Game aesthetics is an expression of the game experienced as pleasure, emotion, sociability, form-giving, etc. (with reference to 'the aesthetic experience')" (Niedenthal, 2009, p. 2)

From these researches, factors affecting video game aesthetics can be narrowed down to the story, action, and visual cognition to further explain its importance in the video game and its correlation with real-world. Experience factor, however, will be looked into separately from aesthetics, as a form of immersion in this case.

One crucial aesthetic element of video games is the story of the video game. Torben Grodal remarks that "several theoreticians have pointed out that at least at present most videogames have a less complicated story than films or novels" (2003, p. 147). The argument in video games and their aesthetics compared to real-world aesthetics are required to be much simpler than many other media and entertainment mediums. This observation can be seen on several of the video games of the industry, such as *Star Wars* video games where the video games storytelling, narrative elements and aesthetics are far more straightforward than the motion picture or movie version of the media title. However, in the perspective of playing a video game and aesthetics, there are different opinions and perspectives concerning this topic. This debate can be seen in Jesper Juul remarks this on the Atari's 1983 *Star Wars Arcade* game example. Juul says that;

> "The primary thing that encourages the player to connect game and movie is the title "Star Wars" on the machine and on the screen. If we imagine the title removed from the game, the connection would not be at all obvious" (Juul, 2001, p. 4).

Image 3.21: Atari's Star Wars Arcade video game from 1983.
Source: https://www.telegraph.co.uk/gaming/what-to-play/star-wars-history-in-video-games/atari-star-wars/

Therefore, we can understand that the story elements relation to commercial or intellectual elements connection creating an understanding of aesthetics and memorable moments recreation is essential. The Atari's *Star Wars Arcade* video game uses the graphical equivalent of the first *Star Wars* movie *A New Hope*'s (1977) final space battle scene provided by an arcade machine, and the player's vision is similar that of the main protagonist of the movie's vision in the space ship attacking antagonists space station. However, as Juul pointed out that if the *Star Wars* logo were taken out of the arcade machine, the video game would make no sense to the player of the video game if the player has not watched the *Star Wars* movie. This unclearness is because primarily player has no reconciliation of the video game is a *Star Wars* video game, and secondly because of the story elements provided in the video game are reduced to the level of an only space battle with no pre-narration and storytelling. It is important to note that video games are a form of storytelling with actions included to progress the story elements. However, storytelling and narrative factors will be looked in following subtopics because it is the current video

games placement of storytelling and narrative elements are mainly integrated with immersion to the video game instead of aesthetics.

According to Grodal, immersion and aesthetics of the video game are achieved with pleasures of game playing connected with the aesthetics of repetition and succession (2003, p. 148) which is directly connected with action and activity. As the second important factor in aesthetics of video game, activity is explained by Grodal (2003) that the first impression of observing aesthetically pleasing new world and experiences that are unfamiliar to the player challenges the player to conquer those challenges with understanding and accepting the aesthetics provided in the video game. Grodal's understanding of aesthetics in video game concurs with Juul's observations because Grodal finds the argument in between the story and aesthetics normative and restrictive (2003, p. 147). The addition of Grodal's perspective in aesthetics relation with video games story, actions and its connection to the player is explained as;

> "Playing video games demands a detailed richness and specificity in cognitive maps of spaces and opposing agents, of causal inferences that do not only have to be vague premonitions as in films or novels in which the author/director is in control, but precise ideas in order to work. The perceptions have to be fast and precise, the motor control coordinated with the perceptions, and thus the computer story demands the acquisition of a series of procedural schemas" (Grodal, 2003, p. 147).

In this observation from Grodal, we can see that compared to Juul's observation of a reduction in video game understanding, that Grodal is accepting the activity of video game playing as an activity, and in several aspects similarizes the activity of gameplay with the repetitive actions of every day human life (2003 p. 148). This familiarization of gameplay with repetitive every day human activities is considered an aesthetic element of video gameplay, which directly connected with the ability to create parasympathetic and sympathetic emotions resulting from the action of playing the video game.

The last important factor of aesthetics in video games, just as considered in real-world, is visual quality and visual reception of the virtual world. For

the last decade, advancements and improvements in computing and production technologies allowed the video game developers and 3D artists to create hyperrealistic quality visuals and almost indistinguishable graphics from reality. Therefore, the visual quality of the video game is also directly related to the aesthetics of the video game. While several different genres and types of video games are preferring simple or cartoon-like graphics for immersive elements of nostalgic elements, most successful titles of 2020 rely on hyperrealistic visual quality that recreates and simulates the real-world perfectly. Besides, compared to video games that rely on simple graphics or cartoon-like graphics, hyperrealistic visual aesthetics serve the majority of video game players. This separation is primarily because the primary audience of video game players use the video game entertainment as relaxation and escape from real-world, and when encountering these hyperrealistic visuals in the video game, aesthetic appeal, immersion and embodiment in the video game happen faster.

When looked into the visual quality of the video games to create the visual part of aesthetics, we can see that the central system used in the aesthetic concept is to create an ambience that the players can visually perceive and experience. There are several persuasive examples of these ambience concepts and their relation to aesthetics. The video game *Dishonored*, upon starting the video game, immediately reflects a slowly degrading victorian-era architecture and cityscape with struggling city occupants fighting both conflicts with authority and a mysterious plague striking citizens. *Dishonoured* fashions a dark, gloomy ambience with colour scheme choices, lighting elements in the tall, edged and pointy structures of the victorian themed architecture, immediately reflecting its grim aesthetics. Another good example is observed in *Wolfenstein: The New Order*, where the player takes up the role of a World War II soldier, spearheading the final assault on axis powers to stop their war efforts. However, in the progression, the protagonist of the story is critically wounded and put fell into the vegetative state due to his injuries, and the player again takes control of the protagonist just after awoken from the vegetative state, fourteen years later. The player is confronted with a changing world,

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different technologies, axis powers being victorious in Word War II, controlling the world. This change is provided visually to the player as changing on colours, lighting, changing cityscapes, totalitarian concrete buildings towering over known cities such as London and Berlin exerting dictatorial power. The introduction segment and the progression segment of the game offer two separate aesthetic elements and ambient environment creating a sharp contrast in between allowing the player to comprehend the changes, and embody further into the avatar of the video game against the antagonists.

This two example of *Wolfenstein* and *Dishonored* video game titles are good examples of how visual aesthetics are proven to be useful information sources and immersive addition to the gameplay. This type of aesthetical approach and ambient information is a crucial part of contemporary video games. The latest video games incorporating ultimate visual qualities and aesthetic elements for perception providing sensory information, combining social and technological elements for gameplay activity, pursue to create ultimate aesthetic pleasure and gameplay activity for commercial purposes. Furthermore, Niedenthal explains that "Digital games share certain forms, aims, content, themes and design practices with other media and art forms, which allows for comparison and generalization" (2009, p. 2). Therefore we can conclude that including these elements in visual form in video games allows a comparison for the player with the real-world to create an aesthetic pleasure. Also, Niendenthal says that when the player observes a form of visual art in a video game, this translates into the information of "the dominant aesthetic of videogames, and considers ways in which an awareness of the history of contemporary sculpture could support new, non-photo real formal vocabularies in games" (2009, p. 2). This opportunity can transform into a new way of virtual worlds communication with real-world, and new ways of creating video games that are aesthetically appealing and constructive at the same time.

3.3.2. Acoustics and Sound

Sound is a critical sensory input for human perception and cognition. Physically speaking, the sound is a vibration that translates into an acoustic and audible waveform that is picked up by ear organs and translated into meaning in sensory organs. Sensory cognition of sound is a crucial subject for any living being, primarily because sound information is used to triangulate the position of incoming threats, used for detecting danger, navigation and hunting. Scientists also use soundwaves to specify events around the Earth, because events happening on Earth creates unique soundwaves which then classified and characterized by scientists to a specific event and even can be pinpointed on the globe using physics, mathematics and scientific equipment used to listen to soundwaves.

When inspecting the humankind's history, humans are known using audible communication skills and sounds as a cultural foundation. This culture, also developed into using sound generating equipment, such as musical instruments and recording or communication devices also to produce sound and transmit sound for communication, socialization and expressionistic art. Because of sounds extensive capacity as art, music and positioning, sound and acoustics are considered a vital factor in entertainment media. This importance also plays a crucial role in video gaming, especially in FPS style video games.

Because sound perception is commonly used for navigation and perception, communication and as a form of psychological stimuli in forms of music and ambient sounds, its strategic use, planning and acoustic enhancements are very crucial for video game immersion, embodiment and pleasure. Ryan Laliberty, in his research of aural positioning and aesthetics of realism in video games, focused on sound design in video games explains the importance of sound design as;

> "sound design is crucial to the development of any audiovisual medium. It becomes especially relevant when the medium is defined by interactivity, as is the ease with video games. Good sound design can make or break a game. It can immerse a player, enveloping them in an interactive, rich soundscape, or distance them through its poor

implementation. Of all video games genres, it is in audiovisually realistic games where the sound design takes on the largest role" (2014, p. 1).

This explanation brings forth the importance of how sound design, acoustics and interactive use of sound in a video game is contributing to the immersion factors, just as in any other audiovisual media medium.

FPS genre video games place the player into the avatar and allow the player to perceive the virtual world just like in the real world, from the avatar's first-person perspective. Considering FPS setting, audial perception is also should be designed as if it is heard like in real-world to enhance immersion and embodiment into the video game. As Laliberty (2014) proposed, good sound and acoustic design in FPS video games are an enhancement in immersion, and poor audial placement or design can break its immersion, distancing player from the virtual world the game designers want to immerse. Acoustic quality, and surround sound systems providing realistically placed and designed audial perception is realism quality and enhanced immersion quality in an FPS style video game, which focuses on recreating or replicating the real-world soundscapes to create a realistic virtual world the player can embody into and enjoy.

Laliberty (2014) also explains the process of hearing, which he describes as an internal process, and the produced sound for the audiovisual medium, which is produced by the physical, electronic hardware devices, which can vary extensively in quality and capabilities. Therefore, in order to chart, observe, experience and correlate with the realistic sound qualities of the real world, a 7.1 channel high-end quality headphones with 3D surround system capabilities were used in this thesis. This study allows researching the audial qualities and immersion of the video games in the best possible way to utilize case study findings under immersion and realism of the video games to compare with the real-world settings.

However, due to the broad concept of sound and audial design in literature and design mediums, this research should not be confused with other classifications of audial design and researches. Instead, this research approach

fundamentally categorizes the aspects audial immersion of video games correlation with real-world and how acoustics are designed in video games to replicate real-world settings. This information is sought to provide means to compare the virtual reality possibilities to real-world settings and potential collaboration of both virtual and real settings for acoustic quality in virtual reality and the importance of sound design.

Immersion in video games and its effects on realism is discussed generally in this chapter. However, the sound and acoustic topic require further explanation of the FPS genre and how it is positioned with audial properties. In an FPS video game, the player is controlling the avatar of the video game, experiencing the video game narrative and story thru the perspective of the avatar, and the audial system is therefore targetted to the avatars ears, which in direct relation to players ears. Therefore every sound generated in the video game is designed to be heard in the first-person perspective, for navigation, perception and supporting ambience for immersion and embodiment into the video game. This system also requires a careful recreation of acoustic properties of the real-world in the virtual world, in order for authenticity. For example, most FPS video games, whether their story progression is linear or open-world, force the player to move throughout several different locations in their virtual world, for breaking repetition in similar locations and providing different locations for discovery and variety. This variety might include small spatial locations, closed indoors, open outdoors or cityscapes depending on the video game title. However, every location is different from one another, mainly because of architectural style, construction materials and acoustic factors and therefore, must have different acoustic characteristics depending on mentioned factors in order to create authentic and immersive effects.

Most FPS video games, including gunfight and war-themed actions, make use of these differences in acoustics to generate more authentic replication of real-world sound perception. An example from Battlestate Games production, *Escape from Tarkov* (2017) video game, commercializes its productions as the most realistic gunfighter FPS video game made, which uses extensive audial and acoustic systems to replicate real-world settings, including many other

realistic simulations of physics and customization options added into the game as well. Therefore, in order to create the most authentic gunshot sounds and its acoustic effects in-game, developers from Battlestate Games used real firearms and recorded their sounds on both wide and narrow indoors, plain or forested outdoors and cityscapes to provide most authentic gun sounds and acoustics created by a gunshot in the video game. Because of the extensive work on acoustics, the players of the *Escape from Tarkov* video game can expect a realistic acoustic quality that is an almost exact replication of the real world acoustic settings depending on indoor or outdoor environments. Accurate replication of sound travel and reflection according to the location, materials, space in indoors or outdoors creating realistic acoustic perception and sound quality which directly increases the realism effect and enhances immersion into the video game by its acoustic effects. These sounds effects are also direct consequence and result of the player's actions which are recognized as diegetic sounds, affiliated with the player's actions, allowing the player to be conscious of the acoustic result of actions.

Over the last decade, with the progression of realism and hyperrealistic graphical quality of the video games also forced game developers to work on authentic and accurate replication of acoustic effects in-game to enhance further immersion acquired by the player. Several FPS titles have also used the benefit of soundtracks and music in action sequences or ambient sound effects to create required psychological effect in-game as non-diegetic sound effects. These non-diegetic sounds or effects used in the video game, therefore, does not belong to the environment and created a virtual world in the video game, but serves the purpose to stimulate player with tempo for action sequences, or emphasis an ambient mood. Fast-paced FPS action video games, such as *Doom 2016* (2016), *Doom Eternal* (2020), *Wolfenstein: The New Order* (2014) and *Wolfenstein II: The New Colossus* (2017) are known to use non-diegetic sound effects and fast-paced, intense soundtracks to stimulate players and induce a tempo in an action sequence.

Image 3.22: Doom Eternal (id Software, 2020)'s fast-paced gameplay, and action sequences are supported with high-tempo music and dramatic sound effects.
Source : Screenshot by Efecan Büyükbaykal.

This type of audial immersion acquired by non-diegetic and diegetic sound inputs are classified as sensory immersion, which is explained by Ermi and Mäyrä, in their category of three immersion types (2005). The kind of sensory immersion Ermi and Mäyrä suggesting here is considered as the physical immersion that is both in the virtual world and that which happens in the real world. While Grimshaw (2007), agrees and uses Ermi and Mäyrä's immersion categories in his doctorate dissertation, he also suggests that the quality of the audio is also crucial for the immersion. Because the audial recognition and hearing happens outside the virtual world of the video games, and have to be physically heard by the player, the quality of the audio reflected from the video game is also essential. Grimshaw mentions that a simple two channelled stereo audio system would be much less effective in immersive capacity compared to 7.1 audio surround system could offer (2007). Grimshaw explains the physical side of the audial perception as;

"There are several technical difficulties which limit the availability or effect of both localization and reverberant cues. The unknown factor of the player's use of stereo loudspeakers, surround sound systems or headphones presents problems for designing sound localization cues in FPS games" (2007, p. 180).

The FPS type of video games audial use of navigation, localization and attraction sound cues in the physical real-world can vary from the system it is being played. That is why this research has used the high-end 7.1 3D surround headphone system that can replicate the perfect audial positioning, 3D sound distribution and localization cues, to inspect acoustic and sound in video games and their immersion.

For the case study to test acoustic quality, FPS video games that can be experienced in cityscapes, closed quarters and indoors were tested to compare how architecture, material, space is affecting acoustic quality. The acoustic difference in each video game, depending on the spatial volume of the location, indoors and outdoors, materials used in the environment, and how the materials responded with acoustic interaction, reflecting and absorbing sound effects are noted. Also how audial cues and attractions are placed to aid the player on the navigation, and how realistic the sound quality was reflected in the virtual world was observed and laid out in graph to clarify the immersive potential of the video game and how accurate representation of real-world it is.

Video Game Title	Acoustic Design	Accuracy	Audial Clues	Navigation and Awareness	Ambience	Realism	Diegetic or Non-diegetic
BioShock	Fantastic acoustic replication	Accurate acoustic replication	Audial clues included	Achieved	Ambient sound is present	Accurate acoustic simulation	Diegetic input
Call of Duty: Modern Warfare	Realistic acoustic simulation	Authentic acoustic replication	Audial clues included	Achieved	Ambient sound is present	Realistic acoustic simulation	Diegetic input

Game							
Dishonored	Diegetic input	Accurate acoustic simulation	Ambient sound is present	Achieved	Audial clues included	Accurate acoustic replication	Fantastic acoustic replication
Doom	Diegetic and non-diegetic input	Accurate acoustic simulation	Ambient sound is present	Achieved	Audial clues are trivial	Accurate acoustic replication	Fantastic acoustic replication
Doom Eternal	Diegetic and non-diegetic input	Accurate acoustic simulation	Ambient sound is present	Achieved	Audial clues are trivial	Accurate acoustic replication	Fantastic acoustic replication
Escape From Tarkov	Diegetic input	Realistic acoustic simulation	Ambient sound is present	Achieved	Relies on audial clues	Authentic acoustic replication	Realistic acoustic simulation
Half-Life 2	Diegetic input	Realistic acoustic simulation	Ambient sound is present	Achieved	Audial clues included	Accurate acoustic replication	Realistic acoustic simulation
Kingdom Come: Deliverance	Diegetic input	Realistic acoustic simulation	Ambient sound is present	Achieved	Relies on audial clues	Authentic acoustic replication	Realistic acoustic simulation
Mirror's Edge	Diegetic input	Accurate acoustic simulation	Ambient sound is present	Achieved	Audial clues included	Accurate acoustic replication	Similar acoustic replication
The Elder Scrolls V: Skyrim	Diegetic input	Accurate acoustic simulation	Ambient sound is present	Achieved	Audial clues included	Accurate acoustic replication	Fantastic acoustic replication
Wolfenstein II: The New Colossus	Diegetic input	Accurate acoustic simulation	Ambient sound is present	Achieved	Relies on audial clues	Accurate acoustic replication	Realistic acoustic simulation

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Wolfenstein: The New Order	Realistic acoustic simulation	Accurate acoustic replication	Relies on audial clues	Achieved	Ambient sound is present	Accurate acoustic simulation	Diegetic input

Table 5. Case Study of Acoustics and Sound Design in Video games

3.3.3. Narrative and Story & Objective

Video games are accepted as a form of a combination of diegetic—or non-diegetic depending on the video game title—narration and storytelling mediums. Narrations importance on video games as an entertainment medium is primarily because of diegetic and non-diegetic inputs of narration or information, forming of the story, and stories success at immersion, just as Ermi and Mäyrä's (2005) immersion categories explained. This immersion-style is directly related to the video game developers and production because the way the story will be narrated, and experience will be conveyed to the player is decided by the developers. However the developers one of the primary purposes on video game development is to develop an immersive and intriguing story experience for the players for commercial purposes, including media, and embodiment with the video game and consumption of video games. On this case, Zimmerman explains storytelling and its importance in video games as;

> "A story is the experience of a narrative. And the dissatisfaction with game-stories is a dissatisfaction with the way that games function as storytelling systems. Remembering the concept of the narrative, story systems function by representing changes of events though pattern and repetition. This act of representation – or, we might say, signification – is how narrative operates" (Zimmerman, 2004, p. 161).

As Zimmerman (2004) explains, the importance of narrative style, story explanation, the diegetic and non-diegetic information is provided on this case, and the experience of the story is fundamental ground for video games to be understood and converted into enjoyment and experience. According to Ermi and Mäyrä's research, the pleasure of video gameplay action, besides being voluntary, includes fantasy, cognitive and physical challenges, and audiovisual, which Ermi and Mäyrä point out that audiovisual quality and style

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is the central aspect of video games (2005). The video games fundamental structures form from the video game mechanics, story and narration, spatial sense creating the audiovisual style of the video game, is then directly used to form a bridge between the players motor and cognitive skills with immersion and sensory input, which is explained by Ermi and Mäyrä (2005) on their gameplay model. The video game theorists and narratologists explain this concept as the ludonarrative. From the research and works of Weimin (2015), Juul (2005), Frasca (1999, 2003) and Murray (2005), this thesis uses the combined understanding of ludonarrative and its relation with video games.

Ludonarrative is explained by Frasca (1999) as one of the entry points to video game and its relation with the activity which forms the ludology, and a discipline that studies activity. Early studies such as Aarseth's (1997) and Murray's (1997) created two opposing viewpoints. However, it was the beginning of new narrative forms and models, which is still developed and studied in-depth today. Nevertheless, narratologists studying narrative connections and ludologists studying action involved in the video game can find common ground in Aarseth's explanation that "to claim that there is no difference between games and narratives is to ignore essential qualities of both categories" (Aarseth, 1997, p. 5). This connection with the action—the ludo— and narrative story, creating a ludonarrative media, can serve as adaptive media for entertainment. This media importance and quality is a basis for audiovisual quality searched for in video games. Jesper Juul also explains the storytelling and video gameplay actions through fiction, instead of narration, allowing the compatibility and adaptive nature of the video games;

> "That many fictional game worlds are incoherent does not mean that video games are dysfunctional providers of fiction, but that they project fictional worlds in their own flickering, provisional, and optional way. Of all cultural forms that project fictional worlds, the video game is a special form in which players can meaningfully engage with the game even while refusing to imagine the world that the game projects—the rules of a game are often sufficient to keep the player's interest. Perhaps this places games on par with songs, opera, and ballet" (Juul, 2005, p. 200).

However, Juul's (2005) explanation is mainly focused on the play elements of the video game, and actively opposed to Aarseth's (1997) and Frasca's (1999) perspective which supports the importance of narration and its importance in the immersion and gameplay.

Therefore, it is very plausible to consider the video games story elements and narrative style, as an audiovisual concept, and its quality can be defined with the realistic elements or diegetic & non-diegetic inputs provided to the player for information is used. It is, as previously mentioned in other immersive subtopics of the video games correlation, generally considered the main focus on at the video games. Otherwise, the lack of story would generate no positive experience, cognition or relationship with the virtual world of the video game, reduces the embodiment with the avatar of the video game and the virtual world, because there would be no purpose to be accomplished which then aligns with the emotion of success player feels with the completion of the objectives. This reduction in immersion, or total lack of immersion, is a factor making the video game unsuccessful at immersion, realism, quality and becomes a non-enjoyable action, which is directly relative to the commercial success of the video game title and developers.

However, different tastes in action and gameplay by the players, the video game industry has adapted to this difference. With the development of the video game industry and media involving the video games, the subclasses and subgenres of video games also surfaced to provide the needs. Such a difference can be seen in several action type video games, such as *Metal Gear Solid V: The Phantom Pain* (Kojima Productions, 2015) which focuses on heavy narrative and story elements, includes rich audiovisual quality and details, or *Dragon Age: Inquisition* (BioWare, 2014). The opposite of this reaching out can also be seen in fast-paced action games with little-to-none narrative elements or storytelling, a mediocre audiovisual quality which is primarily focused on visual qualities and effects rather than immersion elements. This primary focus on gameplay action is rather than narrative, and story elements are subjective to the player, as the consumption of these audiovisual media is subjective to the player's preference.

As studies of Juul and Aarseth create different perspectives for the study of video game and its narratology, ludonarrative qualities, audiovisual qualities and media properties, it is a new crucial topic to research in entertainment media and narratology. However, in order for this thesis to correlate video games with the real world and emphasis on importance and reliance of both mediums to each others connection, the story elements and narration are fundamentally have not been included in the case studies for the primary reason of irrelevance with architecture and spatial understanding.

3.4. Interaction in Video Games

As an action of video gameplay, interaction in video games is considered both a physical and psychological activity. Interaction with video games audiovisually achieved with providing sensory information to the player and the psychological connection is achieved with narrative, information and embodiment to avatar the player controls in the video game. The avatars perspective in the video game is also another form of interaction in which the player's inputs and actions are translated into avatars movements and actions in the video game on the virtual world. Avatars interaction with the virtual world is also considered a form of interaction between the virtuality and the player. Avatars relationship with the landscape and architecture, buildings and digital representations around the avatar can also be studied similar to real-world properties as humans relationship with their surroundings.

Interaction defined in video games can be separated into two separate segments, which the primary interaction is refined and allowed in the video game or virtual reality is it with the avatar of the player with the virtual world of the video game or the surrounding elements of the avatar. This interaction in the virtual world can be with landscape, architecture, inanimate objects or products and NPC's. The secondary interaction is explained as the interaction of video game with the player via immersion, embodiment, ludonarrative and audiovisual elements. Therefore the classification of the primary interaction is a virtual interaction that the player achieves with the virtual world, and the

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subsequent interaction is sensory interaction which is fundamentally psychological stimuli and information registered by the player.

The importance of psychological effects video games reflects and interact with the virtual world of the video game is a profound topic. The Interaction in the video game *Dark Souls* series, which is considered Hidetaka Miyazaki's masterpiece video game title, is given an example in Wildman and Woodward (2018)'s article. Wildman and Woodward express that in Miyazaki's *Dark Souls* video games, the interaction with the world of *Dark Souls* is made to perceive as crucial, however fictional because choices, decisions and interaction with the virtual world define how the game will end, and which ending the players are going to be rewarded with, but separate from any real-world connection (2018). Miyazaki's *Dark Souls* video games consist of a fictional world with gloomy and dark ambience surroundings and architecture and very dark fictional lore that fills up the connection with the player. However, *Dark Souls* is a third-person action game can also be played without reading or listening to the lore of the video game which is provided in-game or understanding the surrounding by just progressing the game without interaction, immersion or narration. The game mechanics work simply by killing enemies and progressing into the next level after defeating a final boss of that level. However, Miyazaki developed the video games lore and fiction in such a sense, the video game itself could be a complete article studying its lore, narrative, style and interaction. Upon further investigation, it is found that the player is given a free will to choose in the video game *Dark Souls*, and ability to interact with many fictional aspects of this virtual world creates a depth in the perception of the video game. Players can choose to interact, or neglect NPC's in this virtual world, some characters are even in the mercy of the player, whether the player chooses to kill or spare those characters are up to the player, and players personal interaction with the virtual world. These decisions and interactions do also have an impact on how the game ends. Wildman and Woodward explain *Dark Souls* as a work of fiction, a representational work (2018). Wildman and Woodward also explains the interaction element in Dark Souls as;

"[but]unlike more familiar works of literary fiction, there seems to be something importantly *interactive* about *Dark Souls*. In part, this is because there seems to an important sense in which much of the story is, in one way or another, in the hands of the player. For instance, if the player enters the Painted World, they can choose to whether to slay or spare Priscilla, and there seems to a sense in which the player's choice plays a significant and essential role in shaping the very content of the story itself: players who spare Priscilla seemingly make it fictional that she is spared, those who slay her make it fictional that she is slain" (Wildman, Woodward, 2018, p. 112).

This explanation by Wildman and Woodward brings out how a video game and a fictional virtual world of a video game can be interactive by the use of story, interaction and the connection of the player to one or another, respectively. While video games are not like traditional media or visual media, their audiovisual quality and interactivity are much more appealing and satisfying compared to the latter.

Another aspect of the interaction in video games has been explained in previous sections. To reflect previous studies, the practical use of architecture, realistic background landscape or cityscape use, known media use, is a successful way to create an interactive environment with the avatar of the player and hence the virtual world. The architectural interaction and use have been given as an example of in the video game *Dishonored* by Zonaga and Carter (2019), in which the architectural systems, constructs and spatial spaces could be utilized in stealth playstyle, and remain undetected, in order to achieve the good ending of the video game. Zonaga and Carter's study of *Dishonored* video game allowed them to observe both playthroughs to achieve opposite endings to see how architecture and interaction with architecture differed in the video gameplay activity. According to Zonaga and Carter, "*Dishonored*'s architecture played a more prominent role when playing stealthily as opposed to confrontationally" (2019, p. 84). The interactivity in a video game virtual world is also tracked back into the earliest 3D video game, *Doom* that is released in 1993 by id Software, where the developers of the video game had many secrets and hidden doors placed around the labyrinthine design of the video game. In 1993's Doom, these secret locations could only be found by the players by 'bumping' on the walls of the hidden location, that reveals the secret

entrance which otherwise cannot be found or seen on the map provided in the video game. Upon this new way of easter egg placement— a mention of real-world cultural references or secret locations that could be interacted in virtual worlds of video games— also created another aspect for the video games to be interactive with the player, physically.

While the video games and their virtual spaces are digital productions or recreations of real-world examples and systems, the interaction in the video game is perceived as real. This perception is achieved by mimicking the real-world properties in institutional or conventional audiovisual mediums for video games interactive purpose. Video games gameplay activity is achieved by physical actions such as motor skills that represent specific actions of the video games avatar. Therefore any physical input generated in real-world is translated to the virtual world, and also every interaction achieved in the virtual world is translated to the real-world via audiovisual mediums.

Therefore in order to clarify the correlation of the virtual worlds of the video games with the real-world settings and their connections importance on both mediums progression, understanding, perception and development, the interaction looked in the case study video games are focused on both the avatars interaction with the spatial surroundings and understanding. This focus is chosen in this case study, to explain the fundamental requirements of interaction with Virtuality, in order to use Virtuality on design mediums as a collaborative design cycle purposes.

3.5. Perception in Video Games

Perception sense and physical observation is the primary sensory input of video games and audiovisual media. Because of the physical importance of perception, the video games of the last decade have heavily leaned on hyperrealistic graphics qualities, best audio and visual effects to support realistic graphics, therefore, developed a lot in order to achieve an excellent perceptive input and sense of joy.

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Many successful and essential video game titles of the last decade can be classified as the AAA Video Game Titles, which are described as the most invested and best-budgeted video game developer studios developing a significant video game title with best possible quality. The AAA titles can be observed and studied in-depth about how the perceptive means in the video game is used. The perception used in video games can be first-person, or cutscene based, personal or narrative experience, interactive or stationary, how are the scenery and surrounding elements have been used, and most importantly, how well the graphics and audial qualities of the video game have reflected the player.

Image 3.23: An interior example of office and perception provided with a security camera in Call of Duty: Modern Warfare (Infinity Ward, 2019).
Source: Screenshot by Efecan Büyükbaykal.

In the previous chapters where this thesis explained the history and development of video games history, and the virtual reality possibilities; perceptions importance is heavily exerted and implied on every progression. The current development and pursuit in VR, AR and MR technologies development are to increase the perceptive quality and how the Virtual reality systems visual quality has reflected the player or user of the system. Previous

improvements in computing history were limited hardware equipment where the program strings and the computations programmed in a computer was limited to the speed and capabilities of the system. However over the last two decades, computer hardware and systems have become so powerful that the programs written for those systems were inefficient at using the computers powers to the full effect, most of the time, the most significant portion of the PC's computing power was not even used. However, the latest studies are pointing out that the current effort in computing systems is the visualization and perceived quality of the systems interface. Compared to the previous works, when the programming was faster than the computers, computers were developed in order to be sufficient and efficient for adequate computing power. Afterwards, the next problem came out when the computers were too fast for the programs to utilize immense computing power, so computer engineering and program engineering mediums developed new programs and systems for adequate workload and efficient load distribution of the computers. Now that the progression on both computing and programming is evolving simultaneously, the next focus on the computer development is the visual quality, realistic graphics and how that virtual reality is transferred to the player, how the player receives that perception.

Image 3.24: An example of advancing graphic quality provided by Call of Duty: Modern Warfare (Infinity Ward, 2019) depicting an environment after a military bombing. Source: Screenshot by Efecan Büyükbaykal.

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On the topic at hand, this thesis can look at how the computing powers evolution, is directly related to the visual quality and perceptive means of the video games on examples of *Doom* and *Half-Life* series which are considered in the best AAA titles of their times. Both *Doom* and *Half-Life* have been considered a vital video game title and considered one of the best video games ever produced while being a significant influence on other video game industry elements.
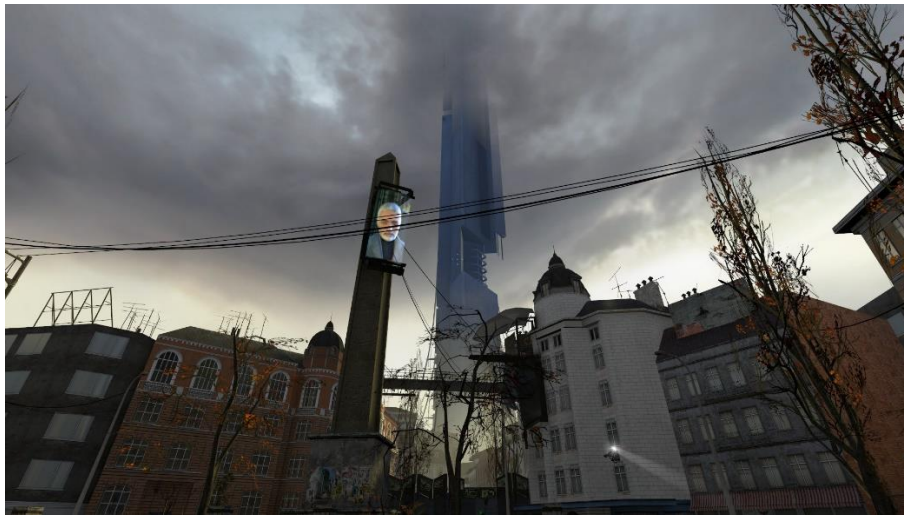
Image 3.25: Half-Life 2's (Valve, 2004) advanced graphics and imitation of real-world architecture were considered groundbreaking at its time.
Source: Screenshot by Efecan Büyükbaykal.
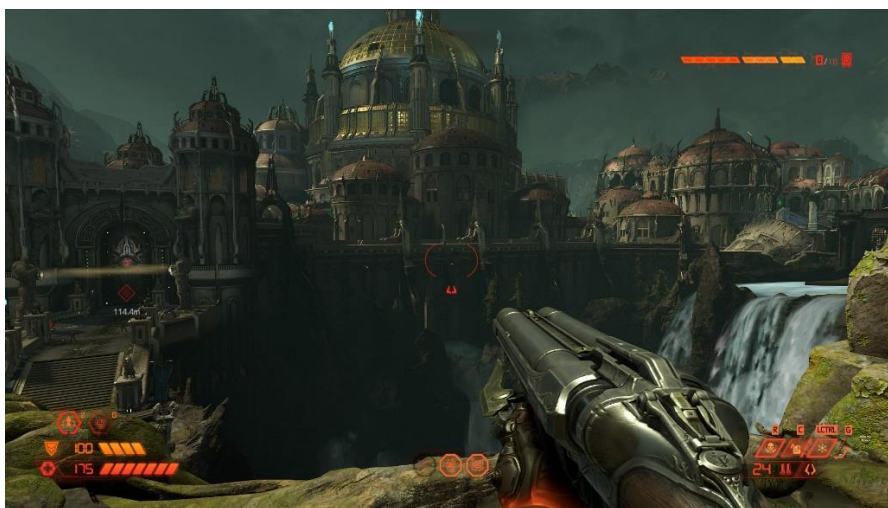
Image 3.26: Doom Eternal's (id Software, 2020) advanced graphics and fluent rendering is considered groundbreaking quality.
Source: Screenshot by Efecan Büyükbaykal.

Also, both video game titles have been developed with the VR technology compatibility on their latest releases which makes them an excellent example at perception in video games and how it is used. First *Doom* video game was released in 1993 by id Software, just after their 1992 release of *Wolfenstein 3D* which used the 1990's advanced 3D visual capabilities provided by that eras computers and systems. The *Doom* consisted of texture covered 3D spatial spaces that resembled labyrinth and is a fast-paced FPS Shoot them all type of video game. The *Doom* is developed by the id Softwares founders, mainly John Carmack, who insisted on developing a reboot for *Doom*, named *Doom III* (id Software, 2005), however, id software developer company only accepted this after realizing the same combinations and game style used in 1993's *Doom* was still accepted commercially. The *Doom III* is considered to be id Softwares most successful release till now, utilizing state of the art graphics, visuals and lighting technologies provided with the latest virtual graphical renderers and game engine created by John Carmack. Carmack insisted to id Software to reboot and remake *Doom III*, because of the evolved technologies ability to create more detailed environments and spatial locations, increasing the LOD in every texture and perspective, and adding more psychological immersion with the use of new lighting systems allowed by the new computer technology. Almost ten years later, id Software rebooted the *Doom* title again and developed the *Doom 2016*, which used the same doom style fast-paced FPS action, consisted more LOD in every level, much more fluent graphics and play style, which is also made with VR systems specifications to be also able to play on VR HMD systems named different than *Doom 2016*, *Doom VFR*. This option was not able before the latest release of a VR HMD technologies such as HTC's *Vive* or Oculus' *Rift S* systems allowing high fidelity visual quality to the HMD, therefore, allowing fluent perception of the video game and environment flawlessly, which was a common problem in predecessors of VR HMD systems.

The *Half-Life* video game developed by Valve is also another example which is seen to rely on perception and quality throughout the years of its existence. First *Half-Life* video game published in 1997 shake the world with new spatial understanding, realistic level designs and spatial space use, how

the narrative and gameplay elements were integrated and were used to create a masterpiece of conscious experience on many occasions. The following release of Valve came in 2004 with the continuation of the first *Half-Life* video game, *Half-Life 2*, where the next generation of computer technology, lighting, textures, level design, ambience and background design was implemented to the video game, increasing the interactivity in the video games virtual world and allowing a more in-depth perception to the world of *Half-Life*. However, besides becoming one of the essential titles in the video game history, the clues left in the video game about a sequel to the story, and developers commentaries about future of *Half-Life* titles continuation were always mentioned by explaining that what they wanted to do in the video game and what they wanted for players to experience and perceive was not technologically available yet. This claim is made by the founder and developer of Valve and *Half-Life,* Gabe Newell on many occasions, which gave the knowledge that there was a sequel to the *Half-Life* series and new technologies were coming to the video game industry. The hiatus of *Half-Life* series ended when Valve released their latest *Half-Life: Alyx* video game at 2020, specially designed only to be played on VR HMD systems because the video game was planned and developed to use VR systems HMD for perception and motion controllers for motor skills. *Half-Life: Alyx* created another impact in the video games industry and increased the commercialization and marketization of VR HMD systems even further.

This impact is also changing the way of how FPS video games being developed and designed with including very free interaction with the surrounding virtual world, and how that interaction is used in the video game. The VR technologies use in FPS video games such as *Doom VFR*, and *Half-Life: Alyx*, allowed these titles one of the very few successful video games that can include in-depth LOD in every aspect. VR HMD systems use of perception to progress the video game with discovery and motor skills of the player, also create an excellent 3D perception, immersion, and total embodiment to the avatar of the video game. This effect is fundamentally observed with the change of motor skills required in playing a video game. Previous video games before VR HMD's inception and adaptation to video game industry, video gameplay

activity was accomplished with the inputs entered into HID connected to the computer. This activity required specific actions to mapped to keypresses of these HID's which then translated into video games diegetic output via audiovisual means. However, with the VR HMD's adaptation to video games allows players to used HMD's motion sensor and apparatuses to physically transmit every movement and action into the virtual world. Therefore every action of the player using VR HMD in real-world is replicated in the virtual world of video games, also increasing the immersion of the player to the avatar and the virtual world, because every move player makes in the real-world is precisely replicated in the virtual world, and perceived by the player from the player's eyes thru the VR HMD's screen.

When looked at these two examples, and the VR systems integration to the video games result, the importance of perception is evident in video games and how the technologies are being shaped to reflect the best perception and interaction.

3.6. Realism of Video Games

Over the last two decades, video games and its entertainment media have become a very crucial industry in the world. Its industry has grown to a point where its economic scale have even surpassed the movie and music industry combined. This improvement and development in video game industry are primarily caused by the immersive criteria, and positive psychological effects video games create, combined with the escapement from real life and real-world for the duration of video gameplay activity. As this thesis explained the immersion criteria on the previous topics, it is a prominent study to consider that the realism effect or alternate realism setting the video games offer is the fundamental choice on the video gameplay activity.

Previously, this thesis studied the various aspects of the video game to explain the realism factors and how the video games replicating real-world properties are explained. These realism factors include every aspect

represented in video games, such as; architectural depiction, interior design and spatial space, furniture, material, lighting, accessories and products depicted in the video game, immersive aspects, interaction and perception. All of the mentioned subjects are combined to create a realistic feel and perception in video games virtual worlds, which can be enhanced even further with the use of VR HMD's capabilities and advantages. Evidently, the realism of video games is always achieved with the combination of mentioned subjects and their fruitful direct relation with each other.

In order to compare realism in video games with the previously explained immersion topics, this thesis' case studies the games and compares their realism correlated with real-world. The case study correlates the accuracy of video games. The study compares the real-world settings and physic laws, immersion with the video game, interaction in the video game compared with how interaction happens in real-world. The comparison is then followed by how the video games UI is used and perceived, its embodiment into the virtual world, and how inputs are classified in the video game. This study also shows how perception is achieved in the video game as well.

Video Game Title	Realism	Accuracy	Immersion	Interaction	Embodiment	Diegetic or Non-diegetic
BioShock	Not realistic	Fantastic accuracy	Immersive due to story elements	No interaction with the virtual world	Limited embodiment due to realism	Non-diegetic
Call of Duty: Modern Warfare	Realistic	Accurate to the physical level	Immersive due to gameplay realism	No interaction with the virtual world	Embodiment is achieved with the player	Mostly Diegetic

Game					
Dishonored	Not realistic	Fantastic accuracy	Immersive due to story elements	Limited interaction with the virtual world	Embodiment is achieved with the player	Non-diegetic
Doom	Not realistic	Science Fiction accuracy	Immersive due to gameplay elements	No interaction with the virtual world	Limited embodiment due to realism	Mostly Diegetic
Doom Eternal	Not realistic	Science Fiction accuracy	Immersive due to gameplay elements	No interaction with the virtual world	Limited embodiment due to realism	Mostly Diegetic
Escape From Tarkov	Realistic	Accurate to the physical level	Immersive due to gameplay realism	Limited interaction with the virtual world	Embodiment is achieved with the player	Diegetic only
Half-Life 2	Not realistic	Science Fiction accuracy	Immersive due to story elements	Limited interaction with the virtual world	Embodiment is achieved with the player	Mostly Diegetic
Kingdom Come: Deliverance	Realistic	Accurate to the physical level	Immersive due to gameplay realism	Complete interaction with the virtual world	Embodiment is achieved with the player	Diegetic only
Mirror's Edge	Not realistic	Science Fiction accuracy	Immersive due to gameplay elements	Limited interaction with the virtual world	Limited embodiment due to realism	Diegetic only
The Elder Scrolls V: Skyrim	Not realistic	Fantastic accuracy	Immersive due to story elements	Complete interaction with the virtual world	Embodiment is achieved with the player	Non-diegetic
Wolfenstein II: The New Colossus	Not realistic	Alternate history-based accuracy	Immersive due to gameplay elements	Limited interaction with the virtual world	Limited embodiment due to realism	Non-diegetic

Wolfenstein: The New Order	Not realistic	Alternate history-based accuracy	Immersive due to gameplay elements	Limited interaction with the virtual world	Limited embodiment due to realism	Non-diegetic

Table 6. Comparison of Video games' Realism

3.7. Experience of Video Games

Video games as an audiovisual entertainment media is an excellent way to relay experience and simulate events or stories. Therefore, when the experience in video games are studied and compared to real-world settings, this thesis can narrow down the specific experience topics into sensory and psychological factors. These factors are acoustic quality, the accuracy of video game compared to real-world, audial clues given to the player, navigation and awareness achieved by the player, ambience and surrounding elements, realism, and how the video game information is relayed to the player if its diegetic or non-diegetic UI and information.

Previous chapters studied the video games and their effects on the players, how experience is relayed, and how experience is designed in the video game. If the addition of VR is included in the study, video games with the current VR support and interaction are considered an example of an experience that closely mimics real-world properties. However, this study has not used a VR system while studying video games. The experience in the video games studied for this thesis has been noted and tabled accordingly to a standard desktop PC used for video gaming.

3.8. Differences Between Real-World and Virtual World

Virtual reality is a reality concept created in the digital capabilities of a computer system that is using certain technological elements to allow users to perceive that virtually created world. Therefore, the boundaries of the virtual world are limited to the creation parameters and the capacities of the system.

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These boundaries can also be explicitly adjusted to convey the experience of the video game even further or restrict the player to follow a specific route.

Main differences between the real world and virtual worlds are senses. At the same time, there are HMD's and HID's specifically developed to inhibit, prohibit the user's senses accordingly, a complete transference from the real world to the virtual world is impossible with the current technological capacities. The user or the player in the video game; however immersed to the virtual world, are always in the knowledge of that the experienced situation is a virtually created simulation. As mentioned, the video game and its virtual world are considered as experienced with VR headset or the screen of the platform. Otherwise improved designs or experiments on virtual reality systems can go as far as HID's implemented to the system and exceed the standard VR support in video games optimal experience.

Considering the limitations of the virtual world observed in a video game, generally, those virtual worlds are constrained by limitations to the traversable area and bound by a set of rules. In these parameters, the created world is purely digital, different from the physical world human's perceive while containing high similarities to induce immersion effects. Such as if the video game offers a segment in an office setting, that office setting is based on the real-world architectural rules, dimensions and aesthetics to psychologically connect the player with the virtual world, just because the setting and environment are going to feel familiar to real-world counterpart. However, that setting will not induce the gravity and atmospheric effects real-world consists and will be off from the happenings in real-world, isolating itself solely to offer the experience of the created virtual world of the video game. Every video game is different in the sense of objective, story, goal and detail. This separation is previously mentioned in previous studies, this thesis researched as the separation or escapement from the real-world. Some studies involving video games and their immersion to the video game and separation video game also explains the phases of immersion, where the player engages, engrosses and achieves a total immersion. Therefore, this total immersion is a subjective topic that differs from title to title, and from the player to player. Outside the

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immersive space of Virtuality Reality Continuum, the real-world cannot be affected by Virtuality. Virtuality, however, resides in the real-world and achieved via technological means. In that sense, the main difference between the virtual world of the video games and the real-world is that the events taken place in the virtual world would not affect the real-world, and the experience or information provided in that virtual world will be limited to the parameters of the video game.

When this thesis studied the video games in this case study, several examples profoundly are shown themselves as not realistic or as the difference between real-world. Such examples are the military FPS games, where the player's avatar is a trained soldier, most of the time with unlimited stamina and vitality. Video games such as *Battlefield*, *Call of Duty*, tells an epic story of a soldier, fighting against terrorism. In these video games, the avatar can sprint long distances without getting tired, carry an excess amount of weight in weapons and ammunition, and able to survive most events without a fatal outcome. For example, in *Battlefield 3*, the mission Going Hunting puts the player in the shoes of Lt. Jennifer Hawkins, who is a weapons systems officer of an F/A-18 Super Hornet Navy Fighter Jet. In Going Hunting mission player controls the weapons of the fighter jet and has an unlimited amount of countermeasures and ordinances. *Portal 2* video game, in this case, is a puzzle-solving FPS game, and the player uses the portal gun given to the avatar to create two connected portals that are used to transport either puzzle-solving objects by the use of physics or avatar themselves to reach unreachable positions. However, when falling from great distances or thrown into another place with terminal velocity, the avatar does not die from impact trauma caused by excess speeds of falling or hitting to a wall. The video game diegetically explains this situation as a test, and the player is provided with advanced shoe-like equipment that prevents fall damage.

Another difference between the virtual world and real-world can be given from id Softwares *Doom* and *Wolfenstein* series video games. Doom 2016 video game takes place in Mars, and a dimension referred to as Hell and is dated in the future. Wolfenstein series of video games take place in the past, dated

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around the 1940s and between the 1960s, however, like *Doom*, is fiction and considered an alternate reality of a different fictional timeline. While both video game examples use real-world time and date settings, their version of the future or past is different and has elements of both fiction and immaterial, and inconsistencies in real-world time and technological progression history. In order to allow video game to engage the player and create an immersion, also showing the difference from real-world to not to be confused with each other, compromises in realistic quality or alignment with the real world are made on many video game titles. The video game *Escape From Tarkov* takes place in a fictional city created in a fictional world that applied the same laws and rules with the real-world, and player's avatar if a mercenary that has specific skills which ordinary civilians cannot have, and able to sustain injuries ordinary people cannot. In *Mirror's Edge*, player's avatar, Faith, is a free runner with exceptional stamina and agility, able to perform free-running activities along poles, bars and rooftops of the skyscrapers of the virtual city created for *Mirror's Edge*. *Deus Ex* video game includes transhumanism, digital and mechanical augmentations implanted into humans for enhancement purposes, which are only starting to be experimented upon in real-world for prosthesis purposes. While *Deus Ex*, creates a fictional Detroit city of future, explaining the possible evolution of technological advances and its effects on human implantation and enhancement augmentations, the video game explicitly tells this idea in a dystopic setting to engage the player to the video game. *S.T.A.L.K.E.R.* video game copies the exact *Chernobyl* region of Ukraine for landscape and cityscape purposes. However, while being one of the most realistic video games of its genre, it includes extraordinary events, such as mutated creatures, physical phenomenons and anomalies that affect the world, which the video game explains, is a result of the accident in the *Chernobyl Nuclear Power Plant*, and creates a fiction based upon a real-world event. Every video game, differentiates from the real history or events one way or another, for copyright and intellectual property issues, and to protect personal information. While a video game or a created virtual reality can be based upon real-world, it will always be a virtual space created in real-world, therefore,

creates a space within space that is observed and experienced only from inside and will not be observable from outside that virtual space.

This compromise and difference from real-world properties or timeline, creating an alternate virtual world resembles the real-world but has extraordinary or fantastic elements serves the primary purpose of entertainment reasons and engagement of the player to the video game. Several heroic actions go against the laws of physics just like in action motion pictures are made in FPS video games in the sake of thrilling action segments to engross the player into the video game can be seen as the main difference of virtual reality with the real world. However, a more important reason this difference is made is for fantasy reasons, where the player of the video game can roleplay according to the avatar of the video game or entirely different persona to fulfil fantasies in virtual reality that can not be achieved in real-world. Within the boundaries of the Virtuality created for video games or other purposes allows the players to be what they want in the virtual reality and its virtual world. This study can confirm that virtual reality has many opportunities to try and experience countless versions of different virtual settings and experiences. However, Virtuality is a reality created in the real world and can be controlled by the creators or developers of the virtual reality align with the player's needs or expectations. For the duration, the created virtual world is a space-bound in real-world and only accessible from specific devices such as PC's and HMD's addition. Therefore, the main difference between the virtual world of video games and the real-world is the video games Virtuality being a space created for entertainment purposes in the real-world.

3.9. Alignments Between Real-World and Virtual World

Progression of the technology to the current 21st-century state provided many benefits to the virtual world and its offerings. The technologies benefit to the tools that are being used to design and visualize ideas, and those ideas shaping various virtual reality concepts allow virtual worlds to mimic that of the real-world closely. Therefore in order to create perfectly mimicked real-

world examples or settings that resemble the real-world locations, virtual technologies are commonly using many tools that are used by AEC industries and those mediums design programs. Such efforts are capable of benefiting both AEC industries and design medium while developing video gaming products as well. Because of the common usage of tools and programs, it is highly aligned with the design, architecture and visualization mediums.

However, the alignments of virtual worlds of video games and the real-world just not align on the planning and designing an area, but include several more details that induce familiarity and immersion to the virtual creation. Since video gaming and created virtual worlds for video gaming made for entertainment and voluntary action, it is aimed to be favourable and enjoyable for the duration spent playing the video game. In order to increase the time spent in the video games virtual world, or create an immersive bond between the virtual world, story, avatar and the video game, video game developers and virtual world creators are extensively working to align as much as real-world properties, aesthetics, history, culture and information to the creations so that the observer can connect and create a psychological connection with the virtual experience and information provided.

One such example could be given from the astonishing virtual world of *BioShock*. *BioShock*'s setting is placed in the 1960s with bright art deco styles over all the virtual worlds interior, exterior and constructions. Besides, every interior detail is carefully selected to reflect the same time frame with same art deco movement, from the colours to the electronic equipment, pictures, frames and art objects to products found in the virtual world. Therefore the player subjected to this representation to art deco movement could guess the video games virtual worlds date, and create an intimate bond with the world, understanding the colour schemes, furniture to used materials and the bright, proud upright structures, just as if the observer is in that time frame. This connection while aligning with the concepts and movements already used in the real-world thus creating a historically correct point while making a timeline placement in the player's mind, also increases the immersion criteria allowing

the player to like the environment and start to feel and live in the virtual environment of the video game as well.

The resemblance to the real-world history or existing locations also creates a media recollection on the player and creates engagement into the virtual world of video games. Thus a conclusion can be made by using the real-world objects, movements, products, references or similarities in created virtual worlds of the video games. The video game designers can enhance the experience provided in the virtual world, and the video game by adding more immersion, allowing players to psychologically create a bond with the settings, environment, story and the avatars of the virtual world and the video game. Alignment of virtual reality with real-world serves the primary purpose of engaging the player further into the audiovisual media and video games, engrossing the player into the story and events happening in the video game and create immersion in the virtual world, separating the player from the real-world achieving the escapement from the real-world requirement that the player has. Escapement from real-world is a strong reason seen in regular video game players. Therefore alignment with real-world properties, however being in a virtual space, allows players to feel more comfortable in immersing into that virtual space. These requirements of immersion and preference on playing video games have been studied and mentioned by researchers such as Frasca, Ermi and Mayra before.

One other notable mention is the direct recreation of the real-world in virtual worlds of the video games, and several essential titles have succeeded in creating immersive settings for these recreations. Such example would be *S.T.A.L.K.E.R.: Call of Pripyat*, which tells a fiction version of the *Chernobyl* incident and the area incident affected, such as *Pripyat* city of Ukraine and the surrounding areas. Therefore video game developers in order to create an accurate recreation of the once beautiful but now desolate city of *Pripyat* and its surrounding environments, used every material and information available to achieve alignment with the real-world in their created virtual world. While some sections of the recreated virtual world of *Pripyat* and *Chernobyl Nuclear Power Plant* are based to real-world, other parts are slightly or extensively

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reshaped and adjusted to accommodate better the story of the video game and the progression of the player. In this almost perfect recreation of the *Pripyat* city in the virtual world, the player can see the famous yellow Ferris wheel and the Olympic swimming pool, sports stadium and precast concrete apartment blocks of Soviet-era constructions. The player is also allowed walk freely on its streets and blocks, experience the same desolation and devastation city has seen over the past years of its abandonment, without being exposed to the radiation and dangers still existing in the real-world *Pripyat*. The avatar of the player also has human needs, such as sleeping, eating, drinking or getting protected from radiated areas, which engages the player further to survive in the zone of *S.T.A.L.K.E.R*. A more contemporary example of this alignment can be given from *Escape From Tarkov* video game. *Escape From Tarkov* has, like *S.T.A.L.K.E.R.* video game have created a fictional region and a city in Russia, near *St. Petersburg* city in the virtual world using Russian style of construction materials, architecture, cityscape, landscape, urban design, resembling real locations in the real world. Developers of *Escape From Tarkov* also utilized the contemporary hyperrealistic graphics, shading and lighting to its advantage to align itself with the realism side of the virtual reality, with integrated mechanics of the video game, successfully aligns itself with the real world. This sort of recreation of a real-world location in a virtual world of a video game creates almost perfect immersion settings for entertainment industry, and especially for players who seek realistically created or based on real example creations for entertainment purposes. *Escape From Tarkov* also uses realistic mechanics and physics engine to simulate the real-world properties accordingly and using motion-capture technology, allowing players a more realistic perspective, movement and feeling in the virtual world. *GTA* video game series are also known to use historical locations and media towards this accuracy and alignment with the real world, offering a virtual living digital world offering gameplay activity in its boundaries.

Another contemporary example of alignment with the real-world can be given from the *Kingdom Come: Deliverance* example, released by Warhorse Studios in 2018. *Kingdom Come: Deliverance* video game, have extensively

used the technological benefits and collaborative work of design mediums to recreate 1400s era the Bohemian Kingdom accurately in Virtuality. With historically accurate replications and mechanics of melee and ranged combat, culture and sociological elements, architecture, interior design and spatial understanding, clothes and historical events, the video game reenacts the events of 1400s Bohemian Kingdom life in an alternate role-playing video game based on real historical events happened in the past. Therefore, *Kingdom Come: Deliverance* video game can be mentioned as a critical alignment of the virtual world with real-world, which includes interaction, psychological and physical alignments with the real-world. This alignment creates a realistic reenactment and replication of real-world in virtual space of video games.

These examples, therefore, allows the understanding of video game being more realistic or identical to the real world, the virtual world is cognitively perceived as more immersive and familiar its environment becomes. With this perception, video games become more successful at creating an adequate video gaming environment for the player to connect, engage and embody into the virtuality of video game environment and enjoy psychologically which also is directly aligned with the success of the video game developers and video game industry.

However, it is also debatable that virtual worlds alignments with the real-world a positive topic or not. Because of the video games primary purpose of being a voluntary action and serves a purpose to escape from real-world for the duration of gameplay activity, some player's might not want a similar setting with the real world and prefer fantastic virtual worlds with extraordinary settings compared to realistic video games. In contrast, another portion of the video game players might prefer real-world simulation for entertainment purposes and possibilities a real-world recreation could offer.

CHAPTER IV. CONCLUSION

According to the comparisons and correlation of the video games interior design, architecture and material use to the real-world examples, the addition of virtuality factor, video games are crucial for development in design cycles and integration of virtual elements to the AEC industries, interior design and their respective collaborative mediums. The results and the observations are evident how the architecture is used and how architecture and design mediums are used in a video game to create an immersive and realistic video game that embodies the played. It is also evident in observations that the programs and development cycle used in making video games are similar, sometimes identical with the AEC industries and interior design system's design cycle phases. However, video games are an entertainment medium and belong to the entertainment industry, while the AEC industry and design mediums are physical manifestations, which is the only significant difference between the comparison and correlation. Video games and the virtual creations can only exist in virtuality, that is sub reality in real-world.

The most prominent examples of video gaming products show an undeniable crossover between different mediums to create a final product, requiring elaborate collaborative work. This crossover between mediums and collaborative work in order to create a video gaming product is also can be seen as a beneficial progression for every medium participating in the collaboration. This beneficial progression is seen in previous researches and produced video games or BIM programs in which the collaboration is providing an update on programs used in those mediums, new possible programs or ways to use those programs in said mediums, or possible new prototypes to ease the workload on collaborative design and production cycles.

The researched and tested video games have been studied on how they are successful in reflecting real-world and architectural elements and interior

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elements   in   that   video   game   have   been   turned   into   a   graph.
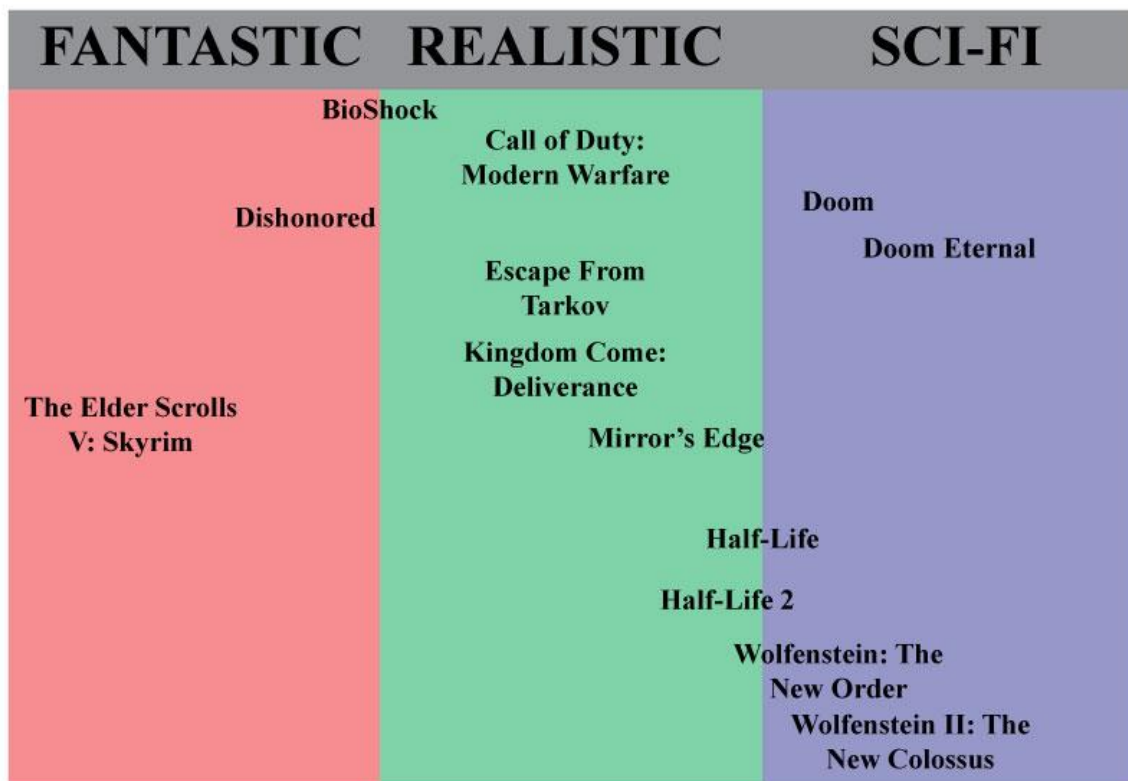
Table 7. Graph of researched video games alignment

The video game history and literature reviews are actively proving that with the improvement and consumption of video games and its entertainment industries speed to produce new products, allowed technological and developmental progressions in computing, programming, producing mediums, and increased use of architecture, historians, interior designers, 3D artists. This progression also allowed computing systems to be adapted for use in architectural and interior design systems to achieve the same better results and faster design cycles achieved in the video gaming industry. The historical timeline of video gaming and their systems can prove how the computing systems evolved to provide better and faster systems, while becoming an economic system themselves, adapting to the faster consumption rates and required system capabilities needed on everyday use. This evolution also allowed production systems and engineering systems to produce cheaper and

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easier ways to produce these systems. The possibilities offered by these systems are also prominent in AEC industries, especially architecture and interior design mediums where the computers power, and the programs used to make both video games and architectural designs or 3D hyperrealistic renderings are used to the fullest potential to achieve best results.

Schnabel's recent studies and efforts to implement the VR systems that are primarily used in video gaming and entertainment industry, to the design cycle and design studio works in architectural education systems is one another vital conclusion this thesis can underline. While the computing and engineering, systems are evolving with the passing time and creating faster and more interactable systems that the designers can work with, the addition of VR systems and availability of collaborative design cycles instant interaction with the system holds strategic value to the development of both video game industry and AEC industries.

The implementation of VR or MR systems to the collaborative design cycles also seen to be improving the efficiency of the design procedure, duration while allowing the users to be freer with the design process, not bound to a specific way or analogue limitations. This freedom and removal of constraints from using VR and MR in such a way also open a possible way for the entertainment industry and video games to use this potential further to increase the efficiency of VR and MR applications and their precision on portraying 3D perception. The correlation of video games with real-world architecture and interior design shows the hyperrealistic graphics provided by these technologies and the LOD capacity the current computing power provides allows both sides of the continuum, the real-world and the virtual world, to use potential benefits to the maximum.

Just as in AEC industries and design mediums progression with technology, video game development and the systems they used also developed. In order to create an original, realistic and immersive video game and embody the player into the virtual world, video game developers have used architecture and design mediums, with the addition of new technological benefits.

This progression is observed in an incremental rise after the world war II, where the electrical pieces of equipment increased used and technologies adaptation to create better, faster, durable and easy to produce electronic equipment allowed computing powers to increase and PC's to spread to every household for personal use. Engineers and programmers tests and new ways to create entertainment systems allowed video games to rise and become an essential economic system. This progression also allowed the creation of new computer programs and ways for designers to use computers for benefit in the design cycle is also a byproduct of this progression. Combined evolution of mentioned systems allows engineers, architects, designers, programmers to use the full potential of the technology to introduce new ways to ease production and development every day while generating new possible ways to enhance it further.

This thesis' literature review on video game history, Virtual Reality systems and their additions and the correlation of video games architecture and interior design use with the real world prove that there is a vital connection in thesis hypothesis. It is also evident that the computing, virtuality, video games, design, architecture and technology, this thesis can not conclude with just proving there is a strong correlation between video games and real-world it replicates in its virtuality. This hypothesis, while proving there are a connection and correlation in both mediums, it must also implore further research and correlation for further improvement on both mediums. This research can be continued with in-depth evaluation and comparison of real-world architecture and interior design, space and systems use in video games for further development on both real-world and virtual architecture. The progression, further research and evaluation are considered to pave new ways to create interactive computing systems, programs and development cycles for both mediums, allowing both sides of the virtuality and reality continuum to take full benefit of the advancing research and new ideas.

Further research on this topic allows new ways for researchers to combine virtuality with reality even further and possible development of new technological equipment allowing better design processes and cycles. It is also

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likely to introduce better virtual systems that are powerful and sufficient enough to replicate major real-world locations in virtual reality for design processes or video game environments that embody ultimate immersion and replication of real-world in virtual boundaries. Improvement on this topic should also allow engineers and developers to research and implement new branches of technological advances in this progression to allow these systems to be more easily acquired and used in design, development and AEC industries.

SOURCES AND REFERENCES

BIBLIOGRAPHY

- Blascovich, J.; Bailenson, J. (2011). *Infinite Reality*. HarperCollins Publishers: United States.

- Blascovich, J.; Ehre, E. O. (2019, February 7). Virtual Reality vs (Actual) Reality: Your Mind's View of Reality Isn't Often "Real" " Brain World. Available at: https://brainworldmagazine.com/virtual-reality-vs-actual-reality-your-minds-view-of-reality-isnt-often-real/ (accessed December 2019).

- Bonner, M. (2014). *Analyzing the Correlation of Game Worlds and Built Reality: Depiction, Function and Mediality of Architecture and Urban Landscapes*. Institute for Media Culture and Theatre. University of Cologne: Germany.

- Byrne, E. (2007). *Elite*. F. Von Borries; S.P. Waltz; M. Böttger (Ed.) *Space-Time Play: Computer Games, Architecture and Urbanism: The Next Level*. pp. 104-106. Birkhauser Verlag: Berlin.

- Cronenberg, D.; Hamori, A.; Lantos, R. (Producer). & Cronenberg, D.(Director). (1999). *Existenz* [Motion Picture]. Canada: Alliance Atlantis.

- Emmerich, R.; Emmerich, U.; Weber, M. (Producer). & Rusnak, J.(Director). (1999). *The Thirteenth Floor* [Motion Picture]. United States: Columbia Pictures.

- Ermi, L., Mäyrä, F. (2005). *Fundamental Components of The Gameplay Experience: Analysing Immersion. Proceedings of DiGRA 2005*

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conference: Changing Views – Worlds in Play. Vancouver, Canada, DiGRA.

- Frasca, G. (2004). *Videogames of the Oppressed*. In N., Wardrip-Fruin, P., Harrigan. (eds). First Person. M.I.T. Press.

- Gazzard, A. (2013). *The Platform and the Player: Exploring the (hi)stories of Elite*. The International Journal of Computer Game Research. Vol. 13, Issue 2. Available at: http://gamestudies.org/1302/articles/agazzard (accessed December 2019).

- Graetz, J.M. (1981). *The Origin of Spacewar*. Creative Computing Magazine. August. Available at: http://www.wheels.org/spacewar/creative/SpacewarOrigin.html (accessed in December 2019).

- Grimshaw, M. (2007). *Acoustic Ecology of the First-Person Shooter* [Doctoral Dissertation, The University of Waikato]. Waikato, New Zealand. Retrieved May 24, 2020, from http://www.wikindx.com/mainsite/acousticEcologyOfTheFirst-PersonShooter.pdf

- Grodal, T. (2003). *Stories for Eye, Ear and Muscles: Video Games media, and Embodied Experiences*. In Wolf, M.J.P. and Perron B. (eds.) *The Video Game Theory Reader*. Routledge. New York. (pp. 129-155)

- Gust, M. (2009). *Room with a grue*. Available at: http://tap-repeatedly.com/2009/06/room-with-a-grue/ (accessed on December 2019).

- History.com Editors. (2017). *Video Game History*. History Magazine. Updated June 2019. Available at: https://www.history.com/topics/inventions/history-of-video-games (accessed December 2019).

- Juul, J. (2001, July). Games Telling Stories?[1]. Retrieved May 24, 2020, from http://www.gamestudies.org/0101/juul-gts/

- Kurtz, G. (Producer). & Lucas, G. (Director). (1977). *Star Wars IV: A New Hope* [Motion Picture]. Lucas Film Ltd. United States: 20th Century Fox.

- Kvan, T. (2000). *Collaborative Design: What is it?*. Automation in Construction. Vol. 9, Issue 4, pp. 409-415.

- Laliberty, R. P. (2014). *Aural (Re)positioning and the Aesthetics of Realism in First-person Shooter Games*. [Master Thesis, University of Rhode Island]. The University of Rhode Island. Kingston, United States.

- Lambert, B. (2008). *Brookhaven Honors a Pioneer Video Game Made First*. New York Times. November 7. Available at: https://www.nytimes.com/2008/11/09/nyregion/long-island/09videoli.html?_r=2 (accessed December 2019).

- LaMosca, A. (2006). *Lost in the Void*. The Escapist Magazine. Available at: https://v1.escapistmagazine.com/articles/view/video-games/issues/issue_54/324-Lost-in-the-Void (accessed December 2019).

- McMahan, A. (2003). *Immersion, Engagement, and Presence*. B. Perron, M.J.P. Wolf (eds.). *The Video Game, Theory Reader*. Routledge, London & New York, pp. 67-86.

- Milgram, P. (2006). *Some Human Factors Considerations for Designing Mixed Reality Interfaces*. Virtual Media for Military Applications. pp. KN1- KN1-14. Neuilly-sur-Seine: France.

- Milgram, P.; Colquhoun, H. (1999). *A Framework for Relating Head-Mounted Displays to Mixed Reality Displays*. Proceedings of the Human Factors and Ergonomics Society Annual Meeting 43. University of Toronto: Canada.

- Milgram, P.; Colquhoun, H. (2001). *A Taxonomy of Real and Virtual World Display Integration*. University of Toronto: Canada.

- Milgram, P.; Takemura, H.; Utsumi, A.; Kishino, F. (1994). *Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum*. Proceedings of Telemanipulator and Telepresence Technologies. pp. 2351-34. Available at: http://etclab.mie.utoronto.ca/publication/1994/Milgram_Takemura_SPIE1994.pdf (accessed December 2019)

- Nakamura, Y. (2019). *Peak Video Game? Top Analyst Sees Industry Slumping in 2019*. Bloomberg. Available at: https://www.bloomberg.com/news/articles/2019-01-23/peak-video-game-top-analyst-sees-industry-slumping-in-2019 (accessed on December 2019).

- Nelson, T.H. (1965). *Complex Information Processing: A File Structure for the Complex, the Changing and the Indeterminate*. A.C.M. '65

Proceedings of the 1965 20ᵗʰ National Conference. Cleveland, Ohio: United States.

- Oxman, R. (2000). *Design Media for the Cognitive Designer*. Automation in Construction, Vol.9, No.4, pp. 337-346.

- Rasmussen, S.E. (1962). *Experiencing Architecture*. M.I.T. Press: Cambridge.

- Ritchie, D.M. (1979). *The Evolution of the Unix Time-sharing System*. Language Design and Programming Methodology Conference. Bell Labs. Sydney: Australia. Reprinted by AT&T. Bell Laboratories Technical Journal Vol.63 no.6 part 2. October 1984. pp. 1577-93.

- Ritchie, D.M. (1993). *The Development of the C Language*. Bell Labs/Lucent Technologies. Murray Hill. New Jersey: United States.

- Ritchie, D.M. (2001). *Space Travel: Exploring the Solar System and the PDP-7*. Bell Labs. Internet Archive. Available at: https://web.archive.org/web/20151226030544/https://www.bell-labs.com/usr/dmr/www/spacetravel.html (accessed in December 2019).

- Rollings, A., Morris, D. (2004). *Game architecture and design*. Berkeley, CA: New Riders.

- Schnabel, M. A. (2009). *Framing Mixed Realities. Mixed Reality In Architecture, Design And Construction*, 3–11. doi: 10.1007/978-1-4020-9088-2_1

- Schnabel, M. A., Wang, X., Seichter, H., Kvan, T. (2007). *From Virtuality to reality and back*. Proc. Int. Assoc. Soc. Design Res., vol. 1, Nov. 2007.

- Silver, J. (Producer). & The Wachowskis (Director). (1999). *The Matrix* [Motion Picture]. United States: Warner Bros.

- Smith, A. (2014). *One, Two, Three, Four I Declare a Space War*. Videogamehistorian. Available at: https://videogamehistorian.wordpress.com/2014/08/07/one-two-three-four-i-declare-a-space-war/ (accessed in December 2019).

- Smith, G.J. (2010). Urban Screens: *The Schematic City in Gaming and Architectural Representation*. 3 AM Magazine. Available at: http://www.3ammagazine.com/3am/urban-screens/ (accessed December 2019).

- Sullivan, L.H. (1896). *The Tall Office Building Artistically Considered*. Lippincott's Magazine. pp. 403-409. Available at https://archive.org/stream/tallofficebuildi00sull#page/n9/mode/2up (accessed December 2019).

- Tavinor, G. (2009). *The art of videogames*. Malden, MA: Wiley-Blackwell

- Taylor, L. N. (2002). *Video Games: Perspective, Point-of-View, and Immersion*. [Master thesis, University of Florida]. Florida, Gainesville.

- Tiemersma, S. A. (2014). *Video Games and Architecture* [Master thesis, Delft University of Technology]. TUDelft Publishing.

- Wang, X., Schnabel, M. A. (2010). *Mixed reality in architecture, design and construction*. The Netherlands, Springer.

- Winter, D. (2018). *Noughts and Crosses – The Oldest Graphical Computer Game*. Available at: http://www.pong-story.com/1952.htm (accessed December 2019).

- Wolf, M. (2007). *Chapter 1: What is a Video Game?*. The Video Game Explosion. pp. 24-28. Westport CT. Greenwood Press.

- Wong, W.L.; Shen, C.; Nocera, L.; Carriazo, E.; Tang, F.; Bugga, S.; Narayan, H.; Wang, H.; Ritterfeld, U. (2007). *Serious Video Game Effectiveness*. The University of Southern California. Ace: United States.

- Zimmerman, E. (2004). *Narrative, Interactivity, Play, and Games: Four Naughty Concepts in Need of Discipline*. In N., Wardrip-Fruin, P., Harrigan. (eds). First Person. M.I.T. Press.

- Frasca, G. (1999). *Ludology Meets Narratology: Similitude and Differences between (video) games and narrative*. Retrieved May 29, 2020, from http://ludology.org/articles/ludology.htm

- Aarseth, E. (1997). *Cybertext: Perspectives on Ergodic Literature*. Baltimore. John Hopkins University Press.

- Murray, J. (1997). *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*. New York. Free Press.

- Murray, J. (2005). The Last word on Ludology v Narratology in Game Studies. Preface to Keynote Talk at DiGRA 2005, Vancouver, Canada. Retrieved May 29, 2020, from https://www.researchgate.net/publication/335541373_The_Last_Word_on_Ludology_v_Narratology_in_Game_Studies

- Frasca, G. (2003). Ludologist Love Stories, Too: Notes from a debate that never took place. Level up. DiGRA 2003. Retrieved May 29, 2020, from http://www.digra.org/wp-content/uploads/digital-library/05163.01125.pdf

- Wildman, N., Woodward, R. (2018). *Interactivity, Fictionality, and Incompleteness*. pp. 112-127. J., Robson, G., Tavinor (eds.) *The aesthetics of videogames*. Andover: Routledge Ltd.

- Krueger, M. A. (1991). *Artificial Reality* (2ⁿᵈ ed.). Reading, MA: Addison-Wesley.

- Coates, G. (1992, March). Program from *Invisible site—a virtual show*, a multimedia performance work presented by George Coates Performance Works, San Francisco.

- Greenbaum, P. (1992, March). The Lawnmower Man. *Film and Video*, 9(3), pp. 58-62.

LUDOGRAPHY

- 2K Boston; 2K Australia. (2004). *BioShock*. Multiple Platforms. 2K Games.

- Arkane Studios. (2012). *Dishonored*. Multiple Platforms. Bethesda Softworks.

- Battlestate Games. (2017). *Escape From Tarkov*. Microsoft Windows. Battlestate Games.

- Bethesda Game Studios. (2011). *The Elder Scrolls V: Skyrim*. Multiple Platforms. Bethesda Softworks.

- Bungie Interactive. (1994). *Marathon*. Multiple Platforms. Bungie.

- D.M.A. Design. (1997). *Grand Theft Auto*. Multiple Platforms. B.M.G. Interactive.

- D.M.A. Design. (2002). *Grand Theft Auto III*. Multiple Platforms. Rockstar Games.

- David Braben; Ian Bell. (1984). *Elite*. Commodore 64. Acornsoft B.B.C.

- EA Dice. (2008). *Mirror's Edge*. Multiple Platforms. Electronic Arts.

- EA Dice. (2011). *Battlefield 3*. Multiple Platforms. Electronic Arts.

- EA Dice. (2013). *Battlefield 4*. Multiple Platforms. Electronic Arts

- Eidos Interactive. (1996). *Tomb Raider*. Multiple Platforms. Core Design.

- Eidos Montreal. (2011). *Deus Ex: Human Revolution*. Multiple Platforms. Square Enix.

- Frontier Developments. (2014). *Elite: Dangerous*. Multiple Platforms. Frontier Developments.

- G.S.C. Games World. (2010). *S.T.A.L.K.E.R.: Call of Pripyat*. Microsoft Windows. Deep Silver

- Galactic Café. (2013). *The Stanley Parable*. Multiple Platforms. Galactic Café.

- id Software. (1992). *Wolfenstein 3D*. MS-DOS. Apogee Software, FormGen.

- id software. (1993). *Doom*. MS-DOS. id Software.

- id Software. (1996). *Quake*. Multiple Platforms. G.T. Interactive.

- id Software. (1997). *Quake II*. Multiple Platforms. Activision.

- id Software. (1999). *Quake III Arena*. Multiple Platforms. Activision.

- id Software. (2016). *Doom*. Multiple Platforms. Bethesda Softworks.

- id Software. (2020). *Doom Eternal*. Multiple Platform. Bethesda Softworks.

- Infinity Ward. (2019). *Call of Duty: Modern Warfare*. Multiple Platforms. Activision.

- MachineGames. (2014). *Wolfenstein: The New Order*. Multiple Platforms. Bethesda Softworks.

- MachineGames. (2017). *Wolfenstein II: The New Colossus*. Multiple Platforms. Bethesda Softworks.

- Rockstar North. (2008). *Grand Theft Auto IV*. Multiple Platforms. Rockstar Games.

- Rockstar North. (2013. *Grand Theft Auto V*. Multiple Platforms. Rockstar Games.

- Valve Corporation. (1998). *Half-Life*. Multiple Platforms. Sierra Studios.

- Valve Corporation. (2000). *Counter-Strike*. Multiple Platforms. Valve Corporation.

- Valve Corporation. (2004). *Half-Life 2*. Multiple Platforms. Valve Corporation.

- Valve Corporation. (2011). *Portal 2*. Multiple Platforms. Valve Corporation.

- Valve Corporation. (2020). *Half-Life: Alyx*. Microsoft Windows. Valve Corporation.

- Warhorse Studios. (2018). *Kingdom Come: Deliverance*. Multiple Platforms. Deep Silver, Warhorse Studios.

- Zenimax Online Studios. (2014). *The Elder Scrolls Online*. Multiple Platforms. Bethesda Softworks.

- Kojima Productions. (2015). *Metal Gear Solid V: The Phantom Pain*. Multiple Platforms. Konami.

- BioWare. (2014). *Dragon Age: Inquisition*. Multiple Platforms. Electronic Arts.