BACHELOR THESIS

VISUAL NAVIGATION

IN INTERACTIVE VIRTUAL SPACES

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Čestné prohlášení

Prohlašuji, že jsem práci vypracoval samostatně s použitím uvedené literatury a souhlasím s jejím eventuálním zveřejněním v tištěné nebo elektronické podobě.

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podpis

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1. INTRODUCTION

Over the last decades the interest in all kinds of interactive virtual spaces has grown exponentially and in a way, as advances in the telecommunication and computing technology brought people closer together and the real world got smaller and smaller, the virtual spaces kept growing ever bigger and ever more complex.

After the emergence of the first 3D environments enabled an interactive simulation of actual spatial navigation, this progress can largely be attributed to video games as they've been at the forefront of development of virtual spaces. Not all virtual spaces can however be labeled as videogames. The characteristic that defines a videogame and separates it from other types of virtual spaces is often referred to as *gameplay*. A more detailed description of this term will be included later in the thesis, for now its important to know that gameplay incorporates all actions that the player may conduct within an interactive space in the pursuit of a goal. Good gameplay is considered the most important quality of a video game. For video games to establish a successful gameplay, the virtual spaces they present must be accessible, meaning that the player should be given the freedom to navigate through the game space in a sensible way. On the other hand, video game spaces should also offer some degree of challenge so that the player feels that his actions matters.

Since the advent of 3D virtual environments in the 90s, there has been an increasing number of games trying to innovate the way we experience virtual spaces. Most of these attempts have been focusing on the technological aspects of games, on harnessing harvesting the ever increasing power of computer hardware in order to improve gameplay by making our interaction with virtual spaces feel as real as possible. This approach has however proved to be a double-edged tool in terms of the lasting success of a game. The very technological progress that made these games revolutionary for the time of their release later made them obsolete as newer, more advanced games were developed. As a result, many older titles with a strong focus on their technological aspect are today largely forgotten.

A number of other games took however a different approach to improve gameplay and instead attempted to innovate the conventions of the way we navigate in virtual space. Some of these games did so by placing navigation at the very core of the challenge offered by the game. This obviously led to a somewhat ambivalent role of navigation in video games, since navigation had to be accessible and at the same time provide a degree of challenge. This twofold role of navigation does not exist in any other media platform and analyzing it should provide us with a better understanding of this young medium and its potential. The prime reason of this thesis is thus the examination of this ambivalence of navigation. Due to the limited length of this thesis, navigation will not be examined in its totality, rather I shall focus on its visual aspects.

There has been a significant number of researches conducted on the matter of spatial navigation in real environments, especially in the field of architecture. A notable work is *The Image of the City* by Kevin Lynch which described how to design an urban environment in order to support spatial orientation (Lynch, pp. 46-90)[1]. A similar work dealing with the architecture of virtual environments is *Architecture's New Media* written by Yehuda Kalay[2]. The most notable work focusing on strictly video game spaces is *Space Time Play*[3] investigating not just the present, but also the future potential of navigation in game spaces.

The subject of the role of navigation in establishing gameplay has however not received as much attention as it deserves. Another underlying reason for the topic of this thesis is thus the lack of researches conducted on this aspect of navigation in video games.

The main aim of my thesis will be examination of the connection between visual navigation and gameplay in virtual spaces with relation to how one can support the other. Under the premiss that gameplay is defined as an equilibrium between accessibility and the level of challenge presented by the videogame, this main goal can be complemented by two sub-goals. Firstly, it is required to examine the rules and methods which are used to implement spatial navigation into virtual environments in an accessible and user-friendly way that would allow the player to conduct those navigational tasks he or she finds meaningful. Secondly, it is important to find out the means through which navigation constitutes challenge without interfering with the accessibility. In other words, find out how navigation is formed to contribute to the gameplay.

In order to reach this goal, theory of visual spatial navigation will be investigated. Firstly I will examine human navigation in its surroundings, with particular emphasis on wayfinding, and the role of our most important sense – the sight – in this process. Then the orientation in spaces of our daily life, such as in urban landscapes and the elements in it which are making our navigation easier, shall be investigated. A significant portion of this thesis will therefore focus on so called *landmarks*, objects which are mediating information that supports our orientation in space and thus helps us navigate without getting lost. The theories of processes behind forming of human *cognitive maps* will be explained and the role of landmarks in these processes will be investigated. Throughout this

1 LYNCH, Kevin. The Image of the City, 1960, MIT Press
2 KALAY, Yehuda. Architecture's New Media: Principles, Theories, and Methods of Computer-Aided Design, 2004, London: MIT Press
3 VON BORRIES, Friedrich. WALZ, Steffen. BÖTTGER, Mathias. Space Time Play: Computer Games, Architecture and Urbanism: The Next Level, 2007, Springer

theoretical part, special emphasis will be put on the role of the respective navigational issue in a 3D video game environment.

A study of two specific videogames, which are broadly considered to have achieved a praised gameplay through innovative use of navigation, will follow.

During this study I fill focus on the characteristics of the 3D space and how it has been formed to support players navigation. The requirement the game places on the players spatial orientation along with the use of landmarks and other navigational tools such as maps will be examined. Special emphasis will be put on the moments of gameplay when navigation becomes a key challenge. The goal of this study is not to encompass the navigation in all types 3D game worlds as that would result in a thesis of immense proportions. Instead the focus will be on one action adventure game and a first person shooter.

The first of these games, *Fahrenheit*, is seen as innovative for its minimalistic use of interface elements in favor of spatial navigational elements. Due to this fact it was at its release even considered by some to be an interactive movie rather than a videogame. The second game, *Aliens vs Predator,* has attracted large attention for the fact that it gives the player an option to play through the game space as one of three different species, each with distinct abilities, creates three different models of spatial navigation and thus three different variations of gameplay within one game. It clearly demonstrates the impact of navigation on the overall gameplay.

The hypothesis has been set as follows: navigation in virtual environments follows the same fundamental rules of navigation in real spaces, there is however one main difference in that videogame space, and subsequently the navigation in it, is designed to provide challenge. Some video games use navigation to mediate a challenging experience to the player and the method used for implementation of navigation can thus become a driving factor of a games gameplay.

The method applied in this thesis is a limited comparative analysis of navigation in the two innovative video games, which use navigation as a fundamental part of their gameplay. This analysis will be founded on game theory and the theory of spatial navigation relevant to the hypothesis of the thesis. My argumentation will be based on a number of academic publications dealing with the nature of human spatial navigation as well as a number of video games to demonstrate how the navigational elements are integrated into a virtual space.

The topic of this thesis is relatively interdisciplinary. Although its main area of interest can be labeled as game studies, a large part is based on publications from media studies and also touches a few topics from cognitive psychology relevant to spatial navigation.

2. A BRIEF HISTORY AND BASIC TERMINOLOGY

The word *virtual* has first been used in philosophy to define something that is not real but at the same time holds some of the qualities of reality. Our fascination by the unreal can be traced back far into the history. The first written account about it dates back to the Roman empire in the first century AD, when a philosopher and author named Pliny the Elder expressed interest in perceptual illusion (Biocca, pp. 7-8). [4]

It took however until relatively recent past and the advent of computers before virtual environments, the way we know them today, saw the light of the world for the first time.

During the second half of 20th century, computers went from being large, noisy machines used for calculations in various military and research facilities into relatively small, efficient and publicly available personal computers capable of displaying their data graphically. This technological advance has been followed by a desire to use its new potential to recreate the real world, to create an artificial, unreal environment that would allow us to interact with it as if it was a real world. The idea of a virtual environment was born.

2.1 Video games

As stated in the introduction chapter, video games have from the start been at the forefront of development of virtual environments. “It is perhaps because of the large sums of money involved in their creation and the guaranteed huge monthly incomes they can generate that computer games remain at the cutting edge of virtual world development.” (Bartle, p. 2).[5] As a result, for any broader discussion on the subject of virtual spaces, the dominance of game-oriented terminology cannot be neglected. Many techniques which first appeared in video games later became parts of other applications for other uses. One of the pioneers of internet and modern computing, Theodor Nelson, describes it like this: “To see tomorrow's computer systems, go to the video game parlors! ... Look there to see true responsiveness, true interaction. Compare these with the dreary, pedestrian office software we see everywhere, the heavy manuals and Help Screens and Telephone Support.” (Nelson, p. 232).[6]

The history of video games begun in 1958 when William Higinbotham created *Tennis for Two*. It was essentially a program simulating a ball bouncing over the net between the two sides of a tennis

4 BIOCCA, Frank. Communication in the Age of Virtual Reality, 1995, Routledge
5 BARTLE, Richard. Designing Virtual Worlds, 2004, New Riders
6 NELSON, Theodor. The Right Way to Think About Software Design: The Art of Human-Computer Interface Design, Addison-Wesley, 1990,

court displayed from side. The users could interact with this simulation by pressing buttons to hit the ball and to control its angle. Although Tennis for two was originally not intended for a mass market but rather as entertainment for visitors of a technological exhibition, it clearly demonstrated the potential of computers to create completely new imaginary environments with their own sets of rules.

The first games that allowed the user to actually navigate through an environment were text-based, meaning that their environments and the events occurring within them were described using words rather than images. They were thus not yet real spaces displayed on a screen. The popularity of such text-based games has been growing since the late 60's. A major breakthrough was signified by the so called MUD games (Multi User Dungeons), originally created in 1978 by a group of students from the University of Essex in UK. MUDs were the first virtual environments to allow multiple users connect through telephone network and interact with each others in one common virtual environment.

Majority of the computer based virtual spaces that followed were usually text adventure games, programmed by enthusiasts at home. This changed after the introduction of the World Wide Web attracted unprecedented number of people to personal computers, many of which wanted to play games. It comes therefore as no surprise that private businesses saw this as an opportunity for profit. As a result, early 90's saw the birth of a large number of commercial virtual environments and things started to really pick of. By then, most of the virtual environments were based on moving image rather than text. Further advances in the computer processing power made it possible for computers to handle large sets of 3D coordinates for calculations of the image displayed on the screen, enabling the first games which took place in an actual space.

The term *space* refers to a boundless extent in which objects have a relative position that can be mathematically described using three coordinates. Space consists of *the dimensions of height, depth and width within which all things exist and move*.[7] This progress resulted in significantly more realistic environments. Moreover, these 3D virtual spaces finally allowed people to navigate through them in all dimensions. Technical progress alone wasn't however enough for a successful establishment of a video game space and had to be complemented by a design of the newly emerged space that would support navigation and all of its aspects in an effective way. As video games grew, so did their virtual environments. Increasingly often games were telling story that interconnected many different environments, each with its own set of spatial rules, which only further increased the importance of navigation.

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7 Oxford Dictionary of Eglish, 2010, Oxfor University Press

2.2 Navigation

The word *navigation* comes from the Latin word for *ship* (navis) and describes the ability to control position, speed and course as well as plan a route through a space. Navigation of a human can generally be split into two components: Physical motion through space, sometimes referred to as locomotion, and a cognitive process often referred to as wayfinding. Wayfinding describes the process of acquiring and coordinating the information necessary for getting to a desired destination. It is the planning that our mind constantly performs while purposely moving from one place in space to another. Locomotion on the other hand refers to the very act of moving through space in the correct direction without any harm. In virtual worlds the very act of motion is usually reduced to pressing a few buttons while the rest is taken care of by the computer. We are only given full control over the cognitive part of navigation. In this thesis the main focus will therefore be on wayfinding.

Since movement is one of the most natural ways in which we can interact with our surrounding, it comes as no surprise that one of the main issues while designing virtual environments is the implementation of navigational elements and making them support wayfinding in the same way as a real environment does. It has however quickly been proven that the signals and impressions which support and guide our navigation in the real world can not be fully recreated in a computer generated world and although there is a constant progress going on, the immense complexity of the real world is still impossible to mimic through the technological means of today. The main ambition has therefore eventually shifted from attempts of fully recreating the reality into creating interactive spaces that would merely make us behave and feel as if we were in the real world by affecting our senses and intellect in the same way as the real world does. In order to accomplish this new goal, the efforts had to be based on understanding of the nature of human spatial navigation and finding out how to substitute the navigational elements which are not possible to implement into virtual environments.

The success of these efforts can be testified to by the fact that this relation between navigation in real and virtual spaces was eventually reversed in the sense that virtual environments begun to serve to help us understand navigation in real spaces. This is due to the significant problem that testing navigation in large natural environments poses. Each such environment is constantly traversed by uncountable number of people and other animals and tends to contain a large number of potential navigational elements. This makes it problematic for the scientists to determine which of these attributes are having an impact on our behavior when navigating. Due to these difficulties almost all of the relevant research from pre-computer era has been focusing on navigation in relatively small environments. Thanks to the development of computers and subsequently the virtual spaces over the past decades, this has changed. The emergence of virtual spaces allowed scientists to create their own testing environment free of all distracting elements. Initially there have been many voices arguing that research of navigation in virtual reality will not be applicable in the real world. A series of studies however proved these concerns to be false. A study by John Bliss for example found out that firefighters navigating in an unfamiliar building while conducting a rescue operation performed equally well after training for their mission in a virtual space as when they studied traditional maps (Kitchin, Freundschuh, p. 115).[8] So at the turn of the millennium, we could therefore see a series of researches which were based on the premise that results from virtual environments can be applied in real world.

Although video games were responsible for a major part of this technological progress leading up to the development of virtual spaces and subsequently the scientific virtual environments described above, there are still some factors distinguishing video games from other virtual spaces.

The most obvious difference might be that virtual spaces in video games do not have to be limited by the same physical rules as the real world. Inside game worlds we can run in inhuman speeds, fly through the air or even get teleported over large distances in an instant. At the same time video games seek to make their space accessible to the players without forcing them to study long manuals. When the players are introduced to a virtual space, they should therefore simply be able to interact with it the way they expect and are used to from a real space. As a result, when it comes to wayfinding, video games are generally attempting to enable it in the same way as reality does. Video games and non-game virtual environments generally share this strive for realistic navigation. The true difference between video games and other virtual spaces lies elsewhere.

Unlike the scientific virtual spaces described above, in video games the simulation of navigation isn't the purpose of their being, rather it's a tool for achieving a given goal, for creating enjoyment and most importantly, it is a part of the gameplay.

2.3 Gameplay

Perhaps one of the most important reasons to the popularity of video games is simply the fact that they are entertaining. “Games are fundamentally designed not to accomplish something through an activity, but to provide an activity that is pleasurable in itself.” (Juul, Norton, p. 1).[9] Enjoyment alone doesn't however automatically make a virtual world into a video game. When defining the essence of a videogame, scientists often refer to the term *gameplay,* which distinguishes it from non video game virtual environments. Gameplay is considered to be the core activity of the game which

8 KITCHIN, Rob. FREUNDSCHUH, Scott. Cognitive Mapping: Past, Present, and Future, 2000, Routledge

9 JUUL, Jesper. NORTON, Marleigh. Easy to Use and Incredibly Difficult: On the Mythical Border between Interface and Gameplay, 2009, ACM

is created through the interplay of player, game-controls and game-mechanics. Everything that the player may do within the interactive space in his pursuit of the goal that has been established by the game is considered gameplay. It is the totality of the possible player performed actions within a game. Furthermore, according to Bartle the gameplay must be designed to make the player feel that his presence is meaningful and his actions are important (Bartle, p. 633).[10] In order to achieve this, the game has to challenge the player to complete a certain task that holds some attributes of difficulty in the form of various obstacles or problems the player has to overcome. When referring to the term *challenge* throughout this thesis, I will therefore mean these situations when the player is introduced to a task that requires some level of effort from the player.

This brings up another interesting issue (besides gameplay) which distinguishes video games from the rest of virtual environments: both ease of use and challenge are desirable and video games are supposed to fulfill both of them at the same time. Although navigational elements in video games are based on the principles of their real counterparts, the way in which they are implemented must be different in order to establish some sort of balance between ease of use and challenge. At first glance it might seem that fulfilling these two requirements is simple. Pressing a button to walk towards a building should be easy. Performing non navigational tasks like shooting at enemies within this building is what should provide some level of challenge for the player. But what if it is the wayfinding that is supposed to be challenging and constitutes the core of the gameplay? As we shall see, sometimes it is required that the process of navigation presents the player with a degree of challenge. This makes the prospect of keeping a game challenging and at the same time accessible appear a whole lot more complicated.

10 BARTLE, Richard. Designing Virtual Worlds, 2004, New Riders

3. VISUAL ELEMENTS OF WAYFINDING

Wayfinding is dependent on the existence of a remote place beyond our immediate reach where we want to get. Due to the fact that our senses are usually limited to a relatively close surrounding, we cannot rely only on information acquired through them in real time while conducting such navigational task. Wayfinding can also use information stored in our memory and various aid tools such as maps. Not only does successful wayfinding require this information to be sufficiently accurate, precise and complete, the form and modality of the information is also important for the success of wayfinding (Montelo, Sas, p. 2004).[11]

Of all the senses used to acquire spatial and other information relevant for wayfinding, our vision is by far the most important one and plays a key role in navigation. In the real world, there are large amounts of visible elements helping us to determine spatial information such as the distance between us and objects in our surrounding. Many of these factors can however not yet be recreated in virtual reality and must be reduced or substituted by other alternatives. To do that in an effective way, we first need to understand the nature of our sight.

3.1 Vision

The Greek philosopher Plato suggested that we humans don't see the world around us the way it really is. Instead he argued that we interpret the world through our intellect. He explained his theory with the help of an allegorical story about a cave with a fire burning in its middle. Along the wall of this cave there are prisoners chained with their heads towards the wall. On the wall they see shadows of other people and objects around the fire, but they can never see the actual sources of these shadows. With other words, Plato indicated that what we see is simply the inside of our consciousness, shadows of reality (Plato, Bloom, p. 193).[12]

More than two millennia later, during the upswing of positivism, the American psychologist James Gibson strongly believed that we see the world the way it really is and rejected Plato's theory by arguing in favor of a direct perception, without the participation of any higher mental processes of our mind (Gibson, pp. 147-187).[13]

Although, there are discussions going on until this day about the nature of human visual perception, modern psychology seems to be closer to Plato's ideas in the sense that it agrees that everything we see is subjective to an interpretation by certain mental processes. It is assumed that our unconscious

11 MONTELLO, Daniel. SAS, Corina. Human Factors of Wayfinding in Navigation, 2006, CRC Press
12 PLATO. BLOOM, Allan. The Republic of Plato, 1991, Basic Books
13 GIBSON, James Jerome. The Ecological Approach to Visual Perception, 1986, Routledge

mind is almost constantly exposed to psychological processes during which various functions of our brain attempts to interpret various information received from the senses in order to solve problems regarding our surrounding and help us to navigate. This type of problem-solving is usually labeled as cognitive processes.

The cognitive processes that will interest us the most are those dealing with depth perception. Some other cognitive processes will also be described more in depth later when examining human cognitive maps, but for now it's important to know that what we perceive visually is not necessarily what's really out there. Rather it's an estimation that our brain produces based on the electric impulses which it receives from our eyes. Without these cognitive processes of our brain, a virtual space displayed on a computer screen would be perceived as a perfectly flat picture (which it really is) instead of a three dimensional landscape giving us room for spatial navigation.

The process leading to our visual and subsequently spatial depth perception begins its journey by light waves bouncing from objects around us. When these waves enter one of our eyes, they travel through the pupil, which regulates the amount of light that it lets through. The light waves are then concentrated by the lens towards its final destination, the retina. Retina is a light sensitive membrane with a surface that hosts hundreds of millions of receptors measuring color and intensity of the light waves. These receptors are responsible for sending all the information through the optic nerve from the eye into the brain for further processing. Since the retina membrane is in fact flat, so are the images that our brain receives. This points towards an important conclusion: the depth perception we enjoy while gazing at our surrounding is constructed from flat images entirely through the mental processes of our brain. Through learning how these mental processes work, psychologists have identified a number of so called *cues.* Cues represent perceived information that the visual cortex of our brain uses to determine how objects are positioned in space relatively to each other in order to enable us with a depth vision.

The most important of these cues to depth perception is provided through our *binocular vision* (sometimes also referred to as *stereoscopic vision*). This term is used to describe the fact that humans are equipped with two eyes and although their fields of view are largely overlapping, there is still a slight offset in their perception due to the distance between them. This can be demonstrated by a simple exercise: if we hold out one of our hands with its thumb risen in front of our face and then focus at it alternately with one eye closed, we'll discover that each eye gives us a slightly different image, each eye perceives the thumb on a slightly different spot relatively to the background. With other words, when we focus both of our eyes on a single object, each of our eyes register a similar, yet not entirely identical image. This fact is often referred to as retinal disparity. The two images are then combined into one by our brain. It is the difference between them that makes it possible for our brain to generate a three dimensional image.

This effect is however very hard to recreate in virtual environments. Although some attempts to simulate depth of vision by sending an image with a slightly different offset into each eye, using special glasses or other tools, have reached some level of success[14], this technology is yet to become a mainstream standard and today a vast majority of interactive virtual spaces are not equipped with it. The images depicting virtual environments are instead projected on a single plane – the screen. As a consequence, users have no choice but to keep their eyes constantly fixed on objects depicted on the flat screen, which prevents our binocular vision from gaining any spatial information. That does however not mean that virtual spaces are incapable of providing us with a sense of depth necessary for spatial navigation. It is estimated that approximately 5-10 percent of the population is incapable of correct binocular vision due to misalignment of their eyes (Blake, Sekuler, p. 293).[15] Does that mean that they are blind to depth in the world around them? Not at all!

This is where monocular cues come in. Thanks to them our brain is capable of generating a degree of depth perception without the information provided by binocular vision. Psychologists have managed to implement these cues into paintings on flat canvases and by doing so they cheated the brain into perceiving these canvases as a real three dimensional spaces. In fact some of these monocular depth cues have since long been well known and used as techniques for achieving an illusion of depth in traditional art.

Unlike the binocular cues, the monocular cues are generally based on our navigational experience which we acquire early in our life. Many of these cues may sound obvious as we have learned to take them for granted and never really had a reason to question them. Their importance is however unquestionable. Monocular depth cues can generally be divided into two categories: *static* and *dynamic* cues, depending on if the depth is perceived based on their static appearance or relative motion.

The two most common dynamic monocular cues are:

- ***Motion parallax,*** which occurs when objects that are moving faster relatively to the viewer appears closer, while those moving slower are perceived as further away. An example from

14 Stereoscopic vision in virtual environments has most often been achieved by using special type of shutter glasses. Each glass of the glasses has been made capable of becoming alternately dark or transparent. The glasses can then be alternately darken over one eye and then over the other one. This process is synchronized with the refresh rate of the screen which meanwhile displays alternately two different perspectives. Thanks to this synchronization, each eye can only perceive one of these perspectives, which cheats our brain into treating those two perspectives as a result of retinal disparity, resulting in a perception of one three-dimensional space.

This type of shutter glasses has been used for research purposes in virtual environments since the 1970s. The first model intended for mainstream market wasn't however released until 2008 when the American company Nvidia released the first *stereoscopic gaming kit* compatible with most PCs. Although it is today still too early to judge the success of this product, Nvidia's general manager is optimistic, reportedly stating during one press conference that *3D glasses will become standard equipment for every player.* (GameLife, April 21, 2010)

15 BLAKE, Randolph. SEKULER, Robert. Perception, 2005, McGraw-Hill Higher Education

our daily life can be experienced while looking at the passing landscape while driving in a car or any other means of transport, when objects further away seems to be moving slower compared to those closer.

- ***Kinetic motion*** describes the changing sizes of objects moving closer or further away.

Two of the most important static monocular cues are:

- ***Linear perspective***, which describes the perceived depth when multiple linear lines appears to converge at the horizon.
- ***Interposition*** which occurs when one object blocks another and thus appears to be placed in front of it.

Other important cues include shadows, which are an important tool for creating a sense of depth to objects depicted on flat canvases. Size and height are also important from monocular depth perception. If one out of two similar objects is smaller than the other one, it is often perceived as being further away from the viewer. The same is true for objects appearing higher than other similar objects. Finally, objects which are not particularly sharp are perceived as further away while those with more detail in them will appear as closer.

All of the monocular cues can easily be recreated through 3D technology in modern virtual environments.

Image 3.1a Image from the video game *Mafia* (2002) the way it's displayed on a flat computer screen. The cars to the left are smaller and located slightly higher than the main car. This makes them appear further away. The sidewalks along the road appears to be parallel lines converging towards the horizon, making a linear perspective cue. The road surface markings appear clearer in the bottom part of the picture and get gradually blurred out towards the upper edge. All of these cues combine to create a sense of depth.

3.2 Orientation

Being able to see and estimate distances is however not enough for successful wayfinding. A cornerstone of wayfinding is made up of orientation. The term *orientation* describes someones ability to be aware of his or her current location in space relatively to the final destination. The required precision of orientation is subjective to the performed navigational task. When moving through space to a certain goal, such as going to a lecture at the university, we usually decompose this task to a series of lower level sub-tasks. Locating the university building, taking elevator to the right floor and finally entering the correct room are all sub-tasks of one final goal and the completing of each one is necessary in order to pursuit a sub-task of the next level.

In order to plan our goal and complete its sub-tasks, some kind of spatial knowledge is required. This knowledge is attained and updated primary through visual perception of the environment while moving through space. Each sub-task usually requires appropriate level of spatial knowledge. When completing one sub-task and moving to another one, the requirements for spatial knowledge changes as well. In order to locate the university building we need knowledge of the city, but once we enter the building, knowledge of the different floors becomes more important.

Besides the increased precision of required spatial knowledge, the required locomotion precision is increased as well. Locating the university building requires getting into a distance of tens of meters, but finding the door of the correct room requires much higher movement precision. If a sub-goal remains uncompleted, it's a sign that additional movement is required. *Spatial knowledge guides movement and movement updates spatial knowledge* (Patel, Vij, p. 110*).*[16]

A very common situation is when we don't know what direction we should go or even where we are. This state is sometimes described as *geographical disorientation* and it can result in serious trouble. In order to avoid people from reaching this state, a space should meet certain criteria. Weisman identified three main environmental factors that affect the ease of orientation and wayfinding (Weisman, pp. 189-204).[17]

- ***Differentiation*** describes the degree of distinctiveness between multiple parts of an environment. A lot of differences makes each part unique and more memorable, which has a positive effect on orientation. Places with low differentiation, such as a vast grass plain or the middle of a sea, will display very little change while moving through it. This in turn will make it hard to determine crucial information, such as the distance we've moved or whether we've moved at all.
- ***Visual access*** describes the degree to which the different parts of an environment are visible from various viewpoints. An example of high visual access is when the final goal of our navigation can be seen clearly without any obstacles blocking our view. This will obviously improve orientation.
- ***Layout complexity*** describes the complexity of the landscape we're navigating through and is determined by the amount of parts a space is broken up into and the way these parts are organized. Crossing a grass field towards a cottage at the other side is simple. Moving the same distance towards a house in a city on the other hand can require crossing of multiple streets and navigating around various building blocks. High layout complexity makes navigation harder.

The visual and structural characteristics of an environment are decisive for the ease of orientation. Relatively flat surfaces with high visual access will by default be easier to orientate in than for

16 PATEL, Kanubhai. VIJ, Sanjay Kumar. Spatial Navigation in Virtual World, 2010

17 WEISMAN, Jerry. Evaluating Architectural Legibility: Way-finding and the Built Environment, 1981, Environment and Behavior

example mountainous landscapes with high layout complexity. Since today's 3D videogames feature a wide range of different environments, each one of them should have an optimized level of information mediated to the player in order to assure a balanced navigational experience. For example, where the layout complexity is high, game designers should compensate by increasing the differentiation.

Image 3.2a *Grand Theft Auto: San Andreas* (2005) is a good example of a video game which gameplay consists largely of navigation through many different environments. When the player drives a car on a highway through an open landscape, the destination of a low level sub-task (such as the city on the horizon) is clearly visible and orientation is therefore easy. When the player walks his character through narrow streets of a city, with buildings obscuring the view and generally low visual access, there is an overhanging threat of geographical disorientation. To prevent this from happening the game designers increased the differentiation by adding various esthetic elements to each building such as boxes, signs, rubbish bins or even homeless people. As a result, every place appears distinct and when moving between places, it becomes clearly visible that we are at a different place.

Orientation based on vision of our immediate surrounding can however prove to be insufficient to wayfind in more complex environments. As seen in the lower left corner of each picture in image 3.2a, a navigational aid tool, such as a cartographic map is often applied to improve orientation in such spaces.

3.3 Cartographic maps

In order to be able to navigate through any environment and to reach a destination beyond our immediate visual contact, all of us need at least some elementary knowledge about the space. This knowledge does not necessarily need to come from our observation of the space. One of the most common tools displaying information that help us orientate in vast or unfamiliar spaces is a cartographic map.

There are a number of requirements that a map should fulfill in a virtual space in order to support orientation. An important factor for effective usage of the map is its alignment. In real life we are free to actively move and rotate a map to guide our navigational decisions. For example while navigating through a large environment, such as a city, people often prefer to align their map with the surrounding so that orientation of objects on the map would correspond with reality, making it easy to be aware of the current position in relation to the final destination. In small environments, such as in a museum, people tend to find it sufficient to keep their map aligned with the direction of their movement. Unlike in real world, where we have freedom to align the map in whatever direction we desire, most video games present us with a map that is integrated into the interface and locked at a predetermined position. D. Montello & C. Sas suggest as a solution that an optimal design for navigation in virtual spaces should include maps with both variable and fixed orientations (Montello, Sas, p. 2007). [18]

Another requirement deals with the amount of information a map should ideally mediate. As described during the previous part of this chapter, the level of spatial knowledge required for successful orientation often changes while performing complex navigational tasks. This means that maps should preferably offer a dynamic information range with multiple levels of spatial information. Furthermore according to Kanubhai Patel, this "...cross scale transition should be smooth so that users can easily see how objects at different levels are related to each other" (Patel, Vij, p. 112*)*.[19]

All these requirements are making effective integration of maps into games a tough task.

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18 MONTELLO, Daniel. SAS, Corina. Human Factors of Wayfinding in Navigation, 2006, CRC Press

19 PATEL, Kanubhai. VIJ, Sanjay Kumar. Spatial Navigation in Virtual World, 2010

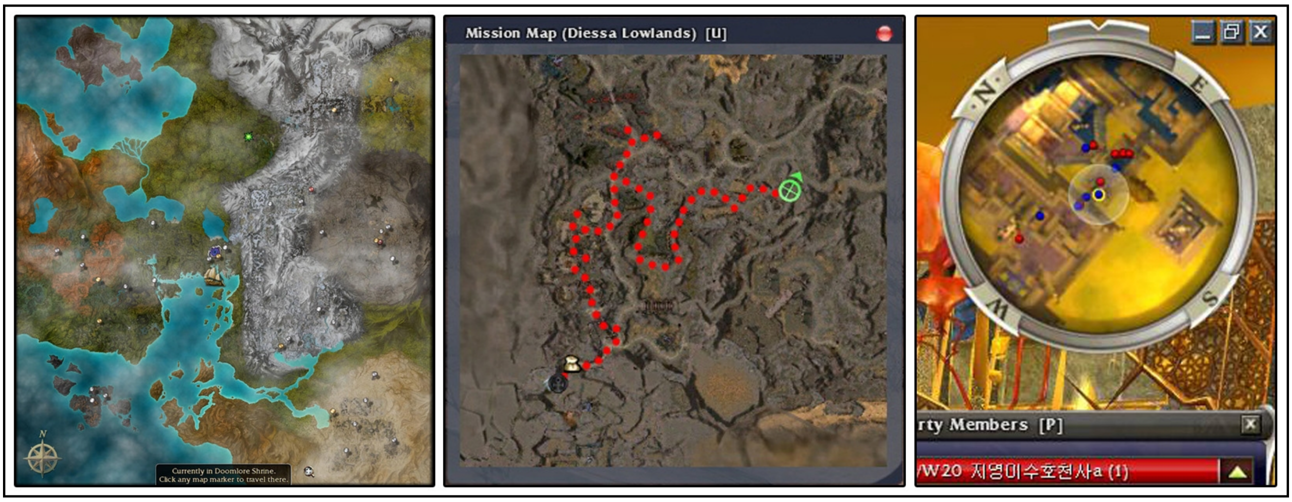

Image 3.3a Some games solved these problems by offering multiple maps with both different orientation and different levels of details. One such example of multiple types of maps integrated into the same game can be seen in *Guild Wars* (2005). The map to the left depicts the entire game world with icons representing all the cities and important locations. The world map is only displayed if the player presses the “map” button in the main menu of the game interface. It remains static regardless of the players orientation and doesn't update during the course of the game. It allows us to fluently zoom-in to see more details. The map in the middle is a so called *mission map*, which only displays the region where the player is currently located and therefore holds more detail than the world map. Like the world map, the mission map doesn't change its orientation based on the player movement. The map at the right side is by default located in the upper right corner of the interface and sometimes referred to as the *radar*. It shows the immediate surroundings of the player. Unlike the other two maps, the radar is not fixed but rotates every time the player turns. The north on the map thus constantly points towards the north of the game world to maintain the map aligned with the surroundings. The radar depicts the smallest part of the game world but also holds the largest amount of details and shows the location of nearby characters.

Merely implementing maps into a game to support its navigation is not always enough though. Maps are also often required to play a more active role in the gameplay than just serving as a mere navigational aid tools. A brief look into the history of video game maps will in fact reveal that their gameplay related function has been at their core from the very beginning.

The first video game map appeared in 1977 and depicted the game world of *Zork 1: The Great Undergound Empire*. The fact that the game was a text based fantasy adventure meant that there was no coherent game space. Instead the computer screen could only describe one isolated location at a time. It may therefore come as no surprise that the map wasn't made by the creators of the game, nor was it integrated into the game. Instead it was a player and fan named Steven Rost who came up with the idea that the game could use a map depicting the relationships between the various locations in the game. Rost decided to take the initiative and drew one on his own. His map quickly became popular among other players, which demonstrated the need of maps in virtual spaces. It was a proof that "...the game creators succeeded in creating a game space that was accepted as having it's own rules that functioned even outside of the player's perspective" (Miller, p.1).[20] From that point onwards, many fantasy role playing games had maps integrated into their gameplay.

Miller argues it's no coincidence that maps first found their way into this genre. Many role playing games are exemplified by a strong story, which in turn requires a strong sense of place. Just like many fantasy books include a map of the imaginary world at their first pages, world maps in role playing games does not only serve as an navigational tool, but help to keep the game world together by providing a geographical context to the the story and all of the players actions. It establishes a sense that the isolated game locations are all part of one world. Thus in role playing games, maps have a great role in supporting the gameplay. Miller argues that this usage of a map was and to some extent still is typical for role playing games, whereas most other genres are implementing maps as pure navigational elements without intending them to play any major role in the game and its story (Miller, p. 4).[21] For example Guild wars from the example above consists of game spaces at various locations that are not always coherent. Through the use of teleport, the player might for example be instantly transported from a city to a distant island, without knowing the spatial relations between these two places. The world map serves to tie these game locations and the story together, giving them a sense of being part of one world.

The use of large scale maps is however not the only method of creating a sense of place in a game. One alternative solution is to make the video game take place in real spaces. *Hitman 2: Silent Assasin* (2002) is one such example. During the course of the game, the player assumes the role of an assassin traveling around the world in order to conduct missions. Each of these missions take place on a famous location, such as in the Petrona Towers in Malaysia or near the Red Square in Russia. These locations are usually known to the player from real life and there is therefore no need for a world map tying the locations together.

During the 1990s a new type of so called *sandbox games* emerged. The sandbox games were unique through the way they offered a large open world in which the player was free to conduct missions, exploring or just messing around. The player was simply given liberty to move freely through the space and do whatever he or she wanted. As a result, rather than using a world map to put the various separated locations into a context, sandbox games were the first to use a map that depicted the actual game space.

Today there is a huge variety of types of maps in various games. As hinted above, one important

20 MILLER, Daniel. Creating Playspace: Cartography in Games, 2010
21 MILLER, Daniel. Creating Playspace: Cartography in Games, 2010

factor determining the type of map (or maps) that is used is the genre of the game. For instance maps in racing games only focus on depiction of the roads, since the player is not expected to drive anywhere else. In Role playing games, such as Guild Wars this level of details would obviously be insufficient.

Cartographic maps provide us with basic information about a given space. In order to successfully navigate from one place to another, we don't just need to know how the space looks, we also have to orientate to know where in the space we are. To be able to orientate, we must manage to match our current location with a place on the map. Without this, it would be impossible to perform the right choices while navigating.

3.4 Landmarks

Moving through unfamiliar large environments can be a tough task in all kind of worlds. During the moon landing in 1970 the astronauts of Apollo 14, Allan Shepard and Edgar Mitchell were about to perform a moonwalk to the rim of Cone Crater. The lack of distinctive lunar landscape features made them unable to orientate and eventually they decided to turn back to the landing module without completing their goal. Despite being equipped with a map, they were simply unable to orientate in the monotonous moon environment. Later they found out that they had been only a couple of minutes walk of their objective.

This example underscores the importance of one of the most important elements helping us to navigate through such large environments. The *landmarks*. This term refers to those object in our surrounding which we use as a help to determine our position in the space, to know where in a space we are. Everyone who ever had to ask for help to find a way to a certain place has come into contact with some form of landmarks.

Let's say we're lost in a big city and need to ask someone how to get to the train station. No one would help us by answering *walk 450 meters northeast*. Instead the reply we would hope to get might be something like this: *Keep going along this street. Once you reach the church, take the first street right. After about ten minutes of walk you'll come to a McDonald's, turn left and you'll be at the station.* Instead of outlining the distance and direction, this description rather tries to describe the path with the help of notable locations along the way. The *church* and *McDonald's* are both used as such locations and can be labeled as *landmarks*. Landmarks are static objects in our surrounding helping us to orientate and determine our position. New York's Statue of Liberty, the Opera House in Sidney or the Eiffel Tower are all excellent landmarks since they are so strongly associated with a location and if we see them, we immediately know where we are. Unfortunately, not all spaces are blessed by such well known landmarks. Many video games present us with a completely new fantasy game world and can thus not rely on the player's previous knowledge of landmarks.

This poses a significant challenge for virtual spaces as they have to introduce objects designed to make the player use them as landmarks for orientation. Lack of potential landmarks would thus significantly limit the success of the whole product. Thanks to their ability to support and significantly speed up navigation, landmarks should be a part of every virtual environment.

In the thesis *Design Guidelines for Landmarks to Support Navigation in Virtual Environments* Norman G. Vinson seeks to establish guidelines for supporting visual navigation in virtual environments. He argues that under the right circumstances a church, restaurant or even a crossroad can all serve as excellent landmarks which we can refer to when describing how to get from one place to another. Vinson argues that a virtual environment should be equipped with the same kind of landmarks that help us navigate in the real world. Spatial knowledge is obtained in the same way in both virtual and real environments and techniques used in real world navigation can thus to some extent be applied in virtual worlds (Vinson, p. 3).[22] In search of a better understanding of landmarks, examining their usage in the real world can thus be helpful.

Landmarks have received particularly large attention in the field of architecture. In his research about urban planning, Kevin Lynch (Lynch, pp. 46-90)[23] argued that the landmarks which people use for wayfinding through an urban environment can be split up into five categories:

- *Paths*, such as streets, canals or transit lines serve as the channel for our movement.
- *Edges*, such as a fence or a river are indicating the limits of a given area.
- *Districts* such as neighborhoods provide us with reference points.
- *Nodes* such as a famous square or a public building serves as focal point for our travel.
- *Elements* such as statues, into which we cannot enter are constituting navigational landmarks as well.

Simply putting these landmarks into an environment is however not necessarily sufficient to support navigation in an effective way. An object doesn't become a landmark until we start using it as a navigational reference point. And in order for that to happen, the object has to be memorable, recognizable and distinguish itself from the rest of the surrounding environment. In other words, for an object to become a landmark, it has to stand out from the rest of the objects. There are several

22 VINSON, Norman. Design Guidelines for Landmarks to Support Navigation in Virtual Environments, 1999, National Research Council Canada - Institution for Information Technology

23 LYNCH, Kevin. The Image of the City, 1960, MIT Press

ways how to make an object memorable and thus make it more likely that the individual will choose it as a landmark. According to Lynch some of the attributes that makes an object memorable are significant height, complex shape or a unique exterior color (Lynch, p. 80).[24]

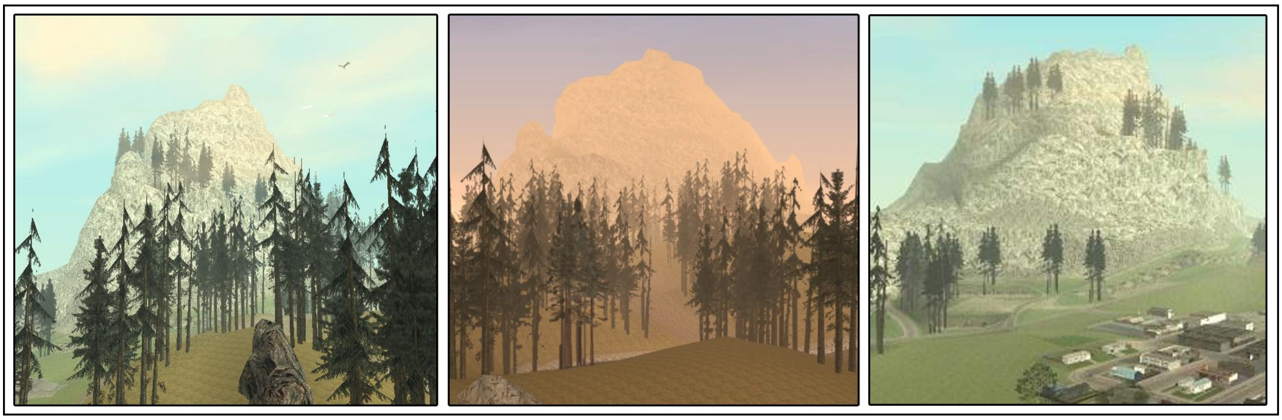

Image 3.4a *GTA San Andreas* (2004) depicts a game world consisting of three fictional cities as well as the wilderness in their surroundings. To prevent geographical disorientation in the monotonous woods, the designers placed out a series of highly visible and distinct objects at various places. One of them, Mount Chiliad, is displayed on the pictures above the way it's viewed from various locations. It functions as an excellent landmark mainly due to its size, making it visible over a large distance.

Furthermore, an ideal landmark object should have all of its visible sides notably different so that the user will be able to use it to determine his position in relation to the landmark. In case the object intended to serve as a landmark is symmetrical and is not supposed to have any variations along its sides, such as a tower or a tree, it is desirable that its immediate surrounding is filled with different objects giving each of the landmarks sides a unique look. A player moving around a radio tower placed in the middle of a landscape will hardly be able to determine his orientation based on looking on the perfectly symmetrical tower. If we however place a big noticeable tree at the foot of the tower, these two objects will combine into a non symmetrical landmark making the orientation significantly easier.

24 LYNCH, Kevin. The Image of the City, 1960, MIT Press

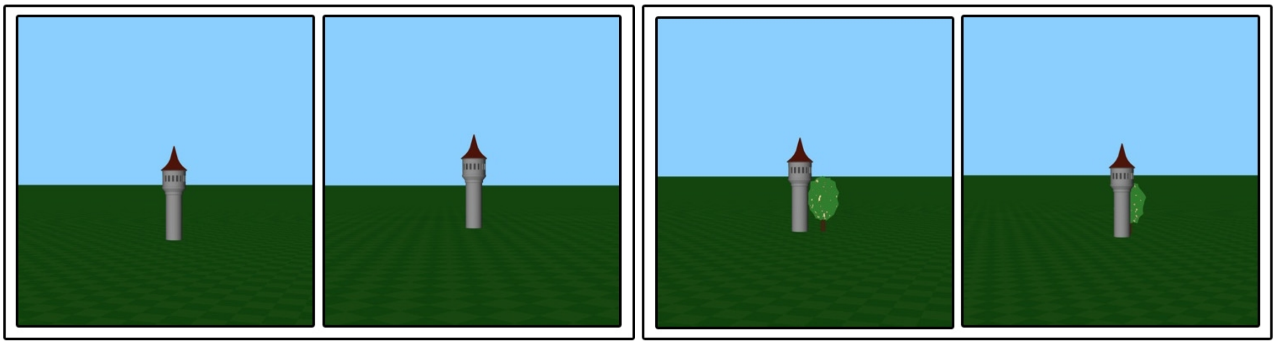

Image 3.4b This tower in a virtual environment stands out from its surrounding and is clearly noticeable. On its own it's however too symmetrical and as a result when a player moves through its surroundings, he or she will have trouble determining his orientation based on his visual contact with the tower. The first two pictures (from left) are taken from two distinct locations around the tower without showing any apparent differences. The last two pictures show the same tower as seen from the same two positions. This time a tree placed next to the tower makes it less symmetrical and in combination with monocular depth cues, these two objects together express a significantly greater variation based on the players position which in turn improves orientation.

The asymmetry and differences of a landmark should however never be taken into an extreme. A highly asymmetrical landmark with each of its side significantly different seen at two different occasions from two different positions could potentially be mistaken for two completely different objects by an individual moving through its surroundings.

Once landmarks are correctly designed, a user should be able to navigate through the environment by going from one landmark to the next. In order to make this possible, multiple landmarks must be within the viewing distance of the user at every occasion. To make a large environment completely navigable in this way would however require a large number of landmarks evenly spread across the entire navigable space. A large number of landmarks increases the complexity of the environment and makes it more difficult to identify the different landmarks. If the number of landmarks gets too high, it will cause confusion and decrease the conditions for navigation. A big casino with flashing neon lights would serve as an excellent landmark in the middle of a dessert. In central Las Vegas, surrounded by equally extravagant structures, the same casino would no longer be as effective landmark. Large number of objects and locations that are designed to stand out and serve as landmarks will paradoxically lead to making them less obvious. When planing an urban area or designing a virtual space, potential landmarks should therefore be evenly spread in limited numbers. This leads to the next factor adding to a landmarks memorability: its position. A landmark should ideally be positioned along or close to roads and other paths, where the user is most likely to move. A *path* is a road or other navigational element connecting places in an environment which are frequent destinations for people. By placing most of the landmarks within viewing distance of a path, it is possible to minimize the number of landmarks and at the same time increase navigability. Although a path could itself serve as a navigational landmark, leading the user to his point of interest, a complex environment, such as a city, holds a large number of potential point of interests and interconnecting all of them with paths would create a large and confusing network defeating their initial purpose. Lynch concludes that it is therefore desirable to create a well structured and thought through network of paths and landmarks which are efficiently placed in those areas where they are needed the most (Lynch, p. 114).[25]

Although landmarks can be used as navigational elements in both the field of urban planning and while designing a virtual environment, we have to keep in mind some radical differences between real and virtual environment. Perhaps the most obvious difference is that in a virtual space we can do things which are impossible in reality. We can jump down from buildings without getting injured, get teleported hundreds of miles in an instant or fly through the air instead of walking. As a consequence the virtual navigational elements needs to deal with some different challenges and have a different impact on the user than they would have in the real world. Moreover, due to the limitations of today's computers, a virtual environment cannot display as much detail as reality, which prevents some factors, such as binocular depth cues, from helping with distance estimation. To put it simply, the navigation in virtual spaces cannot support all the navigational elements of our real life and those elements it does support, such as landmarks, have to make up this lack by being designed to act more powerfully than they would have been in the real world. Luckily, in virtual environments, the designers are not forced to follow the same limitations as in real world (such as law of physics) and thus they can create landmarks which are extremely noticeable.

25 LYNCH, Kevin. The Image of the City, 1960, MIT Press

Image 3.4c This image, created by a concept artist during the development of the game *World of Warcraft* (2003), depicts the city of *Dalaran*. The fact that the entire city is actually hovering in the skies makes it extremely noticeable and at the same time unique. Dalaran is a good example of a landmark taking full advantage of the potential offered by virtual spaces.

In addition Vinson argues that in some cases it is desirable that all landmarks bear some common visual sign distinguishing them from the rest of the environment so that the user easily sees that their only purpose is navigation. To illustrate this claim, Vinson uses the example of an educational virtual interactive model of human blood circulation. As the purpose of the environment is education, it is crucial that the artificial landmarks wont be mistaken for something else, such as blood cells, which could severely mislead the students. The suggested solution in such cases is making the landmarks appear solid and angular so that they sharply contrasts with the rest of the environment. This type of landmark appears in video games as well.

Image 3.4d *Mafia* (2002) uses pillars of red smoke to guide players movement during a race mission. These pillars serves as a kind of ad hoc landmarks, which are clearly distinguished from the rest of the environment, making it clear for the player that their purpose is to guide him. Once the race is over, the pillars vanishes.

So far we've only been dealing with cases of wayfinding when the user does not have much information about the space through which he's navigating, and has to rely on various tools such as maps and look for landmarks to determine his position in space. Forcing the player to rely and constantly focus on these tools and objects while moving through the space can hover potentially degrade the enjoyment of a game. Many video games are therefore attempting to make their space accessible even without them. While it is possible to learn navigating in an environment without the support of maps and landmarks, this can take a long time (depending on the size of the world) and in commercial products, such as those that are the subjects of this thesis, users are not always wiling to invest a lot of time into learning.

Vinson suggests that by repeatedly moving through the world, individuals will eventually learn to associate a navigational action with different landmarks in the environment. For example that taking a right turn once they reach a crossroad will take them to the city. The players then tend to remember the path from point A to point B as a string of landmarks. This is commonly referred to as the *route knowledge,* the knowledge of how to get from one point to another based on the position of landmarks. “In sum, landmarks support initial orientation in the new environment, they support the subsequent development of route knowledge, and they are essential to navigation using route knowledge" (Vinson, p. 4). [26]

This indicates that people traveling the same path through unfamiliar environment multiple times will eventually reach a condition where their navigation tools are no longer needed. This leads us to a question whether it is feasible for us to completely memorize a space in order to be able to move through it freely without navigational aid tools? Should the answer be yes, it will inevitably lead us to another question: in which spaces is such complete geographical knowledge possible to achieve and how can the design of these spaces support us in our attempt to reach this condition? In search of an answer, this condition and the processes behind it should be examined more closely.

3.5 Cognitive map

In the 40's an American psychologist named Edward Tolman made a series of experiments where he placed rats to find their way through a complex labyrinth in search of food located on the other side. Initially the rats struggled and often walked into corridors leading into a dead end. However, as the experiment progressed, they made fewer mistakes and became faster at using the correct way through the labyrinth. Eventually, after many repetitions of the test, they managed to find their way to the food without a single error.

As a next stage of the experiment, Tolman took another group of rats and placed them into the same labyrinth. This time however there was no reward in the form of food on the other end of the labyrinth. As a result, the rats were simply wandering around without any goal. After a while Tolman let the same group of rats repeat the experiment, this time with food placed on the other side of the labyrinth. To his surprise, the rats learned quickly, and after just a few repetitions, they begun to move through the labyrinth without entering any of the dead end paths and learned the path leading to the food much faster than the first group of rats. The only logical explanation was that they somehow remembered the labyrinth from their previous wandering session.

This led Tolman to the conclusion that rats are capable of learning even when the learning process is not associated with any form of reward. According to him, the experiment proved that rats are automatically storing spatial information regarding their surrounding. The information stored in this way then serves for future navigational tasks. Tolman decided to name this type of information a *cognitive map*. Cognitive map (sometimes also referred to as *mental map*) can accordingly to Tolman's experiments be defined as a mental representation of an environment. It is the cognitive map that makes it possible for us to successfully navigate through a known space without any

26 VINSON, Norman. Design Guidelines for Landmarks to Support Navigation in Virtual Environments, 1999, National Research Council Canada - Institution for Information Technology

navigational aid tools.[27]

Even though the environment which we are exposed to during our everyday life is not a rat-labyrinth, it may not be as bad metaphor as it looks. Our surrounding is a complex, uncertain, changing and unpredictable large-scale area with objects usually scattered seemingly randomly across its surface. The individual is on the other hand a small organism with limited mobility and the information about its surrounding is acquired and stored through the individual's imperfect senses. Non the less, after spending long enough time wandering in a space, we tend to reach a stage when we're capable of successfully navigating towards our goal without errors and without the help of any navigational tools. It is a state when our cognitive map has been developed enough to rely on. “A human being's spatial behavior relies upon, and is determined by the individual's cognitive map of the surrounding environment” (Patel, Vij, p. 104).[28] We all form and use a cognitive map in both real and virtual spaces.

To fully understand its effects and how it works, we first have to take a look at the processes leading to the development of a cognitive map. According to Roger Downs the first step leading towards the establishment of a human cognitive map is the process of sensual acquisition and subsequent storage of spatial information while moving through space. Downs calls this process *cognitive mapping*. “Cognitive mapping is a process composed of a series of psychological transformations by which an individual acquires, codes, stores, recalls, and decodes information in everyday spatial environment” (Downs, p. 9).[29]

The fact that a cognitive map is developed by simply moving through the environment for long enough time

suggests that it largely depends on the memorability of the space. As mentioned in the previous chapter, landmarks are designed to stand out from the rest of the environment. It's therefore possible to conclude that landmarks, as the most prominent spatial feature, are easy to remember and thus play an important role in cognitive mapping. However, as opposed to the route knowledge, which allows people to move from one destination to another by following a chain of landmarks, cognitive mapping develops a sense of the spatial structure of an environment. By structure I mean the knowledge of where different landmarks and other spatial objects are located in relation to each other and be able to wayfind freely between them. Route knowledge can thus bee seen as a kind of perquisite or a lower stage in the development leading towards the understanding of the structure of a space. This type of structural knowledge is sometimes referred to as *primary survey knowledge*

27 TOLMAN, Edward. Cognitive Maps in Rats and Men, 1948, Psychological Review
28 PATEL, Kanubhai. VIJ, Sanjay Kumar. Spatial Navigation in Virtual World, 2010
29 DOWNS, Roger. Image&Ebvironment: Cognitive Mapping and Spatial Behavior, (1973), Aldine Publishing Company

and is the backbone of a cognitive map.

Although route knowledge on its own is sufficient for most navigational tasks, in a dynamic and changing environment, such as in a sandbox video game, we often have to adjust our navigational task to the present situation and use alternative routs to our destination. These situations render route knowledge useless. Finding alternative routes is technically possible even without primary survey knowledge through a so called *dead reckoning*. By estimating the direction and distance towards our destination, human brain is capable to geometrically construct an alternative route. This method is however not always reliable and particularly in large spaces with high layout complexity, primary survey knowledge is necessary for an effective navigation.

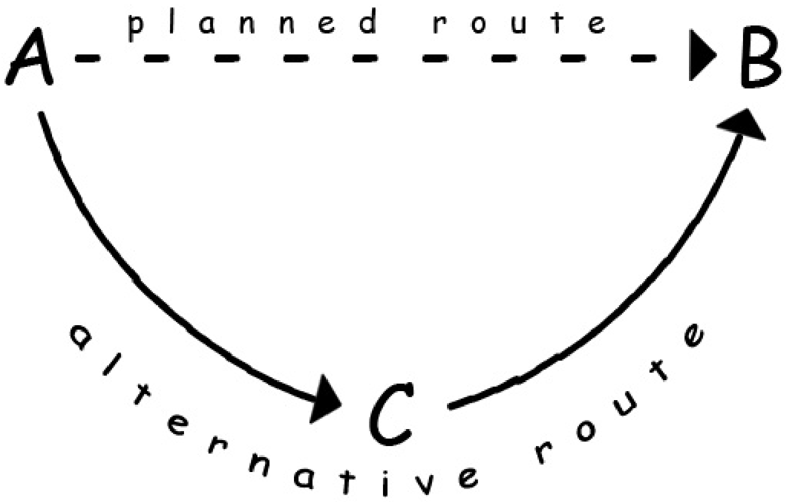

Image 3.1 In dynamic environments we are often forced to abandon our planned route in favor of an alternative. While driving towards a certain goal in the game world of *Mafia* (2002), consisting of a large city, the player can get chased by the police for various crimes. The police often acts by placing out roadblocks, blocking the players path. As a result, the player has to make a turn and take a different route. Since the city stretches across multiple pieces of land separated by the sea, the player is required to have some degree of structural knowledge about the bridges and tunnels linking the city together. Dead reckoning is therefore likely to lead into a dead end.

It would however be a mistake to conclude that humans develop a cognitive map of a space only from traveling through it. Various navigational tools such as maps, photographs, videotapes etc. can also serve as building blocks of our cognitive map. This knowledge about a space attained without actual movement through it is called *secondary survey knowledge*. Secondary survey knowledge on its own doesn't provide our cognitive map with enough information to understand the structure of a space and be able to find alternative routs in an environment. It can thus never fully replace primary survey knowledge. Rather it is a tool that can significantly speed up the process of acquiring primary survey knowledge to fully develop a cognitive map.

A fully developed cognitive map is necessary for performing complex navigational tasks without any navigational tools. Once a cognitive map reaches this level, not only does it help us to find our way in previously visited places and remember their structure, it also helps us to visualize the positional and locational details and most importantly to visualize the rout from one place to another. While moving through a well known environment, with a fully developed cognitive map, our brain tends to produce a series of predictions in the form of mental images of what is likely to be encountered at places along our projected route. The quality of this visualization depends on the quality of our cognitive map.

Some research however seems to indicate that cognitive map contains much more than just a network of geographical positions. Roger Downs argues that our cognitive map is not only used for this kind of predictions while actively navigating. When we're confronted with a news report or a commercial talking about a destination we're familiar with, images of the climate, the attitude of the people or even details such the food they eat immediately pops up in our mind. “We respond to advertisement's exhortation to *“come to sunny Florida”* or, on the other side of the Atlantic, to *“come to sunny Brighton.”* We associate images of beaches, sun-bathing, amusement parks, golf courses with such simple locational terms: our cognitive mapping processes fill in the necessary details” (Downs, p. 24).[30]

This implies that rather than just visual information such as relative positions of landmarks and geographical information from maps, our cognitive map seems to store the overall situation context associated with a given place. [31]

An important conclusion to draw from this description is that a cognitive map is not a map in a cartographic meaning. Rather it's a cognitive spatial representation which has the same functions as a cartographic map, but lacks its physical properties (Griggs, p. 50).[32] Cognitive maps are discontinuous. Some areas are always black due to the absence of any impressions related to them. While Geographic maps are updated only when the geography of the world changes, cognitive maps on the other hand are updated whenever we navigate or attain information about a given space

30 DOWNS, Roger. Image&Ebvironment: Cognitive Mapping and Spatial Behavior, (1973), Aldine Publishing Company

31 It has for example been proven that our brain is capable of generating mental images based on sound (Stockburger, p.191). Although sound on its own has its limitations when it comes to mediating large amounts of information, it's still a medium capable of serving as a foundation for generating a cognitive map. Many role playing games apply different music themes at different locations to underscore the feeling of a different place. One could argue that once the player starts to associate a piece of music with a certain place, this piece of music has become a part of his cognitive map. That is however a different topic as our goal here is to analyze the visual navigation.

32 GRIGGS, S. A. Orientating Visitors Within a Thematic Display, 1983, International Journal of Museum Management and Curatorship. British Museum - Department of Public Services

through any other media. As a result there is almost always a difference between the current form of a space and the way it is stored in our cognitive map. Erik Champion seems to support this theory by arguing that cognitive maps are highly individual. "The way we access these cognitive maps is typically not just via quantitative estimates and measurements but also in a relation to personal attachments and perceptions" (Champion, p. 7).[33] People's actions in a space are always based on their subjective view of this space. No matter what the flaws and imperfections of a cognitive map are, they are always serving as a basis for our spatial behavior. They are strictly egocentric devices.
During cognitive mapping people do not perceive their visible space as a combination of separate objects but rather as one entity. The way this entity is seen and stored depends on the individual. Cross cultural differences between individuals have been proven to have a great influence over the way spatial information is coded (Montello, p.2).[34] The specific task that an individual conducts within a space has also significant effect on the form of its cognitive map. A cognitive map of a taxi driver driving in a well known city will obviously be different than of someone used to walk.

Cognitive mapping leads to establishment of a cognitive map in virtual spaces as well. Just like in real world, a fully developed cognitive map of an environment is however not always required for successful navigation. Route knowledge can be sufficient for simple navigational tasks. In addition, most games contains some form of navigational element, such as a cartographic map, helping the player to navigate without a fully developed cognitive map. There is however no doubt that some games reward a player who has a fully developed cognitive map of the game space. Particularly in many 3D multiplayer games, where the victory is determined by speed and quick reflexes, a player who is forced to follow a classic cartographic map instead of focusing on the actual space is at a significant disadvantage.
In games which take place in a vast space with high layout complexity, to evade geographic disorientation, the player has to orientate using a map. Having to constantly rely on these aid tools could however degrade the enjoyment of the game. It is therefore feasible to say that these games should strive to make the user develop a cognitive map at least of the most important areas. There are several ways how to speed up this process. In a search of an example from a video game space, we can once again turn to the game *Mafia* (2002). During one of the first missions in the game, the player works as a taxi driver and is supposed to drive customers to a variety of important locations across the vast city. During this task, the player is provided with a map. While studying this map supplies the player with secondary survey knowledge, the actual driving through the space is a

33 CHAMPION, Erik, Place, Space & Monkey Brains: Cognitive Mapping in Games and Other Media, 2005, DiGRA
34 MONTELLO, Daniel. How Significant Are Cultural Differences in Spatial Cognition?, 1995, University of California

source for primary survey knowledge. Albeit this first mission might seem as a bit boring, it has a clear purpose – to prepare the player for upcoming, more complex and challenging driving missions taking place in the vast city space.

Even once a cognitive map of a space has been fully developed, in a dynamic and changing space, it can never keep up with all the changes taking place and reach a stage of perfection. Through cognitive mapping it will however be constantly updated and remain as close as possible to the space it depicts. Once developed, a cognitive map is the ultimate tool for wayfinding.

3.6 Constraints and affordance

Although the orientation in space and various tools that are helping us with it all function on the same basis in both virtual and real spaces, we have to keep in mind that video game is a medium and as such it is expected to mediate an experience, such as a story, providing some context and sense to the actions a player is supposed to conduct. In order to accomplish this goal, a videogame has to maintain at least some level of control over the players actions. Video games can never let the player navigate entirely freely. The space is never completely accessible. This means that in video games, not only do we navigate in space but the space also has to some degree navigate us.

This process can get rather complicated. As previously mentioned, one of the key aspects of gameplay is to make the players feel that they can perform all the actions they find sensible and navigate the way they would expect. Any limitations that a game imposes on the player should therefore preferably go unnoticed by the player. This is generally achieved through the application of two strategies when designing a video game space.

- **Constraints:** Sometimes it is required to limit the set of possible actions the individual can take. By blocking access to parts of the space, we can for example alter the navigation of the individual in a desirable way. These so called constraints are also making sure the individual wont navigate into areas that should stay hidden for him.

  The video game *Grand Theft Auto: Vice City* (2002) takes place in a large urban landscape of the fictional Vice City. In the beginning of the game, the player is located on a small island, which is connected with the rest of the city through a single bridge. The player is allowed to move freely through the landscape in order to complete a number of quests. The story of the video game however requires the quests to be completed in a certain order.

  This presents a problem since forcing the player to complete quests in a predetermined order would severely limit his freedom of experiencing the world.

The game designers came up with a creative way how to solve this problem through a constraint. They placed large signs saying “under reconstruction” on the bridge between the island and the mainland and barricaded it with roadblocks and various working equipment. This forced the player to stay on the island where quests related to the beginning of the story were located. Once these quests were completed, the reconstruction of the bridge *finished*, opening it up and allowing the player to proceed to the rest of the city.

The roadblocks and signs fitted the game environment very well and were thus perceived as a natural part of the world. This fact makes it a great example of how a constraint should be implemented into the environment in a seamless way so that the immersion wont be distorted. As we shall see, constraints in various forms, are very common in video game environments.

- **Affordance** offers clues on how to behave by sending a signal to the player to perform a certain action. A chair in a waiting room is for example a signal that we should sit down to make the waiting easier. Its function is therefore similar to the one of constraints as its main purpose is preventing the individual from committing an undesirable action. However where constraints are making it impossible to take *wrong* action, and thus forcing the player to navigate *the right way*, affordance is rather trying to show the player how to navigate by relying on his common sense instead of imposing any restrictions.

  An example can be seen in the vast fairytale worlds of role playing games such as *Oblivion* (2006) or *Skyrim* (2011). While these worlds are fully accessible for the players movement, affordance elements are implemented in a way making the player aware of where to navigate. It is for example logical that roads are connecting major cities. If the player finds himself lost and needs to get into a city, common sense tells him that it's wiser to follow a road rather than traveling through woods.

  Designing such vast fantasy sandbox games poses a challenge to the game designers. Not only is the game space completely open, allowing the player to move anywhere, but initially as the player enters the fictional virtual world for the first time, it is completely unknown to him and the correct wayfinding usually requires some landmarks to make it easier to orientate. In such cases, landmarks can be used as elements of affordance to guide the players navigation as well as shape the narration of the story. Particularly noticeable landmarks can indicate to the player that they are important and make him want to explore them closer and thus a skillfully placed landmark can guide the players first steps in the game space. For example at the start of the fantasy role playing game *Gothic* (2001) the player finds himself in the middle of a fairytale landscape with the only quest consisting in delivering a letter to a mysterious person, without knowing where this person should be found. Not far from the starting point the player spots a large castle at the horizon. When approaching this castle in order to explore it more closely, the player meets other characters from which he or she learns more about the quest and receives new instructions. This castle is not just a landmark but also serves as an element that should attract the player to a desired location in the game space. It's a clever way of how to establish a story and control gameplay without interfering with the players freedom of movement, which exemplifies sandbox games. By constantly offering logical actions to perform, affordance elements are making sure that even in large scale virtual environments users won't get lost or reach a situation where they don't know what to do next.

3.7 Conclusion

Landmarks, cartographic maps and cognitive maps all play an essential role in different situations of human spatial orientation and wayfinding. Based on the examples stated throughout this chapter, it can be concluded that navigation in virtual environments is based on the same fundamental rules as navigation in real spaces and the first part of the stated hypothesis is thus correct. We gain spatial information the same way – mainly through our sight. We use maps to support orientation, landmarks to determine our position and a string of landmarks to memorize a route. This process of memorizing landmarks and other well visible and memorable objects in an individuals surrounding is the first step towards learning how to navigate through an environment without any aid tools. This is the most realistic and immersive way of experiencing a virtual world and just like in the real world, some spaces may require that the player develops a cognitive map. Based on the research stated in this chapter, it is however also necessary to keep in mind that an interactive virtual space is not a mere copy of the reality.

Firstly, this is partially due to the inability of a virtual space to support all of the navigational cues that we are used to rely on from our daily life. Furthermore according to a number of studies, some of the cues that are supported such as monocular depth cues appears to be less effective in virtual spaces. One research by Simon Goerger suggests that people are worse at estimating distances in virtual space (Goerger, pp. 6-7).[35] These limitations make implementation of elements supporting wayfinding more complicated in virtual spaces than in the real world. In order to overcome these limitations, navigational elements such as effective maps and well designed landmarks become

35 GOERGER, S. R. Spatial Knowledge Acquisition From Maps and Virtual Environments in Complex Architectural Spaces, 1998

crucial. It's thus possible to conclude that the strategies chosen to design these elements are of a greater importance in a virtual world, than in real environments.

Secondly, unlike a real environment, a game also needs to establish gameplay. This means that players must have freedom to conduct those actions that they feel would take them closer to a goal. At the same time there must also be some context to the players actions giving them sense. This is achieved by a set of constraints and through the use of affordance making the player navigate in a way that allows for the development of a story or other context. Not even if these criteria are met will a video game have successfully established gameplay. For that to happen, video game space and subsequently the way we navigate through it must also hold some degree of challenge.

4. COMPARATIVE ANALYSIS

In order to find out how this challenge of navigation is achieved, two video games shall be examined.

Aliens versus Predator (1999) gives the player an option to play as one of three different characters, each with it's own set of unique abilities, such as different vision or speed of movement. By studying this game, we should be able to learn more about the impact of these abilities on navigation and subsequently the gameplay. Furthermore, throughout the game the player is conducting missions in a wide variety of different environments with different sets of landmarks and navigational aid tools resulting in different difficulties of orientation. Finding out when and how these difficulties are increased should provide us with an explanation to the twofold role of navigation in video games.

Fahrenheit (2005) on the other hand is set in contemporary New York and thus depicts real spaces. Furthermore, the interactive spaces in the game are accessible and holds all of the elements needed for easy orientation, yet the navigational tasks are often challenging. By examining these navigational tasks, we should be able to pinpoint the source of challenge. Additionally, throughout the course of the game, the player is given many different ways how to interact with the game space and the ability of spatial navigation is not always present. Besides examination of the elements generating challenge in navigation, Fahrenheit thus also gives us the opportunity to examine the role of spatial navigation in gameplay.

4.1 Study I: Aliens versus Predator

The term *first person shooter* (or simply FPS) refers to a genre of video games exemplified by the fact that the player experiences all in-game actions through the eyes of the played character. While moving through a 3D space equipped with various ranged weapons, the only visible elements besides the game space are usually the hands of the character, eventually carrying the equipped weapon, and a Head up Display (HUD) usually displaying information such as the characters health or ammunition in one corner of the screen. Primary gameplay feature consists in fast paced firefight usually with ranged weapons, such as guns, hence the name *shooter*.

Even though there were games displaying a space through the field of view of a character since the beginning of 80's, it took into the 90's and the breakthrough of 3D spaces, before these games achieved a real mainstream standard.

The start of this boom is usually attributed to *Wolfenstein 3D*, released in 1992, which set the standard and served as a model for many of the upcoming FPS games. Other notable pioneers of the genre were *Doom* (1993) and *Half Life* (1998). Although these two games (especially the latter one) presented some new ideas, particularly when it came to innovative problem solving and scripted in-game narrative, the core concept of the way the player moved and interacted with the 3D space remained the same. This lack of innovation can be illustrated with the fact that during the 90's fps games were generally referred to as *Doom clones*. Almost all progress between the released games in the genre focused on improving the technical aspect in order to depict a more realistically looking environment.

The release of *Aliens vs Predator* (commonly referred to by its abbreviation *AvP*) was therefore hailed as a much welcomed break from the formula. Critics often went as far as calling it "...an incredibly refreshing game in a genre flooded with clones and remakes that are hardly worth the shelf space they occupy."[36]

What puts this science fiction themed first person shooter, developed by the British studio Rebellion, apart from the competition was the fact that it attempted to completely change the way we perceive and move through space.

AvP takes place in various locations in the outer space. The player is given the choice to play as either one of three completely different species: human, alien or predator. What distinguishes these characters is the way they see and move through space. Albeit these differences may seem as subtle, as we shall see, they have a decisive impact on the overall game. "The most stunning achievement in AvP is that it allows for three totally separate styles of gameplay."[37] The different models of spatial navigation make this game ideal for studying their impact on gameplay.

When launching a new game from the main menu, we can freely choose which of the three species we want to start playing as. The order in which we chose to play the species doesn't matter, as they all have a unique game space designed around their abilities and their stories are not directly related. A closer look at the abilities of every character and how they are used during the game will help us understand more about the role of visual navigation in gameplay.

4.1.1 Human

The human, or *marine* as the character is called in the game, lacks some extraordinary physical capabilities of the other two species. His speed of motion is relatively low. Furthermore, his vision in the dark is bad. He makes however up for those weaknesses through use of various technological

36 IGN [online]. 1999, June 11, <http://pc.ign.com/articles/153/153952p1.html>

37 IGN [online]. 1999, June 11, <http://pc.ign.com/articles/153/153952p1.html>

tools. He has for example the largest variety of weapons at his disposal and he is able to attack from distance. When playing as the marine the HUD doesn't just display the usual health and ammunition information, but also a sort of radar located at the bottom left of the monitor. This device is displaying enemies up to 30 meters away in the form of blinking dots and their current distance from the player.

The marine starts out in a room of what appears to be a large abandoned space station. Through the speakers mounted on the walls he hears a voice ordering immediate evacuation due to an alien intrusion. This is essentially the first objective – to evacuate. It's in essence a navigational task. Throughout the game there is not much story mediated through cut scenes or any other means that would introduce us to the missions. Instead almost all of the context, providing some atmosphere and giving some meaning to the players actions, is generated through the space.

At the start we're introduced to an almost claustrophobic environment consisting of futuristic looking corridors. The game space is in essence a labyrinth consisting of corridors and tunnels. Almost everything in the game world is very gray or brown. Most of the space has very low differentiation. The surrounding is significantly dark with most of the space completely covered in darkness. Only a few light-bulbs and digital displays are flashing and providing some weak gleams of light at various places along the corridors. To make bad things worst, we don't have access to any form of a map with information about the space. Besides providing challenge, all of these factors are also helping to establish a sci-fi horror atmosphere. This feeling is additionally supported by the fact that in darkness without almost any of the visual cues, navigation becomes impossible. Luckily, the marine is equipped with an *image intensifier*. When the image intensifier is activated, the surrounding is displayed in a shaded green color with improved vision in darkness. This comes however at the cost of the radar, which vanishes, since only one of these tools can be used at the same time.

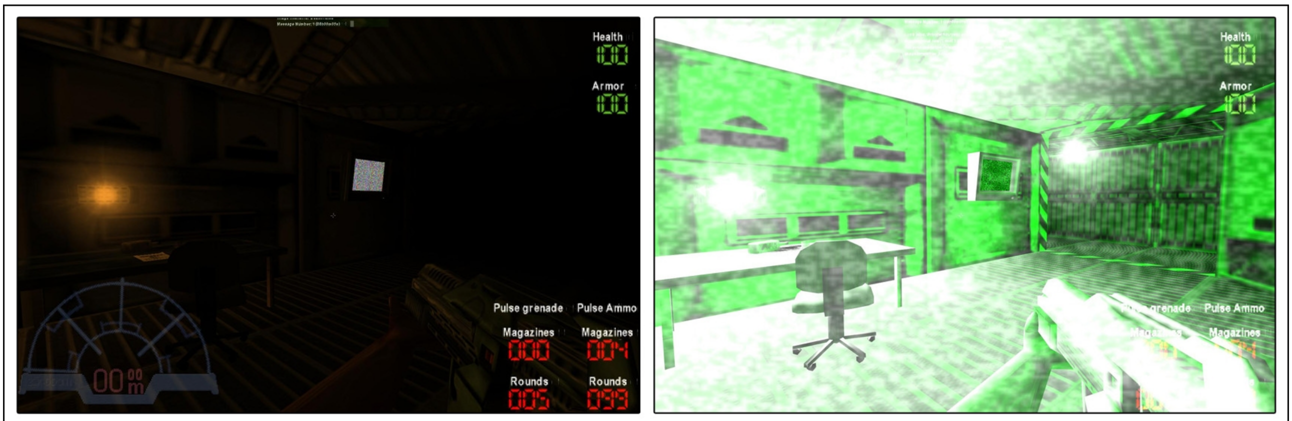

Image 4.1.1a The space, as seen when it's presented to the player at the beginning

of the game, is dark and provides very little visible information and hints regarding where to navigate. The image to the right shows the same view, but this time with the image intensifier applied. The space is now better visible however at the cost of loss of the radar.

The radar has however more uses than just warning us about enemies in our surrounding. Since the enemies are usually static (unless we navigate into their immediate surrounding and they attack us) they can serve as a kind of reference points, supporting our orientation. Especially in dark areas where it might be hard to determine how much we've turned and how far we've walked, the radar is a useful tool for orientation.

If we however choose to use the image intensifier instead, orientation in space will be easier, but on the other hand the player will have to worry for getting attacked around every corner. Perhaps the best strategy is therefore to have the radar turned on wherever possible and move from one light source to another. The designers of the game space obviously thought about this strategy, and the position of lights in the game space is not as random as it may appear. Following them will get us moving to the correct direction towards the goal of the mission.

Merely following lights is however not enough when moving through the level and will sometime lead into a dead end. That is where affordance comes in. An exit sign above a door can for example bee perceived as a sign of the correct way to go during the evacuation mission. Buttons on the wall are inviting us to press them, which will lead to opening of hidden doors and paths. Occasionally we may run into a trail of blood leading through a tunnel, once again indicating where to go. This use of affordance makes it possible for the game space to give us hints and guide us through the game without interfering with the game space through text messages or other elements which are not part of the space.

Image 4.1.1b Buttons on the walls, exit signs and a trail of blood can all serve as spatial elements helping us to navigate through the environment.

Non the less at some places, where the corridors become too monotonous, the space appears to be designed to give us geographical disorientation. In these areas we often end up walking in circles, which can get frustrating and potentially worsen the gameplay experience. Fittingly these areas are often traversed by different hostile aliens. Once killed, the alien corpses remain lying at the floor forming what could be described as a landmark or at least a reference point. As a result when running into an alien body, we immediately know that we've already been here. Together with the surrounding features such as a corner, these locations can help us build a route knowledge, which will eventually help us find the right way.

4.1.2 Alien

Alien is the fastest of the playable characters. It is capable of jumping across large distances and climbing across all surfaces, even over walls and the ceiling, which makes a huge advantage. When playing as the alien the screen is distorted to give a much wider field of view than the other characters, making it possible to see not only what's ahead but also what is happening to the left and right sides. Moreover, the alien has better vision in darkness than the marine and all enemies are displayed with a glowing blue aura around them making them easier to see. At the beginning of the alien game, the player starts inside a tomb-like cave. A brief text message informs him that the alien temple has been violated and that he must eliminate the intruder and seal the temple off.

Unlike the human who navigates towards a certain location in space, the alien is tasked to find and destroy a living target moving through the game space. Where the human is tasked to survive and evacuate, the mission of the alien is to hunt. This atmosphere of hunting is reinforced by numerous factors. Primarily by the speed of motion with which the alien is moving through space, making it impossible for his prey to escape in combat. Furthermore, moving on walls enables the player to silently position himself above the prey and unexpectedly attack from the ceiling.

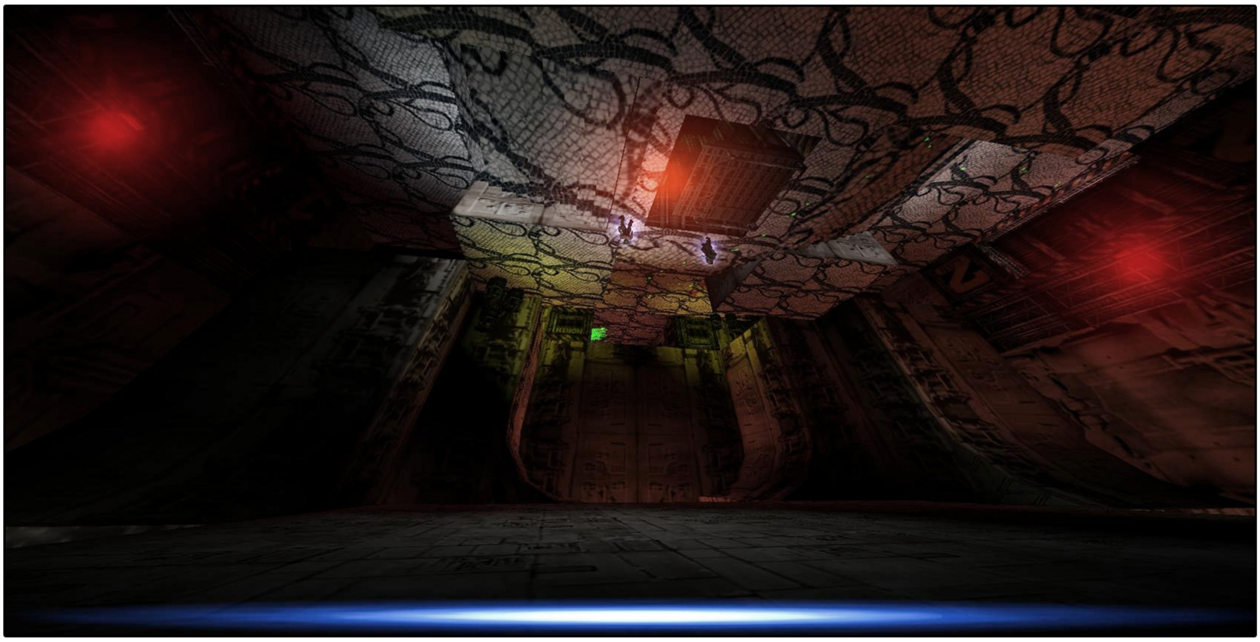

Image 4.1.2a Upside down image as seen when the alien is moving on the ceiling to position himself above his prey – the two marines highlighted in blue aura at the floor.

These navigational abilities come however at a cost. The high speed of movement is making it hard to store any rout knowledge, not to mention developing a cognitive map of the space. In addition the fact that the alien moves over walls and ceilings makes it often hard to orientate or even to determine what is up and what is down. Geographical disorientation occurs frequently and the alien can get lost or find himself walking in circles even more often than the human. In some cases it is possible to randomly move through the space without any real wayfinding and hope that sooner or later the player simply runs into his target. This is however not always the case. During the first mission, the alien is presented with a large gate which is sealed by a stream of fire and therefore impossible to walk through without dying. A text message tells the player that the power generator of the fire must be shut down in order to unlock the gate. This generator is however placed relatively far away and once located and deactivated, the player has to find his way back to the gate. By forcing the player to return to a place, the game makes it required to remember the chosen route. This is no easy task, since an entrance into a tunnel or a door leading the alien further through the futuristic landscape might be located high up on a wall or even a ceiling. In order to overcome these difficulties, the alien is forced to focus on the entire space in his search for his next move. This is making the use of affordance much more difficult than when playing as a human. Luckily, the space the alien navigates through is provided with some excellent landmarks. The gate with a stream of fire described above, large statues or a wide window with spaceships outside are all excellent objects standing out from the otherwise gray and monotonous environment. This makes it possible to develop a route knowledge and successfully conduct the given tasks.

Image 4.1.2b Unlike the human, alien has to focus on the entire space in search of a way to go. The ring highlights an entrance to a tunnel high up in the wall. Luckily landmarks such as the stream of fire seen to the left are making most of the places memorable and remembering a route is made easier.

4.1.3 Predator

If the human's gameplay consisted in getting away and the alien focused on hunting, the predator is somewhere in between those two extremes. He is equipped with the most powerful weapons of all the species. But also has the ability to become invisible and thus hide himself from all enemies. He is also the only of the character capable of healing himself, making him more likely to survive in a space full of enemies. His survivor chances are further increased through his durability, in particular his ability to survive falls from large heights. The alien HUD displays health and energy in two stylized bars at the left and right sides of the screen. Energy is probably the only big weakness of the predator, since using his abilities, such as invisibility, uses energy as fuel and once the energy drops down to zero, the predator becomes incapable of performing most of his actions and thus pretty much lost.

The predators vision has one normal and three additional modes. All function essentially in the same way by making the space visible even through complete darkness and in addition each one of these modes highlights enemies of one of the three species, making them easier to spot.

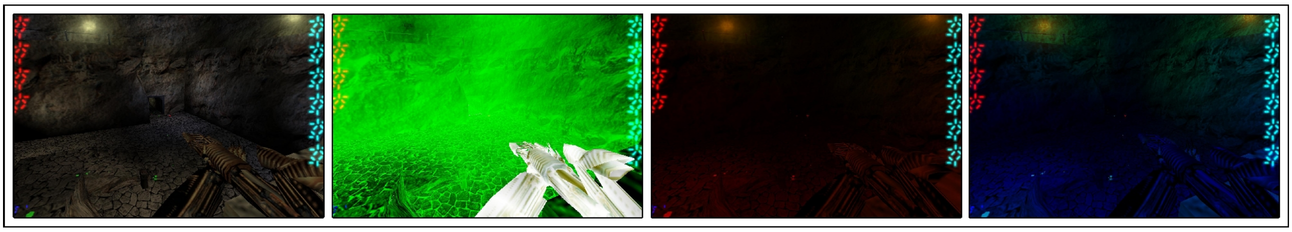

Image 4.1.3a Predator's vision modes. The first one from the left is the normal mode, which displays everything the way it looks. The second mode highlights all predators, the third one is made for finding aliens and finally the fourth one highlights humans.

Unlike the human and alien missions, the predator's first task starts in a large and relatively open space. He is tasked to infiltrate a military base held by a large number of marines. The space has high visual access making the entrance of the base well visible from the starting point. The predator almost never has to look for which way to go, since the correct way forward is always apparent from the space.

The challenge consists of two key features. First of, many paths are blocked by enemy marines, making it very hard to get past them without dying. The ability to become invisible is only partially a solution since it drains energy and it can therefore only be applied for short amounts of time. Fortunately when playing as the predator, the player is given the power to zoom in the screen to better see into the distance. In combination with the predators vision mode highlighting all humans, it is easy to detect groups of enemy at far distances and activate the invisibility only when necessary. Using this strategy makes it possible to get past large mobs of marines without getting killed.

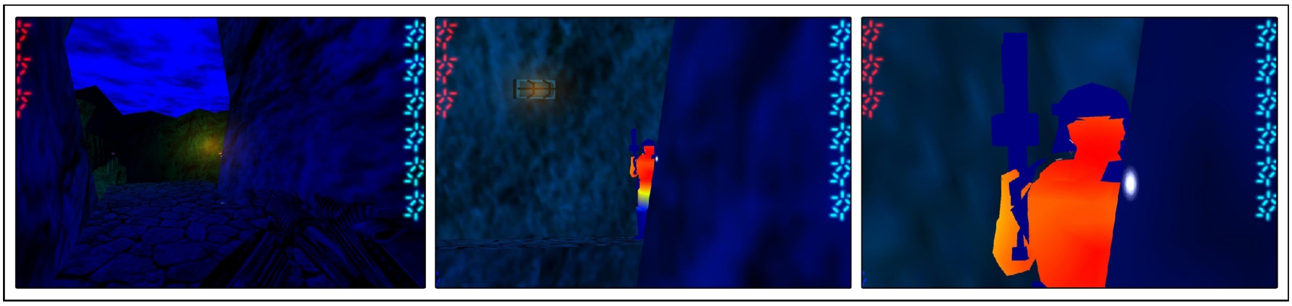

Image 4.1.3b The images above displays three different levels of zoom. Thanks to this ability, all enemies can bee detected in time to activate the invisibility.

Secondly, some of the doors that lead further into the base are locked. This is where affordance once again comes in. Throughout the game space shining buttons can be found at various places. Thanks to their design the player immediately understands that he's supposed to press them, despite the lack of any instruction to do so. After pressing one of these buttons, a text message usually comes up telling the player that a door has been unlocked. Once the player finds a locked door. Since these two objects are usually not at the same place, the challenge consists in finding the corresponding button. Once again, the improved vision, making it possible to see clearly at large distances, makes this task feasible.

4.1.4 Conclusion

The most obvious factor making the game challenging is that all of the species are placed into an unfamiliar space without a map or any other information about the environment. Rather they all have to rely on visual information they gain when navigating through the space. Although all objectives have some kind of context to them, the main goal and all of the sub-goals always consists in figuring out how to get from one place to another.

AvP is however not a sandbox game, meaning we're not given the freedom to navigate wherever we want without restrictions. In fact, especially in the case of the human, there are constraints in the form of corridors and tunnels almost everywhere, giving us few options where to navigate. We're progressing through a labyrinth of corridors with relatively few crossroads and thus without having to make many decisions regarding which way to go. Non the less there are a few dead ends and in the mostly monotonous surroundings it's not hard to get lost or walk in circles. At the same time it's important to note that the game is doing everything to make the spatial restrictions seem natural and support or even create the atmosphere of the game, making the player feel his actions are important and in that way supports gameplay.

The solution to the challenging navigation is generally provided either through the navigational capabilities of the character, mostly through different modes of vision or through objects placed in the game space, such as affordance or landmarks.

To sum it up, AvP gives us three completely distinct characters to play with. All of their tasks can be seen as essentially navigational. The way they navigate is however sometimes radically different. The same thing can however also be said about the space they move through. Every character is given a space that is designed to support his speciffic navigational capabilities. This means that AvP clearly demonstrates the case where the space and subsequently the navigation through it is both a source of challenge and support required to overcome this challenge at the same time.

4.2 Study II: Fahrenheit

A french video game designer named David Cage once said that there are two different categories of video games. Firstly, video games can be seen as toys or simply as devices that keep us entertained. On the other hand, video games, and interactivity in general, can also be seen as a form of art or at least as an artistic platform. The difference between those two groups is that video games falling under the second category do not primarily seek to entertain its user but mediate emotions even in the case that these emotions do not represent entertainment.[38]

The video game Fahrenheit can be seen as a peak of David Cage's attempt to create this kind of an *artistic* video game. It's therefore perhaps not so surprising that after it's release in 2005, Fahrenheit generated significant noise in the media and among gamers. One reason was that the game didn't really fall under any particular genre. David Cage further fueled this publicity by declaring that Fahrenheit is in fact not a video game at all. Instead he preferred to label it as *interactive movie*. As we shall see, the means by which a player navigates in the game space is key in understanding what makes the gameplay of Fahrenheit so much different from other games.

4.2.1 A new movie

The first thing that catches our attention after launching Fahrenheit is the fact that instead of the usual *new game* button, the main menu is equipped with a button titled s*tart a new movie*. As we quickly discover, this label is actually quite appropriate. Once pressed, there's indeed a movie that starts playing on the screen.

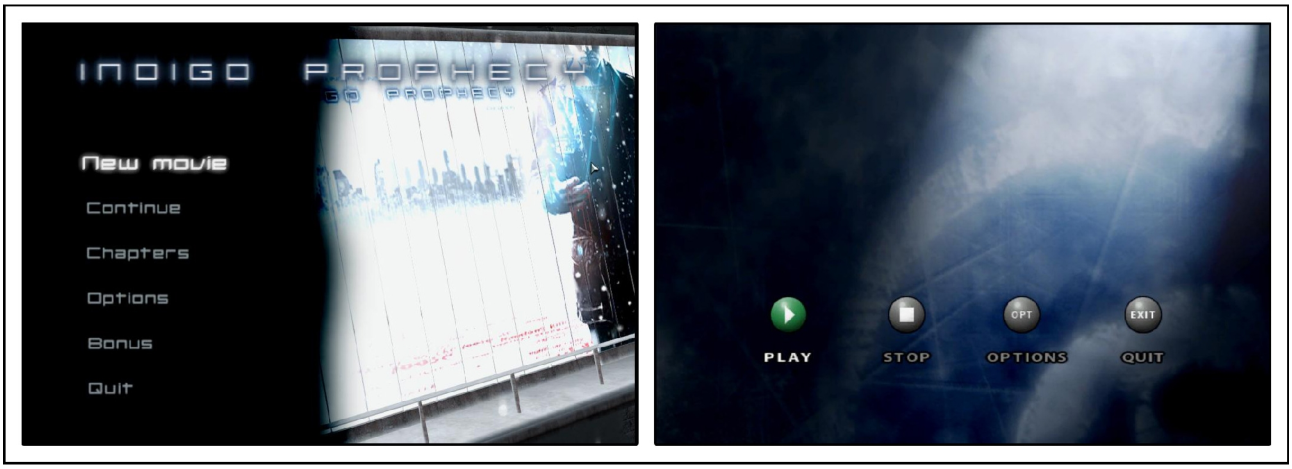

Image 4.2.1a The main menu displayed to the left offers us a new movie. Once the movie starts, we can pause it with the escape button, and the sub-menu seen on the

38Co.create [online]. 2012, February 7, <http://www.fastcocreate.com/1679014/heavy-rain-creator-david-cage-reveals-the-secrets-of-his-photo-realistic-serial-killer-ps3-g>

right side appears. It is stylized more like something we're used to from a DVD movie rather than a game.

The first scenes takes us to a late winter evening in New York. The last guests of a small restaurant are finishing their meals and preparing to go home. The sound of chatter and the tapping of forks and knives against plates slowly fades into distance as the camera moves away from the tables and into the back of the restaurant. Creepy music starts to play, indicating that something is not right. The camera moves-on and takes us to the restaurant bathrooms. Locked in one of the bathroom stalls is a man covered with blood. He's seemingly in some kind of a trans. In one hand he is holding a knife and uses it to cut out bizarre symbols into his other hand. In that moment one of the restaurant guests enters the bathrooms. Without any warning, the blood-covered man throws himself over the guest and stabs him to death with his knife. And then suddenly he seems to regain consciousness. He's disoriented and chaotically fumbles around in the room. Once he spots the dead body of his victim, he realizes what has just happened. He drops his knife and starts to panic.
And it is in this very moment that the movie becomes interactive. At first it's quite difficult to spot this transition and understand that we have suddenly been given control over the character in the movie. Once we press the arrow keys on the computer keyboard however, we discover that we now control the movement of the mysterious murderer and it's thus up to us to solve his awkward situation.
One thing that contributes to the overall cinematic atmosphere is the stunning fact that the screen doesn't contain any kind of interface at all. In terms of visual navigation, this can be seen as a problem. Unlike in Aliens vs Predator where the HUD was supplying the player with some basic information helping him to make his choices, in Fahrenheit the *interactive movie* simply takes up the entire screen. The player thus has to figure out what to do solely based on watching the game space. If we however make the main character walk over to a certain spot or object in the space, a number of options appear at the bottom or the top of the screen stylized as movie subtitles. All of the objects triggering these subtitle-like options are based on affordance so that the player can figure out what to interact with in a space using his common sense. For example when standing over the dead body in the bathrooms, we are given the option to let the murderer hide the dead body. When walking to the sink, we get the option to make the murderer wash away the blood of his hands or attempt to hide the knife. Through picking one of the displayed subtitles, we affect the actions of the character. Once the player makes his choice or just walks away from the given object, the subtitles disappear.

Image 4.2.1b In the first interactive scene of the movie, the player finds himself in control of the murderer who is in the bathrooms with the body of his victim. By choosing from different options, we can let the character perform actions such as hide the body int one of the stalls or attempt to erase the blood traces.

Not choosing any of the offered options is a choice of its own. After a minute or so spent in the bathrooms watching and eventually interacting with the actions of the murderer, the screen is split into two halfs. While one half continues to view the main character which we control, the other half displays a police officer in the restaurant who finishes a cup of coffee and then slowly starts to walk to the rear part of the restaurant towards the bathrooms. Unless we make any choice before the officer walks into the room, the character will be arrested and the story comes to an end.

The challenge thus consists in making the character get away before the police officer discovers what has happened. The introductory movie sequence, described above, provides the player with a basic secondary survey knowledge about the space of the restaurant. Furthermore, the restaurant is fairly small, with low layout complexity. Once we exit the bathrooms, the main room of the restaurant has high visual access, with the exit door clearly visible. This makes it easy to figure out where to go. The wayfinding on it's own does therefore not present a challenge. The challenge is instead generated by the fact that the actions have to be conducted under time pressure.

Image 4.2.1c A split screen displays the character we control to the left while to the right we can simultaneously watch an unsuspecting police officer slowly making his way towards the bathrooms.

The method used to generate this time pressure deserves some attention as well. While other games are usually putting pressure on the player through the implementation of interface elements such as a count down clock displaying a clear time limit which the player must obey, Fahrenheit is different. The pressure forcing the player to act is created in a much more natural and subtle way, simply by letting him see an incoming threat. It's an elegant solution how to avoid unnecessary and immersion breaking elements of visual navigation in the form of an interface. Throughout the game, Fahrenheit is trying to avoid any unnecessary kind of navigational elements interfering with the space. Whereas AvP used text messages to inform the player about a door being locked or about his task, in Fahrenheit the objectives of the player are generated by a non interactive movie sequence and updated only through what happens in the game space once a level of interaction is offered. It's thus up to the player to figure out what to do and how to do it solely by watching the events unfold.

If we make the correct choices in the virtual reality, and navigate the murderer out of the restaurant without being caught, the game switches back to a non interactive movie in which we learn that the murderer is in fact a perfectly normal guy named Lucas Kane, a peaceful citizen of New York, who visited the local restaurant this evening to eat dinner. From then, he has no memory of what was happening until the moment he found himself standing over the body of his victim in the restaurant bathrooms. He believes that he has somehow been hypnotized and used to commit the murder. He is convinced that the police would never believe his story and therefore he decides to try to find out the truth himself so that he could prove his innocence.

A cut follows and the restaurant is displayed once again. The dead body has now been discovered and two detectives have arrived to investigate the crime scene. The movie quickly introduces them and then once again the player is allowed to control the movement of these characters during the investigation. While in charge of the movement of the detectives, they keep talking with each others. Through listening to their dialog the player learns that they need to find some evidence, such as the killer weapon. Despite the fact that the restaurant is fairly small and simple, finding a tiny object such as the knife hidden somewhere in the space would normally present a significant problem. While other games in similar situations usually equip the player with a map and/or an arrow showing the direction to the destination or some other type of navigational element, Fahrenheit once again solves this without them. Since it was the player that controlled the actions of Lucas during his escape, the player is well aware about the hiding place of the knife. Not only does the player have a cognitive map developed over the restaurant building after playing through it as

Lucas, he also remembers the choices he's done. This makes it possible while playing as the detectives to quickly navigate them to the correct place and find the weapon.
As a result the interactive sequences of Fahrenheit are constantly progressing forward. While playing as Lucas the nonstop flow is ensured by putting time pressure on the player. Once in charge of the detectives it is achieved by the fact that the player is aware of where to navigate based on prior experience. The game never comes to a halt waiting for the player to figure out his next move as the case is in many other games. All this contributes to the feeling that we're interacting with a movie rather than playing a game.
Someone could dismiss this game design as being too boring by letting the player search for something the player already knows where to find. Strange as it may sound, in Fahrenheit, this is not true. While the player navigates the detectives to the right spot to find the weapon, they are constantly talking with each others, giving away information about their background story as well as interesting details about the investigation. Meanwhile cinematic music is playing in the background, reflecting and adding to the atmosphere of the whole scene. The scene thus feels as watching an interesting movie. The fact alone that the story is split into different story-lines following the protagonists as well as the antagonists is itself more typical for movies rather than video games.
The whole story of Fahrenheit proceeds in this manner, switching back and forward between scenes with Lucas, who is trying to uncover the truth, and scenes with the detectives trying to catch him in the believe he's a dangerous criminal.

4.2.2 Different levels of interaction

In most of the scenes throughout the game, the player is given some control over the navigation and options to choose what the characters are supposed to do next. The level of control the player is given greatly varies from scene to scene.
One example of a scene where the player is given a lot of freedom of navigation comes few hours into the game. During a flashback scene, Lucas remembers an experience from his childhood when some of his friends were secretly playing hide an seek inside of a big hangar at a military airfield. Lucas however finds out that due to a fuel leek, the whole hangar is going to explode. In an attempt to save his friends, he is tasked to get into the hangar and find them in order to get them to safety before its too late. Once again the movie becomes interactive and it's up to the player to navigate Lucas through the space and make him find his friends. This is one of the few parts in Fahrenheit, when the player is given the freedom to freely navigate through a large space. Perhaps because of

that, it's also one of the very few scenes where the player is given access to a navigational aid tool in the form of a map of the area. The map is static and doesn't display much details besides the fence surrounding the hangar and a few buildings in the surroundings. These buildings however express enough diversity to serve as sufficient landmarks and in combination with the map, they enable successful orientation. The challenge of finding a way into the hangar is increased by guards regularly patrolling around it. The only way how to get past them is by waiting until they turn past the corner of the hangar and then run inside of the hangar. Since the guards are walking in cycles back and forwards, the player only have a few moments to get inside of the hangar before they reappear. This means that once again the player's navigation is put under time pressure without any countdown clock, but merely by what is going on in the space. Once inside of the hangar, the player must attempt to find all of his friends hiding inside. The map is no longer useful for this task since it's not displaying the location of any of his friends. Instead the player has to rely on affordance and look through the space for places that would be fitting for hiding, such as inside of a big plane standing in the hangar. The time for searching is limited as well. Unless Lucas manages to find all of his friends, after a while the game smoothly transforms into a non interactive movie showing Lucas running out of the hangar just in time before it explodes.

Image 4.2.2a The map used during the flashback scene is located in the top right corner of the screen. It's a simple plan of the military complex, with a red dot marking the place where the player is supposed to get. The current locations of all of the soldiers patrolling the space are also displayed.

But there are also scenes when our possibility to interact with the space through navigation are minimal. Roughly halfway through the story, the events take a slightly paranormal turn. In a scene taking place in Lucas's apartment during a late night, various furniture and other household objects suddenly comes to live and start to attack Lucas. Lucas has to evade the incoming attacks by conducting the correct navigational task. If a telephone comes flying through the air towards him, he has to duck. If the refrigerator comes rolling on the ground, he has to jump up and so on. The game wont however let the player control these navigational tasks by directly controlling the movement of the character. Instead the player has to quickly press a displayed combination of buttons on the keyboard. If the player is successful in this task, Lucas will successfully conduct the required navigational task. If the player fails to quickly press the displayed key combination enough many times, Lucas will eventually meet his end, murdered by his evil chair or some other nasty object. The scene will then restart and the player get's another chance. The level of interaction in this scene is reduced to simple button-mashing and the gameplay is severely limited.

Image 4.2.2b The circles seen in the first image from left corresponds to the arrow keys on the keyboard. If the player presses the correct arrow keys indicated by the circles (in this case two right arrow keys) fast enough, Lucas will manage to evade the sofa flying through the air towards him. If the player fails, Lucas will be hit and knocked into the wall.

A third level of interaction that deserves to be mentioned is when the player is given full control over the characters movement, however he's placed inside of a space that doesn't offer any challenge and through various constraints the player can't conduct any important actions. Throughout the story, we are given the option to control the various characters in their home. In one scene for example Lucas is in his flat and when navigating to different objects in the flat, the player is given options such as to let Lucas watch TV, listen to music or take a cup of tea. These navigational tasks lack any real challenge and have no real consequences in the story. In my opinion however these actions makes the character appear more human and thus it is made easier for the player to feel for them, which is important for the character drive story of Fahrenheit.

Image 4.2.2c During some scenes, when not much is happening, we can make the character conduct largely irrelevant tasks such as making them sit down on a chair or play various guitar themes.

4.2.3 Conclusion

Just like in the two restaurant scenes, throughout the story the game is often switching between scenes with extremely easy navigation, allowing more detailed story development, and other scenes offering more challenging tasks, where the player often is put under time pressure. Most of the time however, the player has so limited control over the characters choices and motion that any form of wayfinding is not required.

In scenes where the player is not given control over a character's movement, where the interaction is instead reduced to other simpler means, such as pressing displayed key combinations in the above described scene, the player has very little impact on the unfolding story. There are basically only two versions of how a scene like this can unfold: either the player is succesfull and Lucas survives and continues into the next scene, or he's not and Lucas dies.

One could argue that the same is the case during the airfield scene. Either the player is successful in getting into the hangar and saving his friends, or he's not. This point of view does however not take into account that during this scene, the player may control the characters navigation and the way the scene unfolds is therefore entirely determined by the player. Yes, the ending of the scene is either success or a failure, but everything that happens until then is in the hands of the player. There are uncountable way's in which this scene can unfold. The player may for example get lost or take a different path into the hangar.

Judging by the scenes where the player is not given control over movement of a character, David Cage could very much have been right when he denied that Fahrenheit is a video game. A multitude of possibilities of what to do in a space to achieve a goal is what constitutes the backbone of gameplay and makes a game into a game. The fact that removing or severely limiting navigation blurres the line between a video game and a movie is another proof of the importance navigation plays in video games as a media platform.

5. CONCLUSION AND FINAL THOUGHTS

Based on extensive study of academic literature it is feasible to conclude that navigational elements necessary for wayfinding can be successfully implemented into a video game space. Nevertheless, this implementation has to take into consideration some significant limitations that a virtual space poses. The immense amount of information that we use for our spatial orientation and wayfinding in a real environment cannot be fully recreated in a virtual space through the technology of today. This limitation has to be made up for by an increase of quality of the navigational elements in virtual spaces. Through smart use of highly distinctive landmarks and tools such as maps displaying our current position, video games have managed to supply their players with enough information to make wayfinding just as possible as it is in a real space.

Video game is a medium and navigating through its spaces is one of the most natural ways of interacting with it. Unlike the reality, navigation in a video game space is thus a part of a mediated experience. This makes the game space, and the way the player is made to navigate through it, into a powerful factor when it comes to shaping this mediated experience. Dark unfamiliar claustrophobic corridors, which force the player to move from light to light, are for example instantly generating a horror feeling of being hunted. By giving the player the ability to move through the space at high speed and see in the dark, a game can on the other hand make the player feel like a hunter.

Navigation does not only contribute to the atmosphere and context of the player performed actions but the way a space requires to be navigated through is also expected to generate challenge. Many complex video games task the player to conduct a broad spectrum of navigational tasks. Not all of them are however supposed to be challenging. As found in the examined video games, the required difficulty of navigation is dynamic. In some cases the mediated experience require us to fumble around in a search of a way to go or even to reach a state of geographical disorientation. At other occasions, the navigation is required to be primitive so that we can instead focus on other things, such as a dialog developing the story. Navigation and especially its wayfinding component adapts to different situations to be either challenging or simple.

Through analyzing the two video games, I have found two broad categories of approaches through which navigation is made challenging.

- **Through spatial factors:** In some situations, the game requires the player to feel lost and making it hard to figure out the right way to go. This challenge can be achieved by introducing the player to an unknown space without any map or other information about the space. Locked doors, bad light conditions in the space or low visual access in combination with high layout complexity can also contribute to the challenge.

- **Through external factors:** Challenge presented by moving through space does not have to lay in the space itself. Sometimes it is required that the goal of our navigation is clear and that the player knows exactly how to get there. In such cases it is desirable that the navigational task will be made challenging through specific conditions presented by the game objective. A typical example is putting the player under time pressure through various means such as a need to navigate away from a crime scene before police arrives or running away from an attacking alien.

Both of these factors exist in the real world and it is no stretch to say that we experience some of their forms almost every day. Yet there is one fact that clearly distinguishes the challenge presented by navigation in video games and in reality.

The physician Stephen Hawking once said that one of the fundamental rules of our universe is that nothing is perfect since perfection does not exist.[39] The imperfection of navigation in real spaces can be experienced almost anywhere. In reality, if walking to a university lecture only to find the door to the classroom locked and the lecture cancelled, we will fail to accomplish our navigational goal regardless of how well developed our cognitive map is or if we've managed to successfully orientate. And in this lies the true difference between the real world and a video game. From the gameplay standpoint, the space through which we navigate in a video game must always be perfect. Unlike the reality where we can face impossible navigational problems, in all video games the gameplay requires that the player can achieve the given goal, that every challenge will have its solution. Technological progress might eventually make video games look completely photo-realistic and almost indistinguishable from real spaces but this one difference shall always persist. Once a video game presents us with a task that cannot be solved, it will seize to be a game.

It can therefore be concluded that although video game spaces are designed to generate challenge, paradoxically that does not have to mean that they are more challenging than real spaces. A video game is a medium fundamentally designed to mediate an experience revolving around solving a task and achieving the winning conditions. At the same time it has to generate some degree of challenge to make the players feel that they have accomplished something. While offering challenge, game space however also has to offer some clue on how the player should overcome it.

39 HAWKING, Stephen. [online]. Into the Universe with Stephen Hawking, 2010, Discovery Channel, <http://dsc.discovery.com/tv/stephen-hawking/>

Game spaces are always designed to give us something to solve the difficulties. Where the challenge consists in navigation, either through navigational capabilities of the character, by features of the space or various aid tools, all of the presented problems are always made solvable. In such cases, the way a video game makes us navigate through its spaces is not merely serving for wayfinding but can be used to enrich and develop the gameplay experience. Since moving through space is a vital part of interaction with virtual video game spaces, visual navigation is one of the main innovation factors of this medium.

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