CULT OF REAL-TIME IMAGE

UNDERSTANDING THE HARDCORE
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CULT OF REAL-TIME IMAGE – UNDERSTANDING THE HARDCORE

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“Was that CG[1] or real time? If it’s the latter, color me fucking impressed.”

– Gomu Gomu

First of all, I have to excuse myself for using such a coarse quote as an opening for this introduction, but everything that is discussed in the following pages just comes together so beautifully within it; it just has to be there.

In the history of man, it seems that every time when a new way of accomplishing things appears, i.e. technology, people tend to confront it with fear. In retrospect, it is often hilarious to look back at the ways in which people have had irrational fears in some point of history: photography, cinema, comic books, VHS and probably even fire if we go back far enough. People in general hate change, uncertainty and most of all, the unknown. As the old cliché goes, there is nothing else to fear but fear itself. However, I would say the real fear is that of people mongering it, in order to control others and to further their own agenda, be it politicians, advertisers, or the mass media at large. Damnant quodnon intelligunt – they condemn what they do not understand.

So real-time image (that is de facto video games) has been the new kid on the block for a while now. It has even gotten picked on today by people who simply do not understand the medium and are motivated by fear of the unknown. Granted, we can and should have a discussion over, for instance, torture-games\(^2\), whether they are good for the development of

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2 Like for instance *Manhunt 2* (Rockstar Games, 2007)
a child or not, but it is often forgotten that the medium itself is utterly
an amoral entity, a mere brush or a chisel for an artist to use according
their liking.

Indeed, using a medium, any medium, an artist can create enchantingly
beautiful pieces of art, or the most repelling and nauseating ones. Nev-
ertheless, a medium, like real-time image, does not inherently bear any
moral or ethical dimension: it just is. So in principle we can find beauty
from the said torture-simulator, even if we are otherwise disgusted by its
content. The beauty lies in the structure of the medium itself, which is
basically my whole thesis in a nutshell.

1.1 Goals
The main objective of this thesis is simply to paint a picture of a hypo-
thetic entity I call Cult of Real-time Image, and by doing that, to study
if one could make a case that such a thing in a certain sense actually
exists. It has to be stated that the notion of cult is being used here in a
lighthearted, socio-technical manner without any pejorative or negative
connotations that it may carry today\(^3\). In fact, this thesis is more of an
apologetic endeavor, or a celebration for the phenomenon that is under
scrutiny here – collective “hardcore”\(^4\) enthusiasm towards something
popularly known as video game graphics.

The secondary goal that compliments the first one is to indeed make
a coherent analysis of what makes real-time image such an unique and
subversive platform for creativity among visual mediums at large, and
consequently, an object of a cultish-like behavior and state of mind.

\(^3\) Richardson 1993, 348
\(^4\) See Chapter 2.1 Hardcore Viewership
1.2 Structure

First we are going to establish a notion of ideology governing one’s aesthetical experience when evaluating given artifact, be it an expensive wine, a historical church or a video game. Also, so-called hardcore viewership or mind-set is established at this point. I then propose that real-time image, and thus the Cult, stands on three ideological pillars that are

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Figure 1 Structure of the Cult of Real-time Image
real-time, simulation and definition, which all adhere to a logic of “the more, the better” in a hardcore mind-set.

Then we will explore each ideological pillar separately, some taking more scrutiny than others, like the critical concept of simulation that spans two chapters instead of one. The overall structure of the thesis aims to keep the journey from general towards specific and therefore the heavy technical discussions are pushed later on in the thesis, when possible. Consequently, Chapter 6, that deals with the concept of definition may appear as a mere bullet point list of real-time image features, but it is nevertheless vital for my argument as a whole.

Finally, in Chapter 7 we will take a look at how the hardcore viewership, the Cult, manifests itself through various artifacts and cultural conventions. Up to this point video games have been the vehicle of choice for analyzing real-time image and now we broaden that view to cover the instances that really instantiate the idea of Cult of Real-time Image in a lucid manner. Chapter 7 could be considered as a sort of payoff or a culmination for everything discussed prior.

Naturally the thesis ends with a recap, conclusions and ponderings of the future of research.

And even though this thesis speaks a great deal about video games, they are still treated as mere vehicles for the main subject that is real-time image. However, since video games are such a dominant instance of application of real-time image, the two notions are being often used out of convenience interchangeably through the thesis.

1.3 Regarding Computer Animation

It has to be stated that much of the issues that are dealt with in this thesis apply also to so-called computer animation, or CGI (Computer Animation).
Generated Imagery) as it is often referred to, which is the non-real-time counterpart of computer imagining. Examples of such are, for instance, films produced by Pixar.

Still, I would argue that the concepts (excluding the idea of real-time obviously) that coexist in both sides instantiate much more substantially in real-time imagery, than in CGI. This is especially true with the idea of simulation due to its playful and experimental nature, as we will learn later.

I love computer animation as well, and because of the lack of constrains caused by a demand of real-time, CGI is basically a window to the future of what can be realized somewhere down the line in real-time, as the hardware becomes more capable. However, in the end, computer animation is just another form of cinematography, even if a technologically sophisticated one, and as such, more of a carrier of the legacy of cinema than a creator of something genuinely novel.

As a final word about this introduction, I would like to add that the following inquiry is as much an academic endeavor, even if a modest but sincere one, as a personal, self-reflecting journey to a deeper more profound understanding of why I spent all those long hours in arcades during my youth, just observing games playing themselves. Or why I was always so excited as a kid to simply watch over my brother’s shoulder while he played some new Amiga 500 game in his room. Yet furthermore, why I still to this day keep on gasping at new developments happening in the realm of real-time imagery, over and over again.

For me, it has never been as much about playing the games, than watching, reading, dreaming and contemplating the real-time imagery that was in them, and this thesis is a pinnacle of that spirit, so far.
CHAPTER II

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IDEOLOGY AND VIEWERSHIP
believe it is rather safe to declare video games – de facto vehicle for real-time imagery – as the most prevalent platform for so-called *fanboyism*, which denotes according to Urbandictionary.com:

The collective outlook and behavior of a group of people concerning a subject (movies, games, hardware, comic book characters, etc.), which when challenged, results in an antagonistic, passionate and unreasoned response.¹

Indeed, fanboyism can be an inseparable part of the modern popular culture, as the definition above implies, but fanboyism, or fanaticism at large, is a universal phenomenon of such situations in which one has invested a relatively large amount of faith, trust, money, or any other resource into something one has chosen deliberately, or just by chance to keep in high regard. The object of that investment can be made of something concrete, like a gaming console or a certain brand of car, but it is rather safe to say the actual object of the emotional connection is the ideas behind the tactile object – what that object stands for. This is why we have expensive brands of clothing in the first place. The material corpus is a mere façade for the ideas it represents, which is the fundamental perspective to real-time image in this thesis.

Although the consumption of video games have become more mainstream and an ordinary form of occupation in recent years, the enthusiastic core, the *hardcore*, has remained, whose connections to video games could be described as pathological at its worst – or at its best, depending on the perspective. What is then the most relevant aspect of video games that evokes most of the heated discussions and opinions among

¹ http://www.urbandictionary.com/define.php?term=fanboyism
the hardcore audience? To get the answer to that question, it takes only a brief look at the online discussions dedicated to gaming to see that it is by far the visual side of the games, i.e. the graphics, as it is most often referred to. It is the real-time image in itself.

To summarize, there is something in the visual fabric of real-time image that fascinates certain people in a way that is perhaps a bit unorthodox to visual mediums in general – or any medium for that matter. I believe that peculiarity stems from the fact that the medium in question is everything but typical, meaning it can be genuinely appreciated only through the technological ideas that define and produce it, which makes real-time image in a way an unique representational entity among visual arts in general. Failing to grasp that can lead to miserable and unfair misconceptions about real-time image as a form of visual culture.

2.1 Hardcore Viewership

The old cliché goes that beauty lies in the eye of the beholder, and that might be true to an extent. However, I believe we can yet agree over some aesthetic assessments among ourselves, at least within a mutual cultural context. For instance, members of a wine society are for some reason able to find certain tastes mutually attractive, even though a matter of taste is considered otherwise highly subjective. So, in the case of a wine society, there definitely are certain ideological values, such as the vintage, the brewery and the location of raw materials that affect the wine tasting experience. In fact, there are a number of cases in which so-called wine tasting professionals have failed miserably in blind tests to differentiate the valuable wines from the cheaper ones.  

On that note, Aarne Kinnunen writes:

Aesthetic experience is linked to beliefs, knowledge and convictions. A universal worldview and tendency to the universal interpretation of the world are the ultimate requirements for such.³

So, besides to strive for a shared interpretation, what ultimately steers the aesthetic experience and governs our perception of things as a whole, are the philosophical presuppositions, i.e. beliefs and knowledge we are currently holding. Kinnunen continues with an example of a spectator of church,

[…] who thought he was looking at both artistically and historically genuine and valuable architectural monument. When that belief was refuted, aesthetic experience “vanished”.⁴

The example above illustrates exceptionally well the viewership in question and its logic when one is holding a certain kind of aesthetic value system. Kinnunen’s church spectator certainly qualifies as something I call a hardcore viewer, since he possessed

i. prior expertise (even if false) of the church and

ii. such a philosophical position that “genuine” and “historical” are aesthetically valuable features of the building.

Indeed, the spectator held such an outlook, an ideology, that the church was something he would appreciate, if it fulfilled the variables “genuine” and “historical” appropriately. To put it in other words, the spectator’s logic went roughly like the following: The more “genuine” and “historical” the building was, the more aesthetic pleasure the building provided for him.

³ Kinnunen 1969, 102 (translation mine)
⁴ ibid.
With using that kind of logic, aesthetic in a way enters the realm of comparisons and measurements, which is the very basis of the heated debates over real-time imagery in the online gaming forums mentioned earlier. It may sound silly that one can argue, basically, over beauty by using numbers and data, but that is how debates over visual quality of video games often unfold in the forums. For instance, there was a heated discussion over at notorious NeoGAF forums regarding video game *Alan Wake*’s resolution and its impact to the visual quality and aesthetic experience, even before the game was released. The burning issue was if *Alan Wake*’s resolution really was 960x540 pixels instead of speculated 1280x720 pixels. The NeoGaf discussion in hand portrays aptly the enthusiasm that only one aspect of the real-time image can provoke in people, and the whole debate was fueled by the mere idea of superiority of the higher amount of pixels on a screen.

Another illuminating NeoGaf–related discussion was, if dynamic shadows are more preferable than high quality textures in games, since real-time imagery is often about trade-offs. Some people stated that they were more into shadows while others into textures, by using variety of arguments, my favorite being the one found in the message #48 by alias Botolf:

> Great textures are meat and dynamic shadows are gravy. If you can do nothing else, eat that dinner dry.

To be engaged in such discussion, one has to have a rather high level of understanding about the logic of how real-time image works, since the arguments and assertions make otherwise little sense, just like in any expert field of knowledge.

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5 See Chapter 7.4 Online Discussions  
7 Smallest picture element on a screen.  
This hardcore viewership of real-time imagery can be understood as a visual counterpart to the audio enthusiasts’ high fidelity (hi-fi) culture, in which the technical quality of the audio signal often surpasses its actual artistic content, such as the music. But when recorded audio is somewhat straightforward and an uncluttered medium, real-time image is anything but that. This structural convolution of real-time image is actually one of the key features that separates, in my mind, it from other visual mediums.

So, what makes the hardcore mode of viewing different from a casual one is the combination of prior higher-level knowledge of the nature of the object and a philosophical position, or a system, of valuing certain features over others inherent to the object.

2.2 Infamous Case of Killzone 2

The prime example and a sort of a gaming industry symbol of how the beliefs that one holds define one’s relationship to an image are the events that surrounded the revelation of a video game called Killzone 2 at E3 2005 Expo. The game’s developer Guerilla Games presented a short trailer of their upcoming title Killzone 2, which simply blew everyone away by its high quality imagery that was supposed to be rendered in real-time. The hype was through the roof, until it was disclosed that PlayStation 3 did not produce the imagery found in the trailer, as it was implied, but the presentation was just a pre-rendered animation, CGI, of what the developer was aiming to achieve with the final product.

As a result, people who attended the event ended up watching the Killzone 2 trailer through false ideological glasses, so to speak. The backlash was immediate and many participants of that event, especially the press,

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9 More about real-time in the next chapter.
felt cheated, and that they had been taken advantage of. The incident has haunted the gaming industry even years later, as gaming blogger Jim Sterling states in the context of another *Killzone 2*–related controversy:

We’d already been lied to once before when the infamous “demo” footage for *Killzone 2* a few years back turned out to be CGI [...]. This kind of underhanded behavior is not cool and not something any consumer should condone.¹⁰

For such a hardcore audience, the image is inseparable from the process of how the image is produced. In the case of real-time image, that process is extremely defined by the hardware, i.e. the apparatus that is being employed to generate the images in real-time. To quote Andrew Darley on the history of cinema and spectacle:

It is not just what is being shown that creates the spectacle, but how it is shown; the cinematic apparatus itself is being wondered at.¹¹ [...] [Early cinema was] a form [of spectacle] that was wondered at just as much for what it could do, as for what it did do.¹²

The fundamental part of the audience’s *Killzone 2* fascination was indeed towards the “cinematic apparatus” itself, at the time yet to be released by PlayStation 3, and what could be accomplished with this new and exciting apparatus in the future.

To reiterate, the *Killzone 2* case can be seen analogous to an extent to a children’s drawing contest in which suddenly it comes into daylight that the contest winner’s parent was the actual author of the drawing. The winning drawing sure looks different after that disclosure, and the judges and the audience feel tricked.

So, instead of looking and judging the piece of art as it is, we have this tendency to judge and value things by taking into account the process

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¹⁰ Sterling 2007
¹¹ Darley 2000, 45
¹² Ibid., 46
of how the object has come to be, in addition to other external factors. If we look at a sophisticated painting made by a four year old child, it is the mere idea of a “prodigal child” that fascinates us, not so much the painting itself, assuming we possess the knowledge of the author’s age. The same thing was with the Kinnunen’s church spectator and the people watching *Killzone 2* trailer. Everybody was gasping at the supposed beauty of something only to later learn that it was actually not worth gasping at, at all, in that frame of a hardcore mind.

### 2.3 Story of Sprite Scaling

To yet further illustrate the concept of the ideology and image and the hardcore viewership as well, I have to share my own experience of what can be at its most rudimental level.

In computer graphics there was at one point this certain way to simulate primitive 3D space by scaling 2D entities called sprites on the screen (see Figure 9). However, the utilization of the technology usually made games to look pixelated, or blocky in certain conditions. This pixelation occurs when a sprite is scaled beyond its native resolution, and such an effect is usually an unwanted phenomenon in real-time imagery. Still, that “Lego-effect”, as to which it was often dubbed, did not bother me at all, but quite to the contrary. For me that particular pixelation started to serve as a sign for the scaling technology that had been used, and thus, it started to gain aesthetic value in itself. So, even though the sprite scaling often resulted in something that could be easily deemed as low quality imagery, it was bearable since the Lego-effect was standing for the greater good, which was the smoother spatial movement and a greater scope of it.

For me, this thrilling aesthetic experience of sprite scaling was limited only to the trips to cruise ships and places alike, from which one could find coin-operated arcade video games. However, in 1992 the first af-
fordable game system\textsuperscript{13} that utilized technology comparable to sprite scaling became available in Europe. The console was Super Nintendo Entertainment System, and there really was something magical about finally having arcade-like features in a home environment. The thing Super Nintendo was known for, and partly marketed with, was this graphics mode called Mode 7 which allowed smooth hardware\textsuperscript{14} scaling and rotation of 2D art, although in a somewhat strict and limited manner. Still, it was more than enough for me to get excited every time a game used Mode 7 to zoom, scale or rotate whatever happened to be on the screen. I even bought one Super Nintendo game solely because its title screen was realized by using Mode 7. In addition, I remember the frustration of how little Mode 7 was actually used in Super Nintendo games at large, which did not make much sense to me back then.

Even today I have strong aesthetic feelings towards the look of sprite scaling and the pixelation effect that comes with it. For me, the “oversized” pixels stand for the one crucial phase of the real-time imagery’s project breaking through to the third dimension, and in my mind, this inter-dimensional exodus was one of the most exciting developments in the history of real-time image par none.

2.4 Three Pillars of the Cult

It is often said that cults are formed around secrets, the hidden knowledge which is understood only by the “enlightened” ones. The knowledge that is at the heart of the Cult of Real-time Image has first and foremost always come down to recognizing the medium’s inherent incapacity, “crippleness”, due to the certain technological principals real-time imagery is based upon. The fact is that the sheer visual merits of real-time imagery have never been able to live up to its peers in visual

\textsuperscript{13} SNK’s NeoGeo game system was the non-affordable one, for at least majority of the consumers.

\textsuperscript{14} Meaning the operation is much smoother and more efficient than with “software scaling”
arts, like hand-drawn animation or cinematography, until the most recent years. However, for the hardcore audience, it has never been about either the content or the artistic qualities of the image per se, but rather the ideas and concepts that in a way transcend the image.

That said, I would propose, channeling the famous rule of three\textsuperscript{15}, that the hardcore viewership of real-time image, the Cult of Real-time Image, stands on three ideological pillars, which adhere to a logic of “the more, the better”.

The pillars are:

i. the concept of Real-time,

ii. the concept of Simulation and

iii. the concept of Definition.

Being a hardcore viewer/gamer myself, these pillars are in my view the very foundation of real-time image as a medium and a visual entity, and at the same time, ideals which the medium should be constantly forwarding. There is always the next level and the higher state of real-time, simulation and definition that real-time image could be reaching, which actually comes back to what was said earlier about the inherent incapacity of the medium. Once there is a better technology available by which these ideals can be forwarded, there is basically no going back\textsuperscript{16}. And there is always that next frontier looming on the horizon waiting to get surpassed, at least for now.

\textsuperscript{15} Great things come often in threes.

\textsuperscript{16} This seems to be the logic of technology in general.
All in all, in my view, the whole evolution of video games can be seen as a project of pushing forward these three concepts inherent to the real-time medium. It is a project, which has definitely been the most intriguing one for me to be watching.

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I have now aspired to establish the particular viewership under scrutiny in this thesis, which I call hardcore viewership. This cult-like mode of viewing is, by no means, unique to the real-time imagery, but it manifests it in such a clear way. And as said, the level of fanboyism in video game culture is yet to meet its match.

Secondly, I have introduced the three main conduits of understanding the nature of real-time image and through them, the hardcore viewers themselves, as well as the Cult around it. My argument states that real-time image cannot be anything but misjudged if one does not posses at least an elementary understanding of the said three ideological pillars.

So, in what follows, we are going to look more closely at each three main ideas on which the Cult in question is based. First we are going to take a philosophical look at the idea of real-time, and after that, to the idea of simulation. Lastly, we are aiming our focus on the idea of definition, which concludes our three pillars of real-time image.
CHAPTER III

... REAL-TIME AND IMAGE
The reality we are living in reveals itself by using all kinds of different aesthetic media: light, sound and scent to name a few. One could make an assertion, that our common experience of reality is quite direct and immanent to us, as in everyday life there is little to no delay in how we experience our surroundings. That is, if we have no external factors distorting our perceptions, like drugs, heavy medication, or some kind of mechanical apparatus like a head-mounted display. Those cases are, however, extreme examples out of the reach of this thesis.

Due to limited speed of light and sound, there is in fact always a little delay between the occurrence of events and registration of them, and one could therefore say we are after all always experiencing the past, instead of the present. The key thing here is the amount of delay: are we aware of it or not. In the case of lag of perception due to speed of light, the lag is not de facto noticeable. Even when we watch a star in space a million light-years away, we do not see the delay, we just happen to know that there is one, which is in this case exactly a million years. But if we are watching a man in a distance beating his carpet outside, we can effortlessly notice the lack of synchronization between what we see and what we hear. That is why we must posses at least two kinds of referential information to become aware of the delay or de-synchronization. The nature of that information can be perceptual or simply foreknowledge, like in the case of the star in the sky.

So, it is rather intuitive to state that perception of things as they are actually happening, is a somewhat natural process and something one could expect by default. This stance applies to the “real world” to which I am
referring as an immediate perceived reality that enables everything else, like representations, to exist in the first place.

### 3.1 Real World and Representation

If we postulate the real world as the whole in which *everything* is located in and is subordinate to its natural laws, then *nothing* simply exists outside of it. We have an agency, at least in principle, in that reality, as it is a system of input and output: Things we do have an effect on our surroundings and through that on ourselves as well. The perception of those effects is also rather immediate, as we concluded prior, if we disregard the convoluted causal chain altogether for the sake of clarity.¹ To make it short and to state the obvious: If one strokes a brush on a canvas or breaks a window throwing it with a rock, the visual responses of those actions are downright immediate to us, and it would be rather counter-intuitive to assert otherwise.²

We as human beings bounded to this real world have had a drive through our known existence to create different kinds of representations, sub-realities if you will, of the real world reality, mainly to amuse and to educate us, but also to express us artistically, and traditionally realized by using means of representation and narrative.

Furthermore, these traditional modes of mediation have always, until the recent decades, been something one has had to have first been recorded by memorizing, writing, sculpting or painting and then presenting or publishing that piece to an audience. The creation-presentation processes have been generally considered as isolated entities, unless we are talking about a case where one creates an art piece while presenting it, which we will delve into next.

¹ For instance, if one insults her boss at the company’s Christmas party, she may notice the effect of that action only a day after as a termination of her contract of employment.
² I do acknowledge that many valid assertions can be often counter-intuitive.
3.2 What is Real-time?

Let us start with reflecting on selected cases of what happens when we are experiencing a piece of art or media. When we read a book or watch a movie, we experience the events, historical or fictional, that have already happened in the past or if we read science fiction, suppose to happen in the future – and we cannot do anything about them. The incidents and the stories are once recorded and all that we can do is to play them back and enjoy the experience the best we can. But if we are watching for instance live theatre, the game already changes. We could indeed in theory alter the course of events by shouting or throwing something onto the stage, like they do in *Rocky Horror Show*. Whole modern “impro” scene rests on the audience’s input to the show and the scene would not make much sense without it. Indeed, a production like improvisation, or *freestyling* as it is called in the rap context\(^3\), downright feeds on the audience’s mood, reactions and interventions to how the show should unfold, or what the set pieces of a particular situation supposed to be.

However, the basic act of intervention *on the fly*, so to speak, is reasonable only in performance arts, since the core of such piece is immaterial to an extent. For instance, choreography is immaterial: It consists solely of movements, postures and rhythm, which are all immaterial entities. One could shout directions for a dancer performing a choreographic piece and the alterations of movements would be instant, if the dancer so chooses. A play is also incorporeal, since it is a composition of characters, lines, situations and a plot. Characters of a play are immaterial, because one actor can easily replace another actor without the essence of the play being altered, at least in theory. In short, the author of these kinds of incorporeal pieces is in direct contact with the medium (medium is him/herself), in contrast to a painter, a set maker, or a sculptor for example who operate outside of their medium.

\(^3\) For more about freestyling, see *Freestyle: The Art of Rhyme*, Dir. Kevin Fitzgerald. DVD. 2004.
Figure 2 is my simplistic illustration of the relations between the entities of the setting in question.

The Author and the Spectator in figure 2 are rather self-explanatory, but the Work here is standing for the representation made out of something tangible, and it can be a book, a painting, or a sculpture, for instance. The arrows represent the flow of information in the arrangement and the speed of that flow depends on the attributes of the components involved in the system.

For instance, if the Author is writing a novel, reacting to the feedback i.e. information from the Spectator could be rather difficult task to carry out in a reasonable amount of time, considering the complicated writing process. On the other hand, the reworking of an abstract painting would be more of a feasible task to fulfill according to an input from the Spectator, but only if the skills of the Author are in place.
So, the skills of the Author and the nature of the Work are the critical components in above depicted dynamic system of production process. The information flow from the Spectator to the Author depends on the input interface that is employed in a particular situation and the flow from the Work to the Spectator is instant, due to the intuitive assumptions of perception made in the beginning of this chapter.

So, I have now aspired to lay some groundwork for describing something that I see as a relevant approach to the notion of real-time, even though it has not yet been defined exhaustively. At this point real-time seems something in which the art piece and its production takes place coincidently, thus allowing instant interaction with the piece, but which seems rather impossible in traditional representational making, like sculpting or painting. So, what are the means to achieve such a state of affairs then?

### 3.3 Computer and Real-time

If we examine in what typical context we usually encounter the notion of real-time, three out of four of the primary results in Encyclopedia Britannica Online are somehow related to computer science while inquiring “real-time”\(^4\). Other online dictionaries’ results are equally computer oriented and I quote just a few of them here:

- Of or pertaining to applications in which the computer must respond as rapidly as required by the user or necessitated by the process being controlled.

- Of or relating to computer systems that update information at the same rate as they receive data, enabling them to direct or control a process such as an automatic pilot.

- A term used to describe computer systems that update information at the same rate as they receive data.\(^5\)

\(^4\) See http://www.britannica.com/bps/search?query=real-time#
\(^5\) http://dictionary.reference.com/browse/real-time
The definitions above all seem to refer to a movement of data in a computer system on a certain timeframe. If we then look back at figure 1 and place a computer in the position of the Author, the speed of the information flow will dramatically increase, due to the computer’s superior ability to process a certain kind of data, all the way to the point in which things are no longer occurring consecutively, but seemingly coincidentally. That is, if we assume, for the sake of argument, an ideal scenario. The Author now becomes connected to the Work in a similar sense that a dancer is connected to their body.

New media theorist Lev Manovich, has in turn a straightforward take on interactivity and computers on his work *The Language of New Media*:

> Once an object is represented in a computer, it automatically becomes interactive. Therefore, to call computer media interactive is meaningless -- it simply means stating the most basic fact about computers.6

Indeed, a computer at its core is an interactive entity, it is also de facto a device allowing a setting in which a work of visual art (maintained by a computer) can be subjected for (meaningful”) real-time manipulation. It does not have to be manipulated8, but it makes it possible. And that, in my view, is the ultimate rationale behind the development of computer: interactivity in real-time.

### 3.4 Real-time Image as a Physical Object

A computer-generated image at large can have various physical forms, for instance, as a print does on different mediums, like paper, canvas or even glass. However, a real-time image in turn requires always something known as a display, or a screen in order to exist, in addition to an apparatus, hardware, which produces and upholds the imagery. Indeed, it

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6 Manovich 2001, 71

7 As in a constructive sense. Everything can be manipulated through destruction.

8 See Chapter 7.1 The Demoscene, Demos are more often than not non-interactive real-time pieces.
can be said that real-time image exists as much in the hardware as on the screen that renders the image visible to us.

Figure 3 A screenshot of *Call of Duty: Modern Warfare 2* (2010, Infinity Ward) with a text overlay.

Figure 4 This is a real-time image.
3.4.1 Screen

It is often said that the major breakthroughs in the evolution of technology are more often than not coupled with the history of military inventions and findings. Manovich discerns the birth of radar as the first manifestation of a modern real-time screen found in today’s computer systems: “[…] with radar, as imaging became instantaneous, this delay [of processing of surveillance photographs] was eliminated. The effectiveness of radar had to do with a new means of displaying an image — a new type of screen”.9 “The new type of screen” here is the real-time screen, which is in his genealogy what he refers to as the third (after classic and dynamic) type of screen. Classic screen is something like a painting, dynamic is like a TV and real-time is a dynamic screen in real-time, like radar. Screen as a concept refers to a frame or a window to another world in Manovich’s mind10 but I personally prefer employing screen only as a dynamic matrix-like entity in the context of this thesis.

Additionally, on screens, such as of a TV or a radar, an image is drawn through sequential scanning like in an oscilloscope, in which different parts of the image corresponds different moments in time, in contrast to a simultaneously produced image. An image of such has to be continuously refreshed, even if there are no changes in the picture, excluding so-called e-ink-screens. In Manovich’s view, that is why the image in question seizes to exist as an image in a classical sense – such an image is a mere temporal illusion, which we call image only by habit.11 I would describe the situation here as an airplane’s propeller on full speed that draws steady illusionary circles on the air due to markings painted on the blades, even though there are no actual physical circles to be found in the first place. The rings in the air are

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9 ibid., 102
10 ibid., 99
11 ibid., 103
immaterial entities in the same sense as prior mentioned dance or choreography is.

In that same spirit, even more analogous to a modern screen is an interactive artist Daniel Rozin’s mirror installations, in which every mirror is made out of something that is a non-reflective material. For instance, his Wooden Mirror\textsuperscript{12} consists of 830 square pieces of wood with an equal amount of servomotors controlling them. There is a hidden video camera and a computer behind the “mirror”, which translates the captured video image to data for servos to adjust the wooden pieces accordingly. The mirror is lit by an external light source and the particular shading in the image depends on the angle of the corresponding wooden piece. Everything is happening on the fly, so it can actually be used as a mirror, albeit a rather fuzzy one.

Yet another example of an unorthodox screen is a situation, in which a choreographed crowd is holding and adjusting colored cards over their heads, forming a screen to compose still and moving images,

\textsuperscript{12} See http://www.smoothware.com/danny/woodenmirror.html
like in the memorable Misha’s tears at the ending ceremony of the 1980 Moscow Olympics. Indeed, it is the movements and positions of the hands that determine the outcome of the image, allowing it to “move” and alter as if designed priorly by a choreographer.

So, in today’s culture, outside of the peculiar cases mentioned above, real-time image as an object exists mainly as a screen of something or of some kind of device. We are living in a society of a screen, as Manovich pointed out in 2001 and it admittedly seemed like a pretty accurate view even back then, not to mention today. The number of screens people possess and use every day has grown multiple fold in the last decade: screens can be found more and more in common appliances, like in music players and mobile phones or more exotic locations, like in a backseat of a car or even in a refrigerator. I, for one, possess five screens within five different devices that are in constant daily use: two iPods, a laptop, a phone and a desktop computer and besides the number of the screens, we simply spend more time of our day focusing our sight on some kind of a screen than ever before. One could say, that the evolution of electronic devices by and large is

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13 Manovich 2001, 114
going towards the future, in which there is nothing else for people to interact with other than a screen, as we can see already happening with Apple’s iPhone and iPad.

3.4.2 Hardware

If the screen is what conveys the real-time image to us visually, hardware is where the real magic happens. It is the hardware, as the Author (see Figure 2), which ultimately determines the fundamental nature of the content projected on the screen, and as stated in Chapter 2.2, to understand an image, any image, is to understand the hardware and the Author\textsuperscript{14} behind it.

So, if we look back at the Wooden Mirror, the hardware of that setting is the camera, which transforms the video signal into postures of individual pieces of wood. The visual content of the Wooden Mirror thus depends on the objects that are put before it, just like with a common reflecting mirror, or a camera. The reason why it is not a real-time image as it is understood in this thesis, even though the image alters according to a user input, is that it merely redirects something that is already there existing in front of it – like mirrors do – rather than generating visual material on its own like a true Author.

If we then look at the case of Misha’s tears, which is a step closer to real-time image that is under scrutiny, the “hardware” is the choreographer who has at first designed the content, after which mediated that design as a set of instructions to the people holding the cards. One can make an assumption that this process has taken hours, even days, to carry through, all the way from the first design decision, to the final presentation of work. Consequently, even such an algorithm-
alteration to the imagery as, for instance, rotating the Misha tear 90 degrees would take hours to pull off, each member of the group relearning how and which card to hold. And the delay in question stems solely from the disconnection between the Author (choreographer) and the Work (group of people with cards).

So, as we stated in Chapter 3.3, a computer – be it a laptop, a personal computer, a gaming console or a smart phone – is indeed the entity that is capable to provide imagery that can be thought of as real-time, due to the computer’s interactive core nature, as Manovich pointed out earlier. Instead of being disconnected from the Work like the choreographer in Misha’s case, a computer constantly reworks the image by building it from the scratch, hundreds of times per second at best, making the image and the hardware inseparable in effect.

Indeed, it cannot be stressed enough how dependable real-time image is on the hardware that maintains it, and no other medium comes even close to that arrangement. For instance, a movie can be played back with a variety of hardware, like a film projector, a DVD-player or a mobile phone, without the core of the medium being fundamentally altered. That is not obviously the case when dealing with real-time imagery, which existence is constantly rebuilt through hardware, and thus, is defined by it from top to bottom. Consequently, when translating, for instance, a video game to a different hardware platform, the game is basically reconstructed from the ground up manually.

15 Meaning a non-artistic/creative procedure. See Chapter 5.1 Design vs. Algorithm
Sometimes, the piece of real-time imagery changes in the process to a degree that “the sameness” of the pieces becomes debatable, to say the least (see below).

What then makes a computer such a remarkable device for image creation are the immaterial processes by which computers operate called software. Indeed, no material is transmitted during such processes, and only physical friction is the heat that a circuitry produces under a computational stress.\(^\text{16}\) I believe it is this immateriality that ultimately describes the fundamental nature of real-time image best, even though this fact is probably taken as a given and is self-evident at large. To yet revisit the case of Misha: A computer is like a mind controlling choreographer, who can make those hundreds of people adjust their over-head cards instantly according to choreographer’s will, producing unbelievable moving imagery in the process – and ready to alter the content of the imagery within a certain frame if so suggested, in real-time.

\(^\text{16}\) See Chapter 7.3.1 Overclocking
3.4.3 Input (optional)

What is left is the input device, which can be a crucial component of real-time imagery, but not necessarily.\textsuperscript{17} In short, an input nowadays can entail a vast spectrum of devices, from wand-like motion controllers (Nintendo Wii, PlayStation Move) or no controller (Kinect for Xbox), to traditional joystick and gamepad or mouse and keyboard combinations.

However, as said, real-time image does not need an input device to fully exist, but input gives real-time a purpose. For instance, let us look at a live radio broadcast: One reason how it justifies being live is to allow people to call in and request for a song or to state an opinion. There would be no actual reason to broadcast live without the listener’s input, but a live broadcast still does not require the input in order to function properly, which is chatting about current events and playing hit songs every now and then.

3.5 Frame Rate

Ultimately, the question of real-time comes down to something known as frame rate, which is basically a numerical value measured in frames per second (FPS) that determines the state of real-time of given imagery: How many distinct images the computer is able to produce per second.

The fact is real-time image differs from other kinds of computer or traditional imagery in that regard that there is always a certain budget with which the real-time image is built. However, instead of money, real-time image operates in central processing unit (CPU)\textsuperscript{18} cycles and every CPU cycle can handle only so much of computational stress. The amount of available cycles depends on the hardware, and the more sophisticated the

\textsuperscript{17} See Chapter 7.1 The Demoscene

\textsuperscript{18} Or graphics processing unit (GPU), but let us address only the CPU here for the sake of clarity.
hardware is, the more CPU cycles there are for a developer to rely on. The balance of the graphical workload and the available CPU cycles is crucial in terms of frame rate and exceeding the CPU budget results in lower frame rate since the computer has to then “think” longer about a single image.

I personally would go so far to say that frame rate is the most single crucial aesthetical aspect of real-time image. Sure, other mediums, like motion picture or television, push a lot of frames per second onto the screen – 24-30 frames per second depending on the medium and the region – but frame rate is in the above cases a non-issue, since there are basically no factors that would somehow affect it, which is the total opposite of real-time imagery. In real-time image, everything affects everything, especially the frame rate.

So, that gives rise to a question of what is the exact moment when an image becomes a real-time image? One could make a case that the frame rate above one per second would be it, since the unit of measurement of the frame rate is more often frames per second than seconds per frame in the real-time imagery. However, ultimately the one frame per second-threshold for real-time is as arbitrary as any number would be. Some throw in such estimates as 6 frames per second around which the sense for interactivity starts to emerge, but as said, in my mind, it depends on various factors, such as the context of use, or even the user herself.

The expectations towards the frame rate have been settled in the recent decade down to around 30 FPS, which is considered often as a bare minimum in modern video games, 60 FPS in turn is seen as a sort of a gold standard. For instance, one of the developers of the massively popular Call of Duty—video game series Treyarch states that 60 FPS is “a critical

19 With non-real-time computer generated imagery, it can be easily hours or days per frame.
20 Akenine-Möller, Haines, Hoffman 2008, 1
component” of the gaming experience to their games and they work a lot to keep it that way.\textsuperscript{21} While others may disregard the importance of 60 FPS, for perhaps apologetic reasons\textsuperscript{22}, the visual difference between 30 FPS and 60 FPS is noticeable\textsuperscript{23}, and the fairly common claim that the human eye cannot process images above 24 FPS or 30 FPS (depends on the particular tale) can be rather safely deemed false.\textsuperscript{24}

Frame rate is in my mind one of the most defining aspects of real-time image, which has seen an enormous growth not just in quantity but in stability as well in the past few decades. The ideal frame rate has been steadying to around 60 FPS and frame rates higher than that are highly exceptional. However, the reality is that only some of the modern video games usually can keep a steady 60 FPS in every possible situation, therefore frame rate can vary vastly even within a particular video game, in contrast to rock solid frame rates in motion picture film or television.

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In conclusion, real-time seems something rather natural and un-exotic to our common, everyday experience when we are dealing with the so-called real world. A question rises then, if we are set to construct representations of it, why then should they not adhere to the same principles of reality they strive to represent?

We also noticed the kind of immaterialness in real-time art pieces and representations, and that is essentially a requirement for such. Also, we made an observation that a computer is the entity that allows us to produce images via immaterial, mathematical processes at such a rate that an

\textsuperscript{21} Evans-Thirlwell 2010
\textsuperscript{22} See http://www.thatvideogameblog.com/2010/03/17/60-frames-per-second-not-important-to-codemasters/
\textsuperscript{23} See http://www.boallen.com/fps-compare.html
\textsuperscript{24} Ghazi 2011, 5
image becomes something known as real-time. Furthermore, as a physical object, real-time image is a screen on which the content is projected, and a hardware that produces the content, in addition to an optional input device, by which the content is altered in real-time.

It is rather safe to say, that real-time image is genuinely something unique in the history of man, thanks to the emergence of the computer. Of course, one can make conceptual trajectories to the history of spectacle, all the way to the birth of the Magic Lantern and Phantasmagoria.\textsuperscript{25} However, the key difference and the ultimate point here is not the fooling of the eye with fantastic images, but the particular \textit{simulation} technologies that have not been there before.

So, in the next chapter, Concept of Simulation, we are going to move on to the second pillar of the Cult of Real-time Image by first discussing simulation as a philosophical idea and intellectual framework, and beyond that, in Chapter 5 Simulation of Visual, as particular technologies producing representations.

\textsuperscript{25} Prototypes of modern film projector invented in France in the late 18th century.
CHAPTER IV

... CONCEPT OF SIMULATION
In the previous chapter, we briefly touched upon the fact that representation in all its pre-computer age forms have been mankind’s *modus operandi* in conveying and understanding human condition, its histories and prospects, hopes and dreams, fears and anxieties. The drive to understand our experiences and existence – and to mediate that understanding to others – is nearly as strong to us as the instincts to reproduce and to survive. One could even say, that these traits of story telling and representation-making separate us from the animals and makes us human, *Homo Narratus*.¹

By representations we make sense of seemingly arbitrary occurrences by structuring them to meaningful wholes, understandable entities, which take the place of the convoluted phenomena of reality. Its importance in human history cannot easily be downplayed, as the history itself, being a recorded entity, is a mere representation.

As technologies behind those representations have moved forward, new ways to depict reality have emerged that may not simply fall into the traditional understanding of how representations are being conceived anymore. As I implied in the previous chapter, a computer is the definitive player in contemporary visual culture, which changed the whole game of illusion and make-believe in more ways than one. This is because a computer is by its very nature an interactive system of input and output, which enables representations to be formed in real-time and thus allows the user to affect the process that gives us what we refer to here as real-

¹ The term can be found for instance from Dautenhahn 2002, chapter 6. *Homo narratus*: Implications for Human Society and Technology.
time image.

So, what is the proper intellectual framework for understanding this particular form of visual culture then; what is real-time image? After all, these images are so much more than mere graphical representations of blazing guns and roaming racecars, like they often are within real-time imagery, especially the ones found in video games. Nor are they just immature stories about space marines and aliens, or SAS Forces and faceless terrorists fighting the never-ending battle of their existence.

Therefore, the crucial thing here is not to get stuck with the representational forms and objects found in the images, or with apparent or hidden meanings the images may entail. We have to look beyond the appearance and the meaning – to go through the looking glass, so to speak – by taking account a paradigm outside of traditional representation and narrative.

On that note, game scholar Gonzalo Frasca presents an argument, which I consider as crucial in understanding real-time image: “[...] unlike traditional media, video games are not just based on representation but on an alternative semiotical structure known as simulation.”\(^2\) Another scholar Aki Järvinen agrees with Frasca in his thesis *The Elements of Simulation in Digital Games*, although Järvinen’s “interest is in studying how different gameplay elements [...] combine to produce simulations”\(^3\), which is a completely different approach than I have on this thesis. True, I am speaking of video games, but I am going strictly after the real-time imagery part of them, not elements related to the narrative or gameplay whatsoever.

\(^2\) Frasca 2003, 221
\(^3\) Järvinen 2003
As said, there is a fundamental truth present in Frasca’s assertion, and next we are going to move back a little and take a look first at the overall concept of simulation and then proceed in the next chapter on how it relates to the real-time image.

### 4.1 Overview on Simulation

The idea of simulation can be vague at its best and the content of the notion may vary greatly depending on the context it is employed in. For instance, we can simulate job interviews, symptoms for medical training, molecular structures of substance, traffic conditions in a driver’s license exam, and so on. Or we can go to a simulation ride at the theme park or watch a 3D movie, which simulates depth perception by special glasses.

A general sense of simulation seems to be something that aims to trick one’s senses, in contrast to other forms of representation, which are perhaps more overt in their intent to be unreal or fake.

If we look at the history of simulation, there was a shift in its meaning from mere deceitful to productive, particularly after World War II. According to Evelyn Fox Keller, the shift was due to simulation’s entrance to the domain of the scientific modeling and the primary push for this transition was the introduction of the digital computer. Still, simulations have been conducted long before the computer, by scale models for instance, which are known as analogs, or as an extreme example, according to Frasca, one could simulate things only within their mind.

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4 Fox Keller 2003, 198-199
5 ibid.
6 Frasca 2001a, 21
7 ibid., 23
Even though simulation exists outside of a computer, the substantive form of simulation from the perspective of this thesis is the one that particularly surfaces at the crossroads of computer science and representation, that is the real-time image.

However, the notion of simulation can be ambiguous even in the context of said fields. If we look back at Manovich, he uses the term pretty loosely through his opus Language of New Media, as he does not provide one distinct definition for simulation but few ad hoc ones. In summary section on page 41 Manovich states:

Simulation refers to technologies, which aim to completely “immerse” the viewer within the virtual universe: Baroque Jesuit churches, nineteenth century panorama and twentieth century movie theaters.

And on page 42:

Simulation refers to various computer methods for modeling other aspects of reality beyond its visual appearance: movement of physical objects, shape changes over time in natural phenomena (water surface, smoke), motivations, behavior, speech and language comprehension in human beings.

Above definitions basically describe the two general approaches to simulation: The former definition refers to a certain kind of tradition in art history that persuades the viewer to be immersed in an artwork and believe what they see, and the latter is more specific to computer technology and modeling processes. Still, as said, Manovich does not employ one unambiguous definition for simulation and hence seems rather nonchalant towards its use. But that is not an epistemic problem by all means, since he just does not consider simulation as a central concept on his treatise.

Frasca instead is all about simulation. Since I am relying a lot on his view on simulation, let us take his definitions provided in two separate contexts:
Simulation is act of modeling a system A by a less complex system B, which retains some of A's original behavior.\textsuperscript{8}

To simulate is to model a (source) system through a different system which maintains to somebody some of the behaviors of the original system.\textsuperscript{9}

Both definitions are quite aligned with Manovich's second description and the former definition especially encapsulates it neatly.

Simulation is not just a strategy to trick our perception and to immerse ourselves into the make-believe but an idea of replicating the behavior underneath the surface of the source system, instead of the mere appearance. In a computer simulation, the behavior does not refer only to the objects found in the simulation but to the very structure of the make-believe reality itself.

Lastly, simulation can refer also to a genre of video games, to which we will come back to later.

\subsection*{4.2 Simulation and Source System}

When I was a kid, I imagined my plastic sled as the KITT car from the TV show \textit{Knight Rider} and I was genuinely surprised of the fact that the friend of mine did not see the sled as I did. Therefore, a young child generally does not need sophisticated objects to play with: A plastic sled can be used as a surrogate for a sentient wonder car or a space shuttle, depending on the source system the child happens to project onto the object. It requires a certain degree of playfulness, which a child seldom lacks of, to accept a sled as something that it clearly is not, thus a sled does not reproduce neither the looks nor the behavior of the source system, i.e. the KITT car. However, when an object is designed to replicate

\begin{footnotesize}
\begin{itemize}
\item \textsuperscript{8} Frasca 2001b
\item \textsuperscript{9} Frasca 2003, 223
\end{itemize}
\end{footnotesize}
appearance and functionality of the source system to such a degree that the object no longer requires a significant amount of pretence and bears no other “useful” application, it is commonly considered as a toy.

Frasca notices, that “[…] the definition of simulation perfectly describes how toys represent reality”, and he reasons it by quoting Paul Fishwick: “The use of [scientific] simulation is an activity that is as natural as a child who role plays with toy objects.”¹⁰ So, playing with a toy and scientific modeling are to some extent very much alike: both are experimentations with a modeled phenomenon of reality, which introduces an extremely important aspect of simulation, that is the lack of ethical¹¹ or practical limitations the said procedure could create otherwise. This is apparent when – besides playing nicely with toys – young children often abuse and smash their toys in order to see how they behave in different conditions, like rolling the toy car down the stairs, which is something that is not feasible for the child to do with the source system, a real car. Or scientists model car crashes to see how deformations of the car affect the driver and the passengers aboard by using human analogs or a full computer simulation. There are no ethical issues involved in smashing a human shaped analog into pieces or shooting one in a video game, like there definitely would be with the actual source system, a human being.

Interestingly, when researchers in Austria used dead bodies as crash-test dummies in 2005, they were under the risk of facing criminal charges of violating the dignity of the dead.¹² As said, experimentations can be as much of science than a form of play, so to “indignify” the dead one could have been associated with that ambivalence, I believe. Additionally, the above case was a borderline simulation, since a dead body is not really a much simpler system, as its source system, a living body.

¹⁰ ibid.
¹¹ Assuming the modeling is realized with a non-sentient analog.
In short, since simulation is replicating the referent’s behavior, it allows and somewhat encourages experimentation because of the “safeness” and the practicality of the arrangement, whether it is for greater good, like science, training or education or just for the amusement.

4.3 Source System and Real World

Frasca states, that: “[t]o claim that there is a need for a real referent in simulations is similar to say that the word unicorn is not a sign since its referent is not real.” Frasca 2001a, 25 Aki Järvinen picks up the same Frasca’s argument and employs it as a premise on his own analysis of simulations and video games. Järvinen 2003 I myself, however, find Frasca’s view problematic, especially in the context of real-time image and I will explain why next.

To say that the source system, the referent, in the simulation can lack completely the counterpart in real world, or “even contradict the rules of physics of our universe” Frasca 2001a, 25, is actually taking an integral component out of simulation, which is the safe experimentation, playing with real world concepts. The rules, i.e. how our real world reality behaves, are the very basis of simulation, but I can see the thinking that may lead to the Frasca’s conclusion by simply looking at a number of video games: the settings in video games are more often than not fantastic and unreal, depicting fictional systems without direct real world counterpart, like alien planets or magical kingdoms.

However, since simulation is about modeling looks and behavior of the source system, despite the fact that the former can be – and usually is – without a real world referent, I would state that the latter behavior has to have at least some level of correspondence to concepts found in the real world to keep simulation meaningful. To illustrate my point, let us look at

13 Frasca 2001a, 25
14 Järvinen 2003
15 Frasca 2001a, 25
the general consensus of what kind of video games qualify into a genre of games known as simulation.

4.3.1 Simulation as Genre

Indeed, there is a genre of video games in which games are referred to as simulations. For instance Microsoft’s famous *Flight Simulator* is a clear case of a simulation, even without the loaded title. In *Flight Simulator*, there are planes modeled and named after real world counterparts, such as Boeing 707 and real world locations, such as JFK International Airport. The game models the appearance and the behavior of the referents in detail. And then there is LucasArts’ *Star Wars: X-Wing*, which models a fictional space ship in a fictional universe of Star Wars movies. *Star Wars: X-Wing* is also considered to belong under the simulation genre, even when its direct referent, X-wing – ship of the Star Wars universe, is not part of the real world. So, what makes *Star Wars: X-Wing* a simulator is the modeling of the source system by adhering to some extent real world rules and concepts. For instance, ship’s energy supply is finite, so the energy has to be managed between the shields and the weapons. Energy’s finitude is a real world phenomenon, even though that particular management system is not. X-Wing would probably not be considered as a simulation with infinite ammo and shields.

In addition, in the simulation genre, things that do apparently contradict the real world rules are usually explained by some kind of technological concept, so they “actually” are not breaking any rules or constraints of our universe. This is why we can have such space simulators like *Star Wars: X-Wing* or *Descent: FreeSpace* (Volition, Inc., 1999). But when we are dealing with games that are including concepts like magic or the supernatural, the reason they hardly manage into the genre of simulation is precisely that magic and the supernatural do contradict so profoundly the universe we are in. To put in numbers,
only three games\(^{16}\) out of the 250 of the most popular simulations in MobyGames video game database included supernatural concepts.\(^{17}\) Contradictions that the supernatural pose to reality are so overwhelming, that they just cannot be effortlessly explained away, like the ones in science fiction.

To yet further illustrate the relation between simulation and the real world, let us take a look at the board game *Monopoly*. It can be said, that *Monopoly* simulates in a very modest manner a capitalist economy system by modeling transactions and ownership between the players. There are several versions of *Monopoly* with different kinds of themes, like *Star Wars Monopoly*, *Pirates Of The Caribbean Monopoly*, *The Simpsons Monopoly* and so on. So, the cultural content or theme of a game can be rather real, like in the classic *Monopoly* in which there are familiar real world locations, but it can be also totally fictional. Either way, the core (a capitalist system) stays the same that is the actual simulation’s source system, not the theme with which the core is dressed up and decorated by.

This example of *Monopoly* raises an essential question; what if there was no capitalist system at all in the real world, would *Monopoly* be considered a simulation then? I would say no, since a capitalist system is not a law of nature – even though some people might think so. It is a manmade construction and tradition, so thus there would be no real world concept to simulate in that particular scenario.

\(^{16}\) *Afterlife* (includes life after death), *Black&White* (includes god-like action and magic) and *The Sims* (includes magic)

\(^{17}\) http://www.mobygames.com/browse/games/simulation/
As a conclusion, the notion of simulation seems something that replicates the appearance and the behavior of the real-life source system. A toy is a perfect example of a physical object of such, which at the same time, aptly symbolizes the playful nature simulation has in form of play and games, in addition to the scientific, more experiential, dimension. Furthermore, in my view, simulation as a concept does not make much sense and is a rather empty notion without some level of real world connection, at least in the space of real-time image. This real world referent can be reduced ultimately to the very fabric of the physical universe itself, such as space, time, matter and various forces, along with logic and the rules of how those entities behave.

On that note, now that I have established the concept of simulation in a more general level, it is time to get where the simulation is in its most essential and substantial form, from the perspective of this thesis. Let us consider the next simulation as a principle for creating representations by simulating various real world phenomena.
CHAPTER V

... SIMULATION OF VISUAL
Earlier we discussed simulation’s scientific and playful\(^1\) nature, and how simulation encourages experimentation by allowing user input in the process, sometimes in real-time. This applies to both virtual/digital simulations realized by a computer, and traditional/physical simulations that are, in turn, carried out using analogs made of something concrete, like a crash test dummy.

Also in the previous chapter we touched upon the concept of simulation in a video game context, namely as a particular genre of games, but also briefly as a principle to model real-world phenomena. So, a video game can simulate the whole workings of a city, like in *SimCity* (Maxis, 1989), in a highly abstract manner, but also the very core of our observable reality through something I call simulation of the visual. As Martin Heidegger wondered during his time:

> Sometimes it seems as if modern humanity is rushing headlong toward this goal of producing itself technologically.\(^2\)

Even though the quote is a bit out of its context, I believe that, however, the project of real-time image is one critical front of that rush, struggle of which center Simulation of Visual is in.

### 5.1 Design vs. Algorithm

But before we go any further, we have to establish the concept of *algorithmic* process in relation to creative (or “artistic”) one when constructing representations, since algorithm really is a key in analyzing and un-

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\(^1\) I love how scientific can be juxtaposed with playfulness.

\(^2\) Heidegger 1998, 197
derstanding simulation of visual.

On a general level, an algorithm can be considered as a set of rules by which a certain process is conducted, meaning an algorithm in itself is a non-intelligent agent and thus incapable for human-like creative decisions. One example of an algorithm would be the logic of how traffic lights operate in various traffic conditions. There is no intelligent being (a human) controlling the lights every time traffic conditions change, but a machine that adheres to a particular logic set by an engineer that takes account different variables when deciding which light should go off in which situation.

As another example of an algorithmic process – this time from the realm of visual arts – could be photography. Of course, taking a photograph is an artistic endeavor that consists of everything from cropping the image to deciding the actual visual content of it, but the core image exposure process is an algorithmic, non-artistic process: how the film chemically reacts to photons passing though the shutter. The camera simply manufactures the end result, the image, without any artistic judgments whatsoever involved.

So even though algorithms are designed by a human intellect, the results depend on different variables with which an algorithmic machine operates. In the realm of computer imagining, obviously an algorithm is not a physical machine, like a still camera, but a tiny subset of a program that is designed to handle a specific problem within a larger context, like drawing an image onto the screen. As Lev Manovich points out, algorithms as a whole can be seen as a structural entity in computer language in the same sense that grammar is for natural language.³

³ Manovich 2001, 60
This all means that the algorithmic simulations here are not mere representations of their real world counterpart, but as Frasca notes:

...something different, in the same way that a kaleidoscope should not be understood as a collection of possible images but instead as a device that produces images according to certain mechanics.\footnote{Frasca 2001b}

Simulation is more than a sum of its part. It is, as said, an image-producing machine of which the outcome is determined by various variables, like with a kaleidoscope.

\section*{5.2 Structure of Simulation of Visual}

In what follows, we are going to take a high-level look into general ideas of how the algorithmic simulation of visual manifests, and has manifested, over the brief history of real-time image from the perspective of a hardcore consumer, like me. Indeed, the following breakdown is more of a story or a memoir of how simulations found in real-time imagery have unfolded in my own phenomenal reality\footnote{Even though I have not been able to live through some of the earliest developments personally.}, and not as an absolute truth or perspective on computer imagery in general. This analysis is merely conducted in order to make a case of simulation as a core aesthetical idea for hardcore consumers of the medium, and is thus kept as general as possible. However, there are instances that require more technical jargon than others to get a point across.

Andrew Glassner approaches computer-generated imagery, or “digital image synthesis” as he for one calls it, through three epistemic frameworks, which are human vision, signal processing (i.e. algorithms), and physics:

To design and implement a computer system for creating synthetic digital images for people to view, you need to understand the physics of the world you are simulating, the appropriate methods for simulating those physics in the computer, and the
nature of the human visual system that ultimately interprets the image.\textsuperscript{6}

Glassner’s overall take on the subject matter is as fundamental as it gets, covering the underlying principles – both physical and mathematical – in excruciating detail. Obviously, considering the limited scope of this thesis, we have to take many given low-level ideas about which Glassner discusses in his assertions, such as the physical nature of light, molecule structure of matter or certain basic traits of human perception. We are indeed here interested about more general, high-level concepts regarding the simulation of the visual, and Glassner’s trinity does not comply with that aspiration.

Then again, Lev Manovich breaks down the creation of computer imagery also in three concepts, or categories, as follows:

Creating computer time-based representation of an object involves solving three separate problems: the representation of an object’s shape, the effects of light on its surface, and the pattern of movement.\textsuperscript{7}

Above, Manovich reduces computer-generated imagery basically to the simulations of shape, light and movement. I would, however, formulate “shape” as to more fundamental category “space”, for the reasons that follow. There is some overlapping in some cases when using the three categories presented here, but overall, they function appropriately enough on the context of this thesis. In addition, it has to be stressed that these three categories of simulation are the basis for the real-time imagery, and there is yet an additional layer of simulation, simulation of style, which will be addressed at the end of this chapter.

\textsuperscript{6} Glassner 1995, xxii
\textsuperscript{7} Manovich 2001, 174
To come back to Manovich, another essential point he makes is that “[t]o have a general solution for each problem requires the exact simulation of underlying physical properties and processes.”\(^8\), which is, as he states, an impossible task to carry out because of the infinite complexity of reality. Researchers have thus created a host of unrelated solutions how to simulate shapes, light and motion to some degree.\(^9\) Here, Manovich talks about computer imagery in general, but this becomes even more evident particularly in real-time imagery, in which computational resources and technologies are extremely restricted due to the pressures real-time poses, in contrast to CGI seen in animation films, like Pixar’s. Indeed, there are no demands of real-time in film so it can take weeks to render only one frame of the final movie, thus allowing far more sophisticated simulation technologies and procedures to take place. For instance, there were such lighting simulations employed in Pixar movie _UP_, which one can only dream of seeing realized in real-time in any foreseeable future.

However, as said, no matter what the resources and technologies are there at one’s disposal, the reality as it is, is excessively complex to be

\(^{8}\) ibid.
\(^{9}\) ibid.
fully simulated, or in the case of real-time image, to be even somewhat simulated. This inherent incapacity of the medium has lead to an uneven realism, which means that some areas of reality are simulated in more detail than others. This is why real-time simulations are usually, to quote Juan Guardado, “aesthetic-driven”\textsuperscript{10} endeavors that put the visual appearance of the simulation over the absolute realism of it. The situation of uneven realism somewhat reminds one of an oil painting in which crucial areas are painted with a finer brush to capture the most essential details, while irrelevant background is painted with much broader brush. However, in the case of an oil painting, uneven rendering is often conducted out of mere convenience, or pure artistic choice, unlike in real-time imagery where it is more often than not a compromise for technological reasons.

The reason I consider space, light and motion as fundamental entities computer to simulate, is that each category is basically nonexistent in themselves: They can only be observed indirectly through the objects they have effect on, and thus are in a way like metaphysical entities. This is also why I choose “space” over Manovich’s “shape”, since in computer graphics, simulation of space is the very enabler for creating shapes, such as three-dimensional objects for instance.

On a historical side note, according to Wayne Carlson, University of Utah should be considered as a historical ground zero for many of the algorithms behind the simulation of visual, of which program for advancing the computer graphics back in 1968, fueled by $5M ARPA money, really pushed the field to new heights. And one name of that famous Utah -group raises above all, James Blinn, who is described by many as the synonym for computer-generated graphics.\textsuperscript{11}

\textsuperscript{10} Guardado 2007, also Carlson, lesson 19
\textsuperscript{11} Carlson, lesson 4
In what follows, we will take a look at how each category of simulation of the visual has manifested itself over the years by examining them through selected examples found in the commercial video game space. However, please keep in mind that the evolutionary routes, concepts and technologies depicted here are extremely streamlined for the sake of clarity (and partly argument), and restrained by the amount of space that is available.

### 5.3 Simulation of Space

Space was the final frontier in *Star Trek*, but in real-time imagery, it was really the first of many. The evolution of simulated space can be divided to two main conceptual trajectories, which merged at one point in the history. This comes down to the dualistic nature of computer graphics that is the division of raster/bitmap and vector/polygon graphics\(^\text{12}\) (Figure 9).

![Figure 9 A bitmap entity (left) and a polygonal entity (right) in a virtual space](image)

Polygons are genuine geometrical entities for depicting points and shapes in 3D space, while bitmap is a mere array of pixels in a 2D plane, like a cross-stitching. So, if we understand an object found in modern real-

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\(^\text{12}\) The division is not really this binary, but I will simplify it for now for the sake of consistency.
time imagery\textsuperscript{13} as origami, then bitmap is the paper and what is printed on it, and the polygons are the folds and edges with which the spatiality of the object is created. Sculptures\textsuperscript{14} made of archival card and foamcore by an artist named Susy Oliveira encapsulate beautifully the essence of the prevailing computer imagery paradigm, but only located in the physical world.

However, as said, it took a while before these two worlds finally collided in above described manner, thus there are two parallel histories for depicting space, two origin stories. One story is of bitmap graphics and the other one is of polygon graphics.

In my mind the simulation of space is one of the most defining aspects in the evolution of video games. Dariusz Jacob Boron divides the history of digital gamespace, as he calls it, to a 15-step process, starting from a bare text-based depiction of spatial immersion, ending up to a full visual

\textsuperscript{13} Meaning \textit{texture mapped} polygon imagery, see Chapter 5.3.3 Fusion of Technologies
\textsuperscript{14} See http://susyoliveira.ca/

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realization of 3D space.\textsuperscript{15} However, the borders of his steps are a bit fuzzy and few steps seem perhaps a little arbitrary. But the most relevant aspect Boron is conveying by his analysis is the incremental growth in latitude of the virtual camera over time, by which the evolution of simulated space can be conveyed. My streamlined version of Boron’s concept can be seen in Figure 11.

It all started indeed from game spaces that were analogous to board games in a way that the game space was confined inside the perimeter of the screen (Figure 11: A) The very first home video game system Magnavox Odyssey, released back in 1972, even came with these plastic overlays pictures of tennis courts etc. on them, which were then mounted on the television screen to give a context to otherwise abstract white dots the Odyssey was able to generate.\textsuperscript{16}

The first big breakthrough on simulating space was the paradigm shift from static flat space contained by a screen, to the screen-as-a-window –thinking. Now the game world existed outside the screen as well, which introduced an explorative aspect to the gaming.

\textbf{5.3.1 Bitmap-based Simulation}

In the beginning the movement was restricted only along one axis by scrolling the screen either vertically or horizontally (Figure 11: B), and a little later, along both x and y -axis at the same time (Figure 11: C). This was the time when a sense of depth had to be created by a sort of “trickery”, since hardware could not genuinely move bitmap art along the z –axis, i.e. scaling the bitmaps. The primary (if the only) method for depicting depth at this point was to draw objects on the top of each other, and in addition to that, move objects in such a way

\textsuperscript{15} Boron 2007, 26
\textsuperscript{16} Winter 2010
that art assets were scrolled at different speeds depending on how far the object was supposed to be from the screen, known as *parallax scrolling*. Spatially the situation at this point resembled a table with a sheet of glass on top of it, and between them were paper cutouts trying to depict a three-dimensional space the best they could.

![diagram](image)

*Figure 11* The growth in latitude of virtual camera in bitmap-based space in relation to the screen.

So it was only a matter of time when hardware was capable enough to scale 2D bitmaps (also known as *sprites*) algorithmically and thus simulating the z-axis accordingly, even if in a highly restricted fashion. The sprite scaling technique — mentioned in Chapter 2.3 Story of Sprite Scaling — allowed camera to move along each three axis but without any kind of rotation that would break the illusion of space (Figure 11: D). The proper analogy would now be paper cutouts standing up on a table, all-facing in the same direction.
The state-of-the-art sprite scaling technique was perhaps most famously used by Japanese video game company Sega in its arcade hits like *Outrun* (1986), *Afterburner* (1987) and *Super Monaco GP* (1989) (Figure 12), which all employed something popularly known as *Super Scaler* technology.  

After simplistic sprite scaling strategies came the final effort to simulate space by scaling and distorting bitmaps in a restricted manner, which was known as *ray casting* (Figure 11: E). Ray casting was most famously utilized by *Doom* (id Software, 1993), but the use of ray casting technique and its variant, voxels, were widely in use many years before and after *Doom*. Ray casting was a clever way to make 3D space that was efficient for the computer to simulate, but the price came in a form of restricted movement, as it often does.

Eventually, the simulation of space by “trickery” hit the inevitable evolutionary wall, and it was the time for real-time image industry to move on to something more authentic and, perhaps, conclusive approach.

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17 Fahs 2010, 3
5.3.2 Polygon-based Simulation

So, at the same time, polygon based graphics had been evolving silently in the background, utilized only by flight simulators and other marginal genres of video games. If polygon based graphics struggled with issues of its own, the latitude of spatial movement was definitely not one of them. Polygons are all about the freedom of movement and point of view, and because they are geometrically genuine 3D entities, they do not break down in any condition, like other spatial simulations mainly do (Figure 13). For instance, in a sprite scaling game *Outrun* it would not have been feasible to rotate the camera in a certain way without breaking the illusion of depth, since the bitmap based graphics system allowed scenery to be experienced only from one direction.

![Figure 13 Total freedom of virtual camera in polygon-based space.](image)

As said, the evolution of polygons was never about lack of spatial freedom, as it was with bitmaps, but about the visual quality of how the abstract numerical 3D data enabling that freedom was manifested on the screen. At first – to go back to the origami analogy
– there was nothing but the “folds” on the screen, presented as so-called *wireframe*. Indeed, polygons at the beginning were nothing more but a glorified connect-the-dots-puzzle, which the computer solved x times per second to give an impression of movement, if there was any. The state of the 3D graphics at this point was popularly known as *vector graphics*.

![Figure 14 Wireframe (left), hidden lines (middle), and filled polygon (right)](image)

After that, the evolution of polygonal simulation of space was pretty straightforward. First it was possible to hide the lines that were obscured by other surfaces. Then came polygons filled with one solid color to give them a more cohesive look, and later, different kinds of methods for shading those flat polygons, to which we will come back to later in the Simulation of Light.

On a side note, it is interesting that even though algorithm, say, for hidden lines and surfaces was already written in 1963 by a gentleman called Lawrence Roberts\(^\text{18}\), the commercial implementations of such technology on consumer devices came much later in the mid 80s, when micro computers, such as Commodore 64 and Amiga 500, found their ways into home environments. Consequently, consumers seem to get hold of technology that is in a way already obsolete upon arrival.

\(^{18}\) Carlson, lesson 4
5.3.3 Fusion of Technologies

But then, finally happened the technological breakthrough that defined the paradigm for the consumer computer graphics to this day: the fusion of bitmaps and polygons in the process known as texture mapping first introduced by James Blinn mentioned earlier and Martin Newell in 1976.\textsuperscript{19} On the home front of the things, we could not see texture mapping until mid 90s, and still, the transition from bare polygons to texture mapped ones definitely was not an overnight development, but a rather long and agonizing struggle.

Texture mapping indeed can be seen as a true 3D solution for wrapping and folding 2D bitmaps into 3D space without any spatial limitations to the freedom of movement whatsoever.

Personally, I see the birth of texture mapping as such a big technological breakthrough that the evolution of simulated space beyond that has really been about mere refinement.\textsuperscript{20} If we put a few isolated exotic solutions aside, the simulation of space has basically been about deforming 2D bitmaps with 3D polygons, like an origami, to achieve an illusion of spatiality.

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So, even though there has not been in my opinion a texture-mapping-caliber advancement for a while, there is, however, ongoing development of how the simulation of depth could be brought more close to correspond human perception. As a result, in addition to simulation of perspective, there have emerged lately endeavors like simulation of depth of field and simulation of stereoscopic perception, both of which are in my mind still works in progress. Simulation of depth of field models

\textsuperscript{19} Glassner 1995, 780 ; Blinn, Nevell 1976
\textsuperscript{20} See Chapter 6.3 Polycount
the limited scope of focus of human sight while stereoscopy addresses the dual nature of it. It is a common attitude to consider stereoscopy as “real” or “authentic” 3D, but I would deem such statements as exaggerations, to say the least.

Sure, stereoscopy can provide a nice illusion of depth, but still, it cannot address one of the most fundamental issues regarding the simulation of depth, which is indeed the depth of field. No matter how great the stereoscopy effect is, in the end, one is still staring at a flat image, but only two images simultaneously instead of one. Because everything is physically located at equal distances from the viewer in a flat image, the eye simply cannot focus its sight freely along the supposed z-axis (like in actual, physical 3D space), which is the sole reason why depth of field has to be artificially created, i.e. simulated, when it is needed for.

But as stated earlier, these are developments in progress, and it is intriguing to see how everything is going to unfold in the future regarding depth of field and stereoscopy.

5.4 Simulation of Light

According to some sources\(^2\), God started famously His creative endeavors by proclaiming let there be light. However, in the realm of real-time image, it took a relatively long time before light was even remotely simulated. If the simulation of space in real-time can be seen as a somewhat concluded project, the same definitely cannot be said about the simulation of light. It is somewhat revealing that simulation of space was relatively far evolved before first lighting simulations appeared, so it seems that space – or perspective to be more precise – as a natural phenomenon is far more feasible to communicate with simplistic mathematical algorithms, like scaling sprites, than light is. In fact, it could be

\(^2\) Genesis 1:1
said that certain level of simulation of space is a requirement for even rudimentary simulation of light, just like – to refer to the origin of the real world universe – there had to be vacuum and natural laws in place before something could exist even in principle.

As Wayne Carlson states, “Lighting is one of the most complicated of all computer graphics algorithms […]”\(^{22}\), the history of consumer-level real-time light simulations is yet at somewhat modest state. Indeed, there is a whole discipline in physics; known as optics, which studies the behavior and properties of light, so the knowledge would be more than enough to create near-perfect light simulations with a computer. But still, even today, light simulations found in consumer products are generally carried out with highly simplistic lighting solutions, and much of the innate behavior light holds, has to be either totally ignored or somehow mimicked by “trickery”\(^{23}\). This means essentially every graphical object is lit regardless of its surroundings,\(^{24}\) which is known as local illumination, as in opposite to global illumination.\(^{25}\) So, features like indirect illuminating (light bouncing from an object to another), genuine specular reflections or refractions, subsurface scattering and caustics to name but a few, are still beyond the grasp of real-time rendering, or at least their extensive commercial use is. Yes, there are some great looking commercial lighting solutions that handle features such as indirect illuminating on the horizon,\(^{26}\) but I believe it will take a while before we are really starting to see them applied widely in consumer environments. But that is a future yet to be unfolded.

\(^{22}\) Carlson, Lesson 19

\(^{23}\) Meaning without using an algorithmic simulation.

\(^{24}\) Excluding basic cast shadows to which we will come back soon.

\(^{25}\) Owen 1999, Illumination Models/Introduction

5.4.1 Shading

If we examine instead the origin of consumer level light simulation, it is my belief that the first truly coherent simulations can be traced back to the so-called flat shading, in which filled polygons simply change their diffuse color based on the direction, intensity and distance of the light source, although elementary specular highlights can be realized using proper algorithms. An excellent example of such shading is the Sega’s Model 1—line of games, which includes arcade games like *Virtua Racing* (Sega, 1992) and *Virtua Fighter* (Sega, 1993). But even in those once high-end flat-shading games, real-time shading was limited only to dynamic objects, like cars, characters and such, which have got to do with performance issues.

![Figure 15](image)

Figure 15 Flat shading (left) and gouraud shading (right) from *Star Wars: Tie Fighter* (Lucasarts, 1994)

The real-time shading since flat shading has come a long way. It is not reasonable to go through each and every evolutionary step, but one technology that came right after flat shading has to be mentioned by name, which is the gouraud shading. With gouraud shading, christened after the technique’s first presenter in 1971 Henri Gouraud, polygon now could be shaded by having more than one shade of a color per polygon in order to blend the hard edges polygons otherwise would have (see Figure 15). Indeed, the gouraud shading gives

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28 Vuylsteker 2004, 30
polygons this fairly smooth, unifying appearance using highly optimized but technically limited procedures. The results were often far from realistic due to the archaic principles on which the algorithm was based, but either way, it was a big step to the right direction.

As expected, once gouraud shading was getting outdated, the shading of polygonal objects continued to evolve by simulating more and more natural phenomena inherent to light, one by one. More sophisticated features like mirror-like specular reflections and simulations related to transparency, such as refractions, surfaced at one point, although in a highly restricted and simplified manner. In fact, reflections and refractions to this day are basically realized by distorting pre-defined image (which act as a reflected surroundings) in a way that it provides an illusion of light reflecting from a surface, or refracting through an object. The technique is called environment mapping, which was invented again by James Blinn and Martin Newell in 1976.\textsuperscript{29} I personally would consider such simulations as borderline simulations, or low-level simulations, due to their highly static nature.

All in all, shading algorithms in general have become unsurprisingly more and more sophisticated and accurate over time. Technologies, such as normal mapping (introduced by Venkat Krishnamurthy and Marc Levoy in 1996\textsuperscript{30}) that simulates small bumps and dents without employing polygons, have elevated the depiction light interacting with surfaces into whole new levels in the past decade. But still, as stated earlier, every object is generally illuminated locally without genuinely interacting with each other, like they would in real world. The situation is a lot like if someone photographed every object of a still life separately in a studio and then combined the objects back together in Photoshop, which usually leads to highly unrealistic results. When

\textsuperscript{29} Blinn, Nevell 1976
\textsuperscript{30} Krishnamurthy, Levoy 1996
it comes to lighting, everything affects virtually everything, which is actually one of the reasons why “photoshoping” things in and out of photographs is such a difficult task to carry out convincingly.

### 5.4.2 Shadows

As there finally had been found ways to shade polygonal objects so that they did not all look like a stealth fighter, there emerged a need for simulating another important phenomenon related to light: Shadows cast by objects. So, even though objects are lit locally, separately, there have emerged solutions for them to cast shadows on top of each other, even if highly elementary ones. But still, what the visual impact real-time shadows have brought to the table is enormous, regardless of being rudimentary.

![Figure 16 Shadow volume (left) and shadow map (right)](image)

The dual nature of computer imagery comes, once again, into play when examining cast shadows, which means there are basically two fundamentally different types of shadow, which every shadow system is basically based on. One that behaves somewhat like a polygon, known as *shadow volume* proposed first by Frank Crow in 1977\(^1\), and one like a bitmap, known as *shadow map* of which concept was

\(^1\) Crow 1977
pioneered by Lance Williams in 1978\textsuperscript{32}. The latter shadow type has proven to be more popular in the field, which I believe coming down to the performance issues and optimization. The most obvious difference between these shadow techniques is the mere appearance of them: shadow volumes are laser sharp polygon-like objects, whereas shadow maps consist of certain amount of pixels, and therefore usually have noticeable aliasing. Both techniques have their flaws and advantages, but it seems that shadow volumes remain to be used only in specific cases, whereas shadow mapping has gained a status for being used as a more general shadowing solution.

Shadow volumes were perhaps most famously used by \textit{Doom}\textsuperscript{3} (id Software) back in 2004, which is a good example of a video game in which the whole lighting scheme is realized algorithmically in real-time. \textit{Doom}\textsuperscript{3} was realized by using solely dynamic light sources, which was actually the reason why many deemed \textit{Doom}\textsuperscript{3} as too dark at the time. Since \textit{Doom}\textsuperscript{3} lacked the indirect lighting entirely, the shadowed areas simply remained unnaturally dark. However, \textit{Doom}\textsuperscript{3} was perhaps more like a proof of concept that a game can be lit entirely with dynamic lights, and as such, a success.

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Above leads us to a split that is present when lighting a real-time image. Since the simulation of light in real-time still has its drastic limitations, many games use non-real-time, pre-rendered lighting that is often considered as fake, or trickery. An apt example of that is the futuristic parkour game \textit{Mirror's Edge} (Dice, 2008), which looks absolutely beautifully on the face of it, but being lit with completely non-dynamic light model. In other words, \textit{Mirror's Edge} does not simulate light at all. It just represents, or “plays back”, something that has been made earlier else-

\textsuperscript{32} Williams 1978
where. In some sense, it can be seen as an abusive behavior towards the medium itself, as the simulation of dynamic systems is in the core of the medium. But then again, pre-computer lighting can be sometimes just too beautiful to overlook, and not to forgive in some cases. So, Doom³ is at the other end of the spectrum simulating just about everything related to light in real-time, and Mirror’s Edge is in the other end, looking beautiful, but “faking” everything light related (Figure 17). Real-time image is indeed once again about trade-offs.

In conclusion, simulation of light in real-time is about shading objects with various methods, and casting, yet more or less primitive, shadows on top of each other. There are some cases in which more sophisticated shadows are tried to simulate with moderate success, like for instance, the dynamic ambient occlusion system found in Tom Clancy’s Splinter Cell: Conviction (Ubisoft Montreal, 2009) that performs surprisingly well. But as stated in the beginning of this section, the simulation of light is an

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33 This resonates with the mirror-example in the Chapter 3.4, in that both (a mirror and the game in question) do not generate visual material by themselves, but merely redirect something that is created outside of them.

ongoing project and still at its early stages, and fascinating developments are happening as we speak.

5.5 Simulation of Motion

Motion is the last of the three fundamental entities under scrutiny here and it can be seen as twofold at this point. First of all, motion is a revealing aspect of simulation in general, which means without motion simulation has really no basis for its existence – it becomes futile. Indeed, one equipped with necessary skills can always create a completely realistic still image of, for instance, a sunny mountain vista using paint without that there is any simulation technology been involved. But to make the same image move, let alone interactive in real-time by allowing people to change, for instance, the sun’s position at will, a simulation of how the scenery would illuminate in every possible condition, would surely come useful in that case, if not indispensable. This is also the reason in my mind why there are often claims that “one has to see a certain game X in motion” to really appreciate it.

Secondly, besides being an integral part of the concept and substance of simulation itself, motion is also an object of simulation in real-time imagery. Basically, there are two entities to simulate in terms of motion, which are physics and artificial intelligence. By physics it is meant in this context the causality connected to movement of objects, i.e. how physical matter interacts with itself through collisions and various forces, such as the gravity. And by artificial intelligence, it is referred to a logic that steers graphical objects (usually shaped like sentient beings) in order to simulate an intelligent agent. Simulation of physics and artificial intelligence can be, however, in some cases hard to differentiate unambiguously.
5.5.1 Physics

Simulation of physics can be seen\(^{35}\) as a relatively newcomer in the space of real-time image, even though one can make a case that there were physics simulations to some degree already in place in such archaic games as *Spacewar!* (Steve Russell, 1962), *Asteroids* (Atari Inc., 1979) and not to mention *Pong* (Atari Inc., 1972).\(^{36}\) That may be true, but there is also a strong – more or less accurate – consensus\(^ {37}\) that it was *Half-life 2* (Valve Corporation, 2004) that really started the still ongoing physics revolution in the consumer real-time imagery. Indeed, *Half-life 2* has been credited perhaps too generously for its use of physics simulations, although it was one of the first major titles to implement physics directly to the gameplay itself. Either way, simulation of physics has been almost as long of a project as the real-time image itself, although the most interesting developments have occurred only recently, such as the *Euphoria* –physics system, to which we will come back later.

I believe the very first physical feature that has been simulated in real-time imagery was the basic collision detection, since it is often the basis for even the most elementary video games. *Pong* had collision detection, thus otherwise it would have been unplayable, the ball gliding through the paddles every time. Since *Pong*, the Newtonian view on the physical world has been modeled more or less convincingly over the years. However, it can be said that the use of physics simulation in real-time imagery really exploded after the introduction of so-called middleware physics engines. Middleware liberates game makers and such from developing, for instance, proprietary physics simulation system from ground up by licensing a system from a third party developer, and thus saving a large amount of work in the process.

\(^{35}\) Nvidia is still marketing physics as “The next big thing in gaming” on their website http://www.nvidia.com/object/physx_faq.html

\(^{36}\) Henry, Jacob 2008

Earlier mentioned, *Half-life 2*, celebrated by its physics, utilized physics engine developed by a company named Havok, which was one of the first commercial physics engines in the business.\(^{38}\)

Interestingly, simulation of physics can take place in both 2D and 3D spaces, and in theory in 1D space, too. In 1972 *Pong* depicted a 2D space with a simple physics simulation, whereas *Crayon Physics Deluxe* released in 2009 by Petri Purho offers wide range of physics based gaming all in 2D space as well, only in a more sophisticated fashion. Furthermore, the physics system itself can be mathematically 1D or 2D even though the simulation is represented in a 3D space, like for instance with a pendulum of which motion has only one axis along which to oscillate.\(^{39}\)

As I quoted Manovich earlier, the real world is just far too complex to be completely modeled, which leads us to an uneven depiction of reality. When operating in a highly idealized virtual reality, it is given that we have to make arbitrary divisions for the sake of the mathematical consistency, that do not actually exist in real reality. Therefore physical objects that are included into physics simulations are factitiously divided into distinct fields of scrutiny, such as:

- Simulation of rigid bodies
- Simulation of deformable rigid bodies
- Simulation of soft bodies
- Simulation of fluids

\(^{38}\) Eberly 2003, 5
\(^{39}\) Ibid., xxxi
• Simulation of cloth

The reason why the categories are artificial is rather apparent. For instance, in the real world every physical object is deformable if stressed with sufficient force. However, in a real-time simulation, it is more reasonable to define some objects deformable and others not, which has got to do with the optimization of the work load the computer has to bear. Also, it is a highly philosophical question even in the real world where the exact line between flexible and solid matter is.

Furthermore, there is this one particular area in the simulation of physics that enjoys rather high profile in gaming industry, which is so-called ragdoll physics. By ragdoll physics it is referred to a collection of various physical simulations that are related to a human, human-like or an animal body subjected to various forces and collisions. The importance of ragdoll physics cannot be downplayed, since a large amount of video games are, like it or not, based on doing harm to other people, and in some cases animals too. Indeed, the introduction of ragdoll physics truly was a game changer in visual landscape of any real-time image product using the system, because with ragdolls every kill became a unique event with unique reactions, in contrast to the old way of using predefined animations to do that. Enemies could now, for instance, roll down stairs convincingly, reacting to every step on the way down, which would be otherwise virtually impossible.

On that note, the company named Natural Motion introduced in 2005 a ragdoll physics system which not only simulates collisions and such, but motor nervous systems and muscles, combined with specific artificial intelligence a system they call Euphoria. With Euphoria

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40 These categories become apparent only by looking at the feature list of commercial physics engines, such as Havok or PhysX
41 See the demoreel at http://www.naturalmotion.com/euphoria
it is possible to simulate the actual nervous impulses that move the muscle fibres that in turn move the skeleton, enabling simulation of various human behaviors such as a sense of self-preservation and balance. The technology in question is truly astounding and I see it as a huge step on the road of ever increasing simulated human behavior. Currently Euphoria can be seen used in Rockstar Games’ *Grand Theft Auto IV* (2008) and *Red Dead Redemption* (2010) to name but a few.

### 5.5.2 Artificial Intelligence

*Euphoria* leads us conveniently to the issue of artificial intelligence. As said, in *Euphoria*, simulation of physics and artificial intelligence come together in an unprecedented way, which becomes evident by merely observing a game using the system. For instance, in *Grand Theft Auto IV*, characters react dynamically to bullet impacts by covering the wounds with their hands, trying to keep balance in the process. Also, characters have the prior mentioned sense of self-preservation, so they try to soften impacts with hands, or protecting their head from a trauma when jumping out from a moving vehicle, for instance. *Euphoria* is, in a way, the state of the art system of applied artificial intelligence in the realm of real-time imagery at the moment of writing, but obviously it did not spring up from nothingness all suddenly.

The use of artificial intelligence in real-time imagery can be traced all the way back to the ghosts found in *Pac-Man* (Namco, 1980), or even further to early digital chess games. *Pac-Man* is actually one of the first examples of using something called non-playable characters (NPC) governed by an artificial intelligence trying to either obstruct or help the player to reach goals set by the game. The most fundamental mode of interaction with NPCs has remained basically the same throughout the history of video games, which is some form of a physical violence. The reason for that may be found from Manovich who states that
[...] these characters [NPCs] have expertise in some well-defined but narrow area such as attacking the user.

[...]

In short, computer characters can display intelligence and skills only because the programs put severe limits on our possible interactions with them. Put differently, the computers can pretend to be intelligent only by tricking us into using a very small part of whom we are when we communicate with them.  

Indeed, pulling a trigger or punching someone in the face is a highly reduced and restricted mode of interacting with each other, in contrast to genuine conversation, reflection and negotiation. The project of artificial intelligence is not just there yet, that we could simulate such traits of human existence like creativity or exchange of thoughts – and perhaps never will. In a way, the same ghosts are still chasing us from *Pac-Man* even in the most sophisticated video games today.

Indeed, the project of artificial intelligence is one of the most failed one in the history of computing, if we compare the results to the expectations. It is almost moving to read excerpts from the past regarding artificial intelligence and its future. Charles Csuri and James Shaffer wrote back in 1968:

> At M.I.T. and Stanford University considerable research is in progress, which attempts to deal with artificial intelligence programs. Some researchers suggest that once we provide computer programs with sufficiently good learning techniques, these will improve to the point where they will become more intelligent than humans.

Obviously, 43 years later we are nowhere near replicating human intellect, or even of an earthworm for that matter.

... 

So, what is being simulated by artificial intelligence is the virtual subject’s
ability to make decisions, express emotions and act creatively in front of different situations. Respectively, the simulation of physics is about modeling the mere deterministic causal chain of material interactions. Of course, artificial intelligence is ultimately just that: a deterministic causal chain in a computer’s programmed mind, but it is masked and presented as there would be something extra going on. This gives raise to a philosophical question of free will of our human minds, meaning, is freedom just an illusion generated by our consciousness, and our choices are mere results of materialistic causal chains? It must be one of the most fundamental questions in philosophy, which we will probably not solve in any near future.

5.6 Simulation of Style

Finally we get into the simulation of style that is the final layer in simulating the visual. If space, light and motion are the base components of simulating the real world phenomena, simulation of style is the icing on the cake, as “style” may already give away.

But before we go any further, simulation of style here should not be mistaken with something about which Aki Järvinen writes on his essay Gran Stylissimo: The Audiovisual Elements and Styles in Computer and Video Games. Järvinen classifies the history of video games in three distinct “audiovisual styles”, which are according to him photorealism, caricaturism and abstractionism. He explains the categories as follows:

> [P]hotorealism simulates environments and characters familiar from film and real life [...]. Caricaturism simulates environments and characters familiar from cartoons and comics. In abstractionistic games, basic aural and visual forms are simulated.44

What makes Järvinen’s stance on simulation of style problematic is his use of the term simulation: According to Järvinen, if something is in a video game, it must be some kind of a simulation, which is an inac-

44 Järvinen 2002, 121
curate view to say the least. Once again, as I have tried to convey on the previous pages, the simulation (defined as a replication of appearance and behavior of the real world referent) is only one dimension of the real-time imagery or paradigm of video game, even if it is, in my view, the most fundamental one. So, while Järvinen’s categorization of styles is not without a merit and definitely valuable in its own right, the issue with his “simulation” is that it really does not take account the technological nature of the content and the way it varies within the medium. And that renders the classification he presents irrelevant, at least from the viewpoint of this thesis.

So what we mean by simulation of style in the context of this thesis is a technological operation in which a computer image is algorithmically processed to adhere to a certain visual principle, style, that has a real world counterpart.

The prime example of the simulation of style must be the so-called cel shading technique, which makes it possible to simulate hand-drawn imagery, but also technical, “blue print”, imagery by tracing outlines of
objects and shading the objects with sharp, usually bi-shade, scheme. The trailblazer of the cel shading technique in the video game context must have been the *Jet Set Radio* (Smilebit, 2000), which simulated quite successfully graffiti-aesthetic and so-called urban art. And the outline tracing was the very enabler for the simulation of such visual landscape, since graffiti rely very much on heavy outlining. A more recent example of cel shading is the ultra-violent *Madword* (Platinum Games, 2009) of which look of an underground graphic novel is coupled with a high contrast black and white aesthetic.

Another form of simulation of style is replicating screens of various technical devices, like a thermal imagining camera, an x-ray camera or a night vision camera. An obvious case of such simulation of style is *Call of Duty 4: Modern Warfare*’s (Infinity Ward, 2008) famous *Death from Above* -scene in which the player is firing at the enemy on the ground from an “AC-130 –Gunship”, using “a thermal imagining camera”. The imagery of that particular scene is almost indistinguishable from the real thing, which is philosophically interesting arrangement: A video game simulating a weapon mimicking a video game. And not to mention the original

Figure 19 *Call of Duty 4: Modern Warfare – Death from Above*
*Tom Clancy’s Splinter Cell* (Ubisoft Montreal, 2002) which was known for its simulations of various technically enhanced visions.

Then again, one of the most interesting design decisions related to simulation of style can be found from *Kane & Lynch 2: Dog Days* (IO Interactive, 2010) of which style simulates low quality digital video camera. The game in question must be the first case in which deficiencies of a digital camera is simulated in real-time in order to create an aesthetic parallel to imagery found in poor quality YouTube -videos. What makes the effect even more interesting is that it reacts to the game events by using the visual artifacts and digital video errors to indicate the damage the player’s character is getting from bullet impacts, which is something I have not seen before. Visually the effect as a whole is like a modern version of the classic film-grain-effect that is as well used in various real-time image contexts.

All in all, simulation of style is perhaps the latest phenomenon in real-time imagery, since it requires fairly sophisticated hardware to pull it off adequately. Also, because style comes as a layer on top of the other
simulated material, it is quite natural that there had to be visual material existing there first, like polygons, before the simulation of style was reasonable, or even possible.

... I have now analyzed and broken down the forms of something I call simulation of visual, and which I see as a central lens through which real-time image should be understood in a way that is not only illuminating, but also fair and justified towards the medium. Real-time image should not be judged only by mere representations it might contain, but by taking account the processes and principles how the image has come to be. By doing this, we can wonder at just as much for what it does, as for what it can do.\(^{45}\)

It is now apparent that real-time imagery has moved throughout its existence towards a higher state of simulation, in that more and more features of reality are simulated in contexts of scientific experimentation, computer animation, and, of course, video games. Furthermore, relatively recent developments, such as the simulation of nervous systems, indicate that the evolution of real-time imagery is still an ongoing process and likely far from its completion, if never.

Regarding the Cult of Real-time Image, it seems rather obvious and self-evident that the more of visual landscape of real-time imagery is being algorithmically simulated, the better and more “true” to the medium the given image is. Simulation is the native language of real-time image and a paradigm without which it simply remains concealed.

\(^{45}\) To reformulate Andrew Darley’s quote used in Chapter 2.2
I would go even so far as to credit the lack of simulation technologies for the sole reason why “interactive cinema” failed back in the early 90s, the supposed golden era for CD-ROM spectacles and such.

And respectively, I would argue that the success of devices like the iPhone and the iPad stems partly from the sleek real-time simulations on their interfaces, like in, for instance, the so-called Cover Flow feature with which the user can flick through their music catalog in a highly impressive fashion by using nothing but a finger. The Cover Flow indeed is an apt example of an application of real-time image, which employs simulations of space (perspective), light (reflections), and motion (inertia) to create a compelling way to interact with one’s music library – all in a relatively high definition. Furthermore, the idea of simulation as a platform for play and experimentation actualizes in the Cover Flow to an extent, since it is simply fun to flick album art back and forth with it. It is fun to play with it.

That said, what is left there of the three main ideological pillars of the Cult of Real-time Image is the notion of definition, which happens to be a subject of our next chapter.
CHAPTER VI

... NEED FOR DEFINITION
From the previous chapters, it has already become quite apparent that real-time image has always been very much defined by its limitations, compromises and a certain kind of general handicap-ness. One could say that technological restrictions are rooted in the very core of the real-time medium, since no other image is as dependent on sophisticated programming and semiconductor technology as real-time image is. The reason for that lies obviously in the demand of real-time, which forces images to be built constantly from ground up, each and every time, a hundred times per second in some cases. But that is the beauty of it, as image can be thus manipulated on the fly.

Besides the concepts of real-time and simulation, the understanding of real-time image needs yet one additional concept, that is the notion of definition, and the hardcore audience’s constant demand for more of it. In fact, this demand is the very engine that drives the real-time image industry to constantly update graphic cards and other ever-renewing gaming hardware. The fact is that when a certain level of technological quality has been reached, it becomes a standard and everyone recalibrates his or her expectations according to the new “normal”, and the cycle starts over. It is much like with a narcotic addiction: there is no going back once the new standard of chemical dependency is reached. In real-time imagery, there is no going back once the new level of definition is reached.

Even though hardware has evolved enormously in the past few decades, and as a result opened possibilities which one could only dream of in the past, there is, regardless, never truly enough processing horsepower
available so that it would fully satisfy everyone making and consuming these real-time images, and perhaps never will be. It is in the nature of real-time image that developers tend to operate at near the boundaries of the medium, pushing them in the process if possible. This finitude of processing power can be considered as a burden for real-time image, but at the same time, the limitations are often a tremendous source of creativity, which is especially apparent in the so-called demoscene.

As we earlier examined the concept of simulation, how it replicates the appearance and behavior of the real world source systems, such as light, the human nervous system or gravity, we noticed that since the reality is infinite in all its detail and depth, a mathematical model, i.e. simulation, is always an incomplete, finite rendition of that reality, as representations tend to be in general. And because the processing power running these simulations is also highly limited and finite, from this follows that the simulated reality is always represented in a certain definition, or fidelity to use another terms. The reality is infinite, but simulations and the processing power of computers are everything but.

Next we are going to look into the selected manifestations the notion of definition has in the context of real-time imagery by examining briefly the most crucial instances of the concept, and how it penetrates nearly every layer of the medium under scrutiny.

### 6.1 Resolution

One of the most fundamental aspects of definition is the concept of resolution, which has a few different contexts of use in the real-time image. At this point it has to be made clear that yes, resolution is practically interchangeable with the concept of definition that is our umbrella term in this chapter. However, because resolution has in addition more

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1 See Chapter 7.1 The Demoscene
specific meanings in the real-time imagery, it is examined as a separate entity here.

First of all, resolution is referred to a sample frequency of the so-called digitalization process, in which the continuous analog object or signal (photograph, sculpture, painting etc.) with infinite detail is converted to a digital, finite numerical form. So, if we compare digital image, such as real-time image, to analog artifacts, such as a painting or a drawing, we see a fundamental difference in them: the analog artifact is continuous in its structure, whereas digital image consists of discrete, measurable units. Lev Manovich writes:

Sampling turns continuous data into discrete data. This is data occurring in distinct units: people, pages of a book, pixels. Second, each sample is quantified, i.e. assigned a numerical vale drawn from a defined range (such as 0-255 in the case of a 8-bit grayscale image).²

If we apply the above excerpt to the Wooden Mirror presented in Chapter 3.4, the number of square pieces of wood (830) is the distinct units of data, i.e. samples of the video-to-wood -conversion, and conversely, and the number of possible positions the pieces can have (unknown, depends on the capability of particular servo-motor) is the quantification of those samples. In short, digitalization is a process in which something infinite becomes finite and thus, measurable, and resolution is the numerical measurement of that conversion.

Then again, as Manovich points out, there are mediums that are combinations of continuous and discrete data, such as motion picture film, since it consists of separated frames, which can be considered as samples of time.³ But the crucial difference according to Manovich is the quantification of samples, which is absent in motion picture films.

² Manovich 2001, 49
³ Ibid., 50
6.1.1 Screen Resolution

In every day use, however, the notion of resolution is often employed to indicate the number of pixels on the screen. Traditionally screen resolutions of real-time image have been for instance 320 x 200, 640 x 480, 800 x 600, or 1280 x 1024 pixels in 3:2 or 4:3 aspect ratios, but in the past decade, the transition has been towards more cinematic 16:9 aspect ratio with resolutions such as 1980 x 1080. Obviously the number of pixels on screen has been steadily growing over time, although there have been signs that screen resolutions are finally reaching a plateau and becoming more fixed in recent years, which indicates saturation of some degree in that particular area of real-time image.

Yet the interesting aspect relating to screen resolution is the evolution of smaller screens, likes of smart phones or handheld gaming consoles, of which screens have seen an enormous advancement in the past few years. For instance, in 2010 released Apple iPhone 4’s screen resolution (326 pixels per inch⁴) well exceeded the resolution of a standard print magazine (300 dots per inch), which is an astounding achievement in itself.

6.1.2 Texture and Lighting Resolution

Secondly, besides referring to the number of pixels on a screen, resolution also points to the amount of pixels on a 2D texture. As we concluded in the previous chapter, texture mapping consists of pixels, known as texels, that are wrapped around the polygon object to depict colors, different kinds of materials, reflections and small dents and bumps, to name but a few. Unsurprisingly the resolution of textures has also increased dramatically from the early days of texture mapping to the point that it can take a real effort from one to differentiate singular texels anymore in a modern video game. Still, it seems that

the resolution of textures is an ongoing project in terms of quality and sophistication, in contrast to the fairly stabilized resolution of screen.

Finally, since previously mentioned shadow maps consist of pixels, they as well have a certain resolution (see Figure 16) Since real-time shadow maps are a rather novel visual feature in real-time imagery, and still relatively taxing to any current hardware, shadow maps are therefore often represented in a relatively low resolution, giving away their bitmap nature even to an untrained eye.

Since simulation of light is moving constantly forward, and new ways to depict light interacting with surfaces are emerging, such as ambient occlusion, resolution can yet refer to overall quality and fidelity of those more sophisticated shadowing methods.

### 6.2 Color Palette

As the screen resolution, the amount of colors available seems to be a project on its final phases, if not fully concluded, too. Today, we perhaps tend to take the modern rich color palette for granted in real-time imagery, but as with the screen resolution, the color palette had a humble beginning of its own.

It was only natural that color palettes started to evolve from the smallest possible amount of colors that was a palette of two distinct colors, which can be found in use from such instances as *Pong* (Atari Inc., 1972), and not to mention *Tennis for Two* (William Higinbotham, 1958). The latter was actually played on an oscilloscope-screen, which made it as the first graphical video game in history, according to some accounts.\(^5\) In a way, the early bi-color scheme was true to the digital medium in question,

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\(^5\) Nosowitz, 2008
since in its most rudimentary level, digital is all about ones and zeros, ons and offs, black and white. Of course, besides the black and white combination, black and green and black and orange—variations were also quite popular at that time.

People’s need for more colors ultimately drove computer industry to find ways to expand the color palette. The number of available colors has been basically increased exponentially from two to four colors (known as CGA, first color display standard to the IBM-PC), and then continuing to increase to

- 16 colors (used by Commodore 64 among others), then to

- 256 colors (VGA, more advanced color display standard for IBM-PC), and proceeding to

- 4096 colors (used by Amiga 500 among others), after which to

- 65536 colors (known as Highcolor), and finally ending up to the modern color palette of

- 16777216 color variation for each pixel that is known as Truecolor.

One does not have to be a mathematician to notice the pattern of $2^n$ , which is actually typical for computer science at large because of the binary system of ones and zeros with which computers operate.

In addition, there are color systems beyond Truecolor, such as Deep Color, which can represent more than 16,7 million colors, in some cases trillions of colors, but they are at the moment mainly used in high-end workstations out of the reach of everyday consumer.
So, we started from only two colors, ending up to trillions of onscreen colors. It seems that color palette in real-time imagery really has not many places to go anymore, even though it is usually difficult to make predictions, let alone declare something for certain, in the field of technology. But one thing is clear, and that is the fact that for a while now the number of colors in real-time imagery has not really been an issue as much as it was, for instance, 15 years ago. Modern color palette seems to be “good enough” for majority of people, even the hardcore ones, which is a rare case in the context of real-time image at large.

6.3 Polycount

In the previous chapter we discussed simulation of space and how it is nowadays usually, if not entirely, realized by using mathematical entities called polygons. Polycount in turn indicates the number of polygons particular object or scenery contains – or is made of, put differently – and more polygons means more detail and simulated accuracy.

Unsurprisingly, the number of polygons is also something that has started from just a few triangles representing objects in a highly abstract manner, to hundreds of thousands of polygons simultaneously on the screen, depicting everything from inanimate objects to people, flora and fauna – in some cases very convincingly. Indeed, after many other techniques hitting their evolutionary dead ends, it was polygons that finally developed into a universal standard for simulating space and creating shapes, and as computer hardware advanced and became more capable, the polycount increased allowing more and more life-like objects to be constructed.
Chapter VI: Need for Definition

The real benchmark for the polycount has always been obviously the round shapes, such as tires of a car (see Figure 22), of which resembled for a long time more like something folded out of paper than a real round shaped set of wheels. Of course, the evolution of shading algorithms has played its part – a substantial one – in the project of smoothing the surfaces, not just the number of polygons alone. Nevertheless, the impact of today’s relatively high polycounts cannot easily be downplayed, it has had on the visual quality of, for instance, modern video games. More building blocks simply mean more creative possibilities and life-like simulations and judging by the history of real-time imagery, polycount is likely to keep on increasing in the future as well, at least to some extent with technologies like hardware tessellation. As stated earlier, predicting the future of any technological endeavor is exceptionally difficult.

Figure 22 Polygon structure taken from GRID: Race Driver (Codemasters, 2008)

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6 Hardware method (i.e. more efficient) for subdividing geometry.
Obviously, polygons are not the sole graphical entities, or building blocks, in the real-time imagery, but nevertheless, the rise of polycount represents aptly the general tendency of increasing the graphical objects on the screen at once. Before people talked about polycounts, there was discussion of “sprite-counts”, meaning with how many single images certain animation was carried out in a sprite or how many parallax-scrolling levels there has been used to create illusion of depth.

### 6.4 Level of Detail

It is only fitting to proceed from polycount to the concept of level of detail, which could be seen as one of the consequences of a relatively high amount of polygons (or any graphical material) in spatially large real-time scenery. As the simulation of genuine, polygonal 3D space became more common in real-time imagery, and because every graphical object takes its own slice of the limited computational “resource-cake”, there emerged a need for developed methods to somehow limit the amount of graphical entities that are visible on the screen at once.

At first, the solution was simply to hide objects on a certain distance from the viewer, which led to a highly noticeable phenomenon effect known as the “pop-up”. The pop-up –effect basically means that an object simply appears out of thin air onto the screen when approaching it in a 3D space and the threshold that determines which objects are drawn and which are not is called *draw distance*. So, leaning solely on the draw distance to limit the number of graphical entities on screen is rather crude and straightforward method, and it was often masked with a high-density fog –effect, so objects seemed like they appeared gradually from the “fog”. One of the most iconic cases of using such fog –effect is the Iguana Entertainment’s *Turok: Dinosaur Hunter* (1997).
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The level of detail is basically a strategy to push seemingly more graphical entities on the screen that would not be otherwise feasible by using distance\(^7\), which is a byproduct of the simulation of perspective, as a sort of a masking device. Thanks to the perspective, objects in a distance appear smaller on the screen, so they do not need so much detail in them as the objects closer to the viewer. As the granddaddy of level of detail techniques James Clark argued back in 1976, “It makes no sense to use 500 polygons in describing an object if it covers only 20 raster units of the display.”\(^8\) Indeed, it does not.

Figure 23 Level of detail and distance.

Basically when using level of detail, a developer creates of every object multiple variants, each with progressively less detail. A computer then selects and uses these variants depending on the distance the objects are in: Faraway objects are substituted with low-detail variants while objects

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\(^7\) Or in some cases velocity, eccentricity, or depth of field, but not so much in the real-time context, I believe. See, for instance, the slides of Martin Reddy’s SIGGRAPH 2002 presentation http://graphics.pixar.com/library/

\(^8\) Clark 1976, 548
close to the “camera” are represented with high-detail ones. There are also techniques with which level of detail can be carried out algorithmically, without the developer having to create each and every object manually. This approach is usually implemented on rendering a terrain –like objects.  

An intelligent use of level of detail has enabled to depict vistas with “kilometers” of visible landscape that would not be otherwise feasible in real-time imagery using current hardware. And besides the increased visibility in real-time imagery at large, the level of detail –techniques themselves are constantly evolving and becoming more sophisticated and unnoticeable – as they should.

The level of detail is somewhat of a necessary evil that in the ideal world of infinite computing power would not exist in the first place. The paradox of level of detail is that by limiting the amount of less important graphical entities on the screen, it allows seemingly more objects to be presented as a result. For instance, Rockstar Games’ Grand Theft Auto IV

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9 See http://vterrain.org/LOD/Implementations/
(2008) relies heavily on powerful level of detail –system in depicting a rich urban environment full of detail, although in this case the process can be highly noticeable at some points, and thus a little distracting.

6.5 Accuracy of Motion

As we concluded in Chapter 5.5, simulation of motion consists of the simulation of physics and the simulation of artificial intelligence, both of which are calculated on a certain sample rate, i.e. definition. From this follows that simulated motion is always an approximation of the physically and mathematically ideal situation, just like in the digitalization process discussed prior.

The accuracy of the simulated motion is rather esoteric field to examine, and it manifests usually only when it is way off. For instance, in Bioshock –games (Irrational Games, 2007 and 2010) physics calculations were performed at noticeable low rate for some reason, which resulted in jerky and stuttering motion. Otherwise, modern physics simulations usually are carried out reasonable well in terms of the sample rate, and in fact, it is safe to say that physics algorithms themselves play as big role in physics simulations as the update rate.

Interestingly, discussion concerning the sample rate of physics simulations has recently found its way to the marketing lingo, as the Turn 10 spokesman Steve Beinner demonstrates:

As well as more events and more cars, Forza 3 brings a 360 Hz physics engine, which can deal with the way in which the tyres move as they grip the road.10

Marketing speech is rarely motivated by genuine seek for truth, and thus should be taken with a grain of salt, but either way, 360 Hz (meaning the physics engine is updating itself 360 per second) apparently is such a

10 Goss, 2009 (italics added)
high rate that it is worthwhile to bring up in the context of an interview and indicates that it is “an accomplishment”.

Additionally, when simulating collisions, there is a strategy similar to level of detail to keep calculations as simple as possible by using something known as collision mesh. Collision mesh is basically a much simpler (invisible) object that is used as a proxy for more detailed (visible) one when calculating physical interactions. At the dawn of the simulation of physics, collision mesh could be as simple as a box or a sphere bounding the object, and in some cases, they were enough to convey an illusion of physicality. Naturally, the collision meshes have since developed to match more closely the actual representative objects, but still, the cap is there due to the cumbersome nature of physics simulations.

### 6.6 Image Quality

When real-time image is finally rendered on the screen, there are yet multiple variables that come into play, which all contribute to the final quality of the generated image. The serious discussion involving image quality in the realm of (consumer) real-time image is relatively recent, and the birth of it can be traced back to the rise of 3D accelerated video cards in the late 90s. 3D acceleration made possible to “filter” images in various ways in order to smooth out the rough edges the untouched real-time image usually contains, making the image visually more pleasant.

One of the crucial aspects connected to the definition of the computer generated image is so-called aliasing, which refers, according to Andrew Glassner, to all unwanted visual artifacts that stems from the finite capability of digital “signal” to represent continuous ones.\(^\text{11}\) However, a process called anti-aliasing aims specifically to soften the crisp edges that make singular pixels exceptionally noticeable, a phenomenon known as

\(^{11}\) Glassner 1995, 118
the “jaggies”\textsuperscript{12}, and furthermore to make rendering of 3D data more accurate overall. The need for anti-aliasing stems, as said, from the finitude of screen resolution, meaning the smaller the resolution of any given image is, the more relevant anti-aliasing becomes. Put differently, the fewer pixels there are available for the computer to depict a 3D entity on the screen, the more careful and “intelligent” the computer has to be in choosing the right colors for the right pixels. However, this extra “thinking” the computer has to carry out comes with the price of increased workload, and decreased frame rate in effect, to which we will come back in the next section. One method for anti-aliasing is the so-called supersampling, which renders image by taking more samples than would be the minimum necessity (which is the number of screen pixels)\textsuperscript{13}. More samples mean more definition.

![Figure 25](image)

*Figure 25* A raw, unfiltered cube (left) and a supersampled and filtered cube (right), both represented with equal number of pixels. Notice the unwanted moiré-effect on the unfiltered cube.

Besides anti-aliasing, there are yet other ways to improve the quality of the real-time image. Another approach to this is to filter textures so that they look optimal regardless the angle they are in, in relation to the screen. The fact is that textures in large can create visual problems, such as moiré-like artifacts, that are beyond a remedy of anti-aliasing, so the

\textsuperscript{12} Owen 1999, Aliasing/Overview of Aliasing in Computer Graphics: Part 1

\textsuperscript{13} See http://www.everything2.com/index.pl?node_id=1028947
solution for reducing the noise is to filter the textures separately. Texture filtering can be used to complement the anti-aliasing, which deals with the whole screen equally no matter what the content is, but naturally the hit to the performance is far greater in that way than using anti-aliasing alone. One of the most sophisticated current methods of filtering textures is so-called anisotropic filtering, which can take up to 16 times more samples of a texture than without filtering.14

In short, image quality answers more to the question of how the graphical entities are rendered on the screen, than what is rendered. Features concerning the image quality have increased enormously from none (pre-mid-90s) to modern days’ dozens of options, and they all share the common goal, which is to make the real-time image more defined.

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The need for more definitive experiences and accurate visual representations in real-time imagery is an observable phenomenon only by looking at the history of the medium, how it is evolved from abstract figures to almost photorealistic images. Indeed, there has always been the next tier of image quality looming on the horizon, just waiting to render the current state of the art obsolete, and only time will tell how long this development will continue into the future within the medium under scrutiny.

Even though low definition in real-time imagery is generally considered as an unwanted phenomenon, there are instances in which purposefully limited color palette15, lower resolution16, or lesser amount of polygons17 are been used as an artistic decision, not due to technological circum-

14 Covac 2009
15 For instance MadWorld (Platinum Games, 2009)
16 For instance Scott Pilgrim vs. The World (Ubisoft, 2010)
17 For instance We ♥ Katamari (Namco, 2005) to an extent
stances. In fact, the whole video game genre of so-called neo-retro\textsuperscript{18} is based on arbitrary limitations that are directed mainly to the visual side of the video games, consequently making them still enjoyable to play with, for a modern consumer. Interestingly, limited frame rate by design is yet to be used as an artistic instrument, at least in the mainstream real-time imagery, which stems perhaps from the still ongoing struggle with high and steady frame rates at large.

On a personal note, my own connection to real-time image could be described as of a loving parent watching his child to grow, even though I have obviously no part in conceiving the medium. But still, watching the real-time medium to develop and “learn” new things year after year has been nevertheless exhilarating and inspiring, and the ever-rising definition of the medium has been without a doubt one of the reasons for me to keep following the real-time image industry from my childhood to this day.

In real-time imagery, devil is in the detail, and the more definition there is, the better any given real-time image is generally considered. As said, the notion of definition and the hardcore audience’s demand for a higher state of it is woven into the fabric of real-time medium, just like the notions of real-time and simulation. And failing to recognize that is to ignore a large proportion of what makes the medium, and the Cult of Real-time Image, what it is.

Speaking of the Cult, in the next chapter we will finally dive into the different forms that in the end constitute and makes visible the Cult of Real-time Image.

\textsuperscript{18} More on neo-retro, see http://www.gamasutra.com/php-bin/news_index.php?story=20836
ow that we have scrutinized the ideological underpinnings of something I call the Cult of Real-time Image, it is time to dive into the different ways the Cult materializes, how it becomes visible. At to this point, video games have mostly been the paradigm of choice in which the ideas of real-time, simulation, and definition have become tangible, cultural objects. And in a way, video games are a celebration of real-time imagery at its purest form, and at the center of the Cult, there is hardy a question about it. However, there are artifacts and conventions outside of video games yet to be analyzed, in which the hardcore frame of mind that acknowledges those ideas, the Cult, becomes visible in a variety of ways.

Next, we will take a brief look at some of the incarnations of the Cult by examining the following entities more as mere examples than anything else. Again, thorough analysis would not simply be reasonable, if even possible, within this thesis, and the following should be considered as a mere outline of the tactile part of the Cult.

7.1 The Demoscene

Perhaps the most ideologically orthodox instance of the Cult is the computer subculture known as the demoscene. In short, demoscene is a collection of people who make “demos” using computers to impress, either other people making demos, or people who happen to be interested in such a phenomenon. Demos themselves are (more often than not) non-interactive music video –type products containing various computer-generated imagery rendered in real-time.
7.1.1 The Scene

The roots of the demoscene, or the scene (a colloquial term for demoscene) can be found from the underground illegal activities, which consisted of different groups pirating software by breaking the copy protections, after which distributing the software via diskettes, and later so-called bulletin board systems and the Internet. To raise notoriety of given group, “little screens with effects called crack intros were placed at the beginning of illegal software to display the name of the crackers and to send messages to other groups.”

As the time went by, crack intros developed to stand-alone demos, abandoning their shady roots on software piracy. From now on, the effects themselves became the central entity around which the demoscene started to revolve by pushing the hardware through meticulous optimization processes. However, later, according to Markku Reunanen, aspirations of the demoscene have geared more toward self-expression, as tools available have become more allowing for such endeavors, but still, it would be inaccurate, at the least, to state that the layer of technological ambitions and motivations would not be present even in the most artistic demoscene productions.

That said, I would argue that one cannot genuinely recognize and appreciate demos made within the scene without at least an intuitive assimilation and understanding of the ideas of real-time, simulation and definition scrutinized previously in this thesis. I would even go as far as to say that this hardcore mindset that acknowledges these ideas to the point of a fetish is what has differentiated demos and the scene from other forms of new media art, and the art world at large. Reunanen, though, provides

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1 Reunanen 2010, iii
2 ibid., 52
3 ibid., 104
4 Even though there are other artifacts made within the demoscene, such as still images and music, demos are easily the main category.
other additional reasons for this division, such as different origins of the communities, underground nature of the demoscene and the strict rules and conventions that define the whole scene, which the art world generally lacks completely. Not to mention the thematic differences: demos focus generally on non-political audiovisual show-off instead of activism\(^5\), (presumably) in contrast to the mainstream art scene.

The most interesting aspect of Reunanen’s list from the viewpoint of thesis is by far the show-off attitude that separates demos, according to him, from other forms of new media art. This mentality can be seen manifested in so-called demo parties in which artifacts produced by different groups go head-to-head for prizes and prestige. Indeed, this kind of sports-like behavior is highly unorthodox in the context of visual arts at large and I believe it stems from the mental attitude under scrutiny through which the demoscene productions are being evaluated. A mindset that quantifies art pieces, and thus subjects them to head-to-head comparisons, qualifies indeed to something I call hardcore viewership in this thesis.

### 7.1.2 Understanding the Demos

Now keeping in mind the three pillars of the Cult, the requirement of real-time is the very basis of demos, which alone is a quite peculiar demand for a visual art piece. Real-time is what justifies everything else. Even the first comprehensive book about demoscene was titled *DEMOSCENE: The Art of Real-Time*\(^6\), so evidently the concept of real-time is at the heart of the demoscene and if one fails to grasp the idea of real-time and what its connection and repercussions are to an image, it will be an uphill battle for anyone striving to understand the people and the artifacts of the scene. So, when judging the demoscene productions, the idea of real-

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5 Ibid., 29  
6 Edited by Lassi Tasajärvi 2009
time is, and should be, constantly present, and the more effects are being rendered in real-time at highest possible frame rate, usually the “better” any given demo is. Furthermore, since demos hardly ever are interactive, they can be considered as pure celebration for real-time, given that we paired real-time to interactivity in the Chapter 3. Real-time becomes a value in itself.

Second, one can make a case that the visual content of demos for the most part focuses on various simulations, which are often referred to as effects. In fact, if we ignore the most mundane elements, such as the “scrollers”\footnote{Usually a horizontally moving text element.}, there are only few facets of the visual landscape found in demos that do not fit in the concept of simulation as depicted in Chapter 5. Indeed, Reunanen’s categorization of various demo effects spanning the different eras of demoscene validates the fact that only at the very beginning, from 1985 to 1989, there were no actual simulation techniques present, obviously due to technological circumstances. But after that early period, various simulations related to space, light and motion (through mainly physics) started to emerge more and more as the hardware became more capable.

An interesting detail is one particular simulation effect that Reunanen, for one, calls “star field”, which was part of the demoscene repertoire at the offset. Star field is an effect in which dots are being moved on the screen in parallel motion at different speeds creating a simple illusion of a three-dimensional star field gliding past. It was an early attempt to simulate space, quite literally, and in fact, I believe the star field –effect is the most rudimental way to simulate three-dimensional space, which is the beauty of it.

But as said, the visual content of demos have since the early days relied heavily, if not entirely, on various simulations judging by, again, the cat-
categories presented by Reunanen. Later when demos started to have more ambitious art direction and design in them, and began to develop towards a platform for self-expression, I would argue nonetheless that the actual substance of the demos is still in the simulations of space, light or motion. If we examine, for instance, the way Reunanen – an expert in the field – describes a screenshot of a demo in a caption “[…] shaded texture mapping and an overlay with a popular culture reference,” we can notice how Reunanen ignores entirely the content of the “cultural reference”, which was a black hip-hop man, focusing on the simulation technologies instead: Shaded texture mapping. It also becomes painstakingly clear only by looking at number of demos that demo makers really are not actually keen to convey deep stories, thoughtful metaphors, or meaningful reflections, but simulations, simulations, and simulations.

Lastly, demos and the demoscene cannot be but misjudged without acknowledging the concept of definition scrutinized in the previous chapter. To paraphrase Reunanen’s apt description, the demoscene exists to break borders and do the impossible, so in the end of the day, demos as a human endeavor are at the most profound level about optimization, and furthermore, definition. Indeed, I would argue that taking the most out of the hardware available using the most efficient algorithms possible is what ultimately makes the whole demoscene tick, driving people to find ways to ever-increase the definition of the demos. This aspiration seems to be hard-coded into the demoscene DNA so much that, according to Pilvari “Nosfe” Pirtola, there are cases in which demo authors have exaggerated technical specifications by locating, for instance, false polycount statements to company certain effects on the screen, making

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8 Reunanen 2010, 50-51, if we exclude still images that are being used here and there to pace the sequence of effects.
9 See ibid., 59
10 Ibid., 94
11 Ibid., 52
12 Puha, Mattila 2010, episode 4
the demo appear more defined, and thus “better”, that it actually was. This brings us back interestingly to the case of church spectator, or the *Killzone 2* case in Chapter 2.2 in which mere belief or idea, even if false, steered the perception of a certain artifact when the spectator subscribed to a certain aesthetical ideology. In the demoscene, the amount of definition plays a substantial part in evaluating the artifacts made within the scene, in addition to the notions of real-time and simulation.

### 7.2 Tech Demos

If the demoscene is about pure enjoyment of creative process and fraternal rivalry among the peers in a non-commercial fashion, technology demonstrations, or *tech demos*, are basically the commercial side of that same coin. Indeed, a tech demo usually contains a commercial interest that involves selling a certain technology (hardware or software) by demoing it in a compelling way, either to a specific industry entity, or to a wider audience. While tech demo is a broad term that can cover various areas of technology, in what follows, we concentrate on the instances that are made in order to demonstrate real-time imagery.

#### 7.2.1 Hardware Tech Demos

A prime example of tech demos that instantiate quite nicely the ideology of the Cult are the ones that hardware manufactures, such as NVIDIA and ATI in graphics cards; or Microsoft, Nintendo and Sony in gaming consoles, use to push their offerings to the consumer real-time imagery market. At first, these demos are typically designed to promote yet to be released hardware at different media events, and later (mostly with graphics cards) end up shipped with the final product for the end user to play with. These kinds of tech demos are highly specific to the hardware they are showcasing, and thus designed to highlight the areas in which the hardware in question is performing particularly well, in the most favorable light.
Since hardware is basically the ultimate enabler for real-time imagery\footnote{See Chapter 3.4.2 Hardware}, such tech demos can contain genuinely novel (and in best cases groundbreaking and paradigm shifting) concepts of how various simulations are carried out in the realm of real-time imagery, which makes hardware tech demos often the most exciting ones. Seeing at the first time what the next generation gaming console or graphics card is able to perform can truly be a magical, Cult-like, experience for the hardcore audience. For instance, judging by the video\footnote{See Savov 2010} filmed in an NVIDIA press event in the autumn of 2010, the ambiance of such happening can be nothing short of fanatical, attendees cheering and raving about new (simulation) technologies they are presented to, perhaps even more so than in the demoscene parties. If something comes close to a Cult of Real-time Image, it is definitely events like that.

### 7.2.2 Software Tech Demos

Then there are software tech demos that showcase usually particular rendering technology using current, established hardware. Usually software tech demos are not tied into any particular hardware setup, which means that technologies and algorithms are the main object of marvel, not the hardware on which they are running. As an example of such tech demo it could be mentioned the *Unreal Engine 3*\footnote{See http://www.youtube.com/watch?v=-m4pe6UAS2M} demo presented in the Game Developer’s Conference ’08, which encapsulates neatly some of the ideas of the hardcore mindset. The whole basis of the presentation is to virtually fetishize certain simulation technologies, such as of light and motion (physics in this case), and the aspect of definition as well.
As the *Unreal Engine 3* –demo (like “engine”\textsuperscript{16} –demos in general) was a relatively comprehensive showcase of various technologies in one presentation, there are more specific tech demos that focus on one narrow subject in real-time imagery. For instance, a web site realtimeradiocity.com, run by Stepan Hrbek, gathers material and hosts tech demos\textsuperscript{17} only which focus on the real-time simulation of indirect lighting, or global illumination as it is called in the field, and these demos represent unquestionably the deeper end of the Cult what comes to the level of sophistication.

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All in all, tech demos basically adhere to the same ideological-aesthetic underpinnings as the ones made within the demoscene, but with commercial interests. What situates technology demonstrations into the heart of the Cult is their tendency to basically encapsulate the essence that ultimately makes the real-time medium tick and stand out from the traditional or other digital media. It really is the technology, *tech*, which remains left when everything else is stripped down and there is nothing like as watching a developer bringing something novel, or in the best-case scenario groundbreaking, technology to the table using a tech demo.

\textsuperscript{16} An “engine” means basically a number of different technologies bundled in one.

\textsuperscript{17} See http://realtimeradiosity.com/demos/
7.3 Benchmarking

As touched upon earlier, hardware on which given real-time artifact runs is the ultimate framework that in the end determinates the technological boundaries of such imagery. The more there is computational horse-power available “under the hood”, the more defined real-time simulations are feasible to be performed. In the Personal Computer (PC) – world, it has been a tradition among hardcore gamers to build one’s own computer setup out of variety of available components, such as different graphics cards and central unit processors. This freedom of choice has led to a highly fractured hardware milieu, in which two identical setups are more of an anomaly than regularity, causing the identical real-time imagery to run unevenly across the PC hardware-base, in opposite of fixed-hardware on the gaming console side of the industry.

This state of affairs has given a birth to a culture of benchmarking among the most hardcore ones of the Cult by comparing test results of particular hardware’s capability to handle real-time imagery using specific benchmark software.

Easily one of the most recognized software for such aspiration must be the Futuremark’s 3DMark –series of benchmarks, of which system of reference points has been basically de facto standard for the hardcore PC gaming community over the years, all the way from the release of the 3DMark99 MAX\(^\text{18}\) back in 1999. The higher the test results of given hardware are, the more defined the real-time imagery is on that setup. In addition, Futuremark is maintaining a dedicated Hall of Fame\(^\text{19}\) on their web site for people to submit and brag about their benchmark scores, thus contributing on its part to the ongoing “arms race” in the PC side of the gaming.

\(^{18}\) 3DMark99 MAX is still available for download at http://www.futuremark.com/download/3dmark99max/

\(^{19}\) See http://www.futuremark.com/community/halloffame/
Content-wise, _3DMark_ benchmarks do not fundamentally differ from the demoscene demos – or some of the tech demos either – even though the technological emphasis may vary to an extent. Since _3DMark_ benchmarks are aimed to measure the hardware performance in real-world situations, the various rendering processes, simulations and effects are perhaps more analogous to those of commercial video games, since it is indeed the games that require and make use of the graphical performance the most. As said, the biggest difference to the demoscene demos and tech demos is the performance sheet that follows the presentation illustrating how the hardware handled the rendering procedure.
Furthermore, there is a host of dedicated web sites that benchmark with scientific precision real-time imagery found in video games as they are shipped to a consumer. An apt example of such site is the Digital Foundry\textsuperscript{20}, which is perhaps best known of their thorough technical breakdowns using a proprietary benchmarking technology\textsuperscript{21} that measures frame rate and screen tearing\textsuperscript{22}, and then presents the acquired data graphically on a timeline. In addition, sites like LensOfTruth.com and Japanese based ps360\textsuperscript{23}, among others, conduct head-to-head comparisons in order to find out which version of given video game performs best on which hardware platform, which obviously feeds fanaticism related to the platform of choice.

7.3.1 Overclocking

And lastly, there is yet a subculture that could be considered as a derivative of benchmarking known as \textit{overclocking}, which aims to the highest level of performance possible with no holds barred by modifying the very conduct of how the hardware itself operates. The fact is, every digital circuit, such as a CPU or GPU, run on a certain clock rate (measured with Hz), which determinates the amount of information that is transferred in a second within the circuitry. So, by manually raising the hardware’s internal clock rate, it becomes possible to increase the performance of given hardware beyond the specifications set by the manufacturer. The catch is, however, that the more under stress the chipset is, the more heat it generates, making the hardware increasingly unstable or even damages it.

\textsuperscript{20} See http://www.eurogamer.net/digitalfoundry/
\textsuperscript{21} Leadbetter 2009
\textsuperscript{22} Meaning an unwanted flickering effect.
\textsuperscript{23} See http://blog.livedoor.jp/ps360/
This heating issue really is pivotal to the overclocking culture, and indeed much of it revolves around the different cooling solutions people come up with.

According to Thomas Soderstrom, overclockers are basically divided between two camps: “the many” who seek a cheap way to better their hardware and “the few” who are after ultimate performance regardless the price. It is those “few” who really make computer cooling as an art onto itself, and communities such as Overclock.net further fuel the evolution of cooling. In fact, in the most extreme cases that can involve even liquid hydrogen, overclocking has little to do with any real-world application, such as running a video game, but solely to increase particular benchmark result for cash in contests and/or to gain prestige among the peers.

24 Soderstrom 2006
25 See for instance http://www.overclock.net/overclock-net-contests-promotions/
7.4 Online Discussions

As it often is with many things, the best (and perhaps the worst) is saved for last, that is the discussions taken place in the Internet. They can be good, bad and even ugly, but nevertheless, online discussion forums and blogs with their comment sections are a major venue in this day and age that bind people sharing a similar ideology and worldview, in an unprecedented fashion in the human history.

So even though Internet discussions play more or less a part in all prior mentioned cultural objects and conventions, still, it is reasonable in my mind to discuss the forms they have as a distinct self-contained entity, since the hardcore mindset, and more importantly the pure passion, of the Cult materializes in them in such a lucid fashion.

Internet discussions can be basically divided between the ones taking place among the creators and the ones that involve consumers of real-time imagery, although the line can be a bit blurry in places.

7.4.1 Creator Discussions

It is rather safe to argue that *artistically* creative forums, such as Polycount.com and GameArtisans.org, are sites gathering perhaps the most positive and optimistic real-time imagery discussions, which becomes evident only by skimming through the said forums. Discussions rarely heat up, get personal or completely derail as online discussions tend to in general, and one can sense a certain kind of fellowship and solidarity between the members of such artistic forums. Things like workshops\(^\text{26}\), contests\(^\text{27}\) and showcases\(^\text{28}\) seem to bring like-minded real-time image people together in a quite constructive manner, which manifests as encouraging and helping one’s projects.


\(^{27}\) http://www.polycount.com/forum/forumdisplay.php?f=47


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Chapter VII: Manifestation of the Cult

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out, like:

That looks great! Maybe some anti-aliasing would help? – undoz

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This is looking real good. Only one thing that is missing in my point of view is a bit of gloss on the cobbles, so they catch some highlights, defining them more. – bbob

…

Very nice. I agree that the wall on the right and the ground could use a little more texture tho. good stuff still. – EricV²⁹

As complimenting the more artistic creative forums could be considered the ones that concentrate on the pure technology and programming side of the medium, forums such as of OpenGL.org, Forums.nvidia.com, and Gamedev.net. The discussions over this type of forums get exponentially more analytical and academic when comparing to any other online discussion presented here, which presumably reduces to the exceptionally high level of commitment on the subject matter. Graphics programming or any programming for that matter, can take easily years to get into, and reading some of the discussion threads can be hard for one to comprehend that people are actually referring to a visual medium at all, much of the discussions being littered with excerpts of code³⁰:

When I draw triangle in front of near plane, absolute value of NDC are more then one but they sometime have different signs and triangle is visible (it intersects clipping frustum) but it should not.
Example:
  glViewport(0, 0, WIDTH, HEIGHT);
  glMatrixMode(GL_PROJECTION);
  glLoadIdentity();

³⁰ Programming language.
Otherwise, the social dynamics adhere more or less to similar principals as of artistic creative forums mentioned earlier, although the overall nature of dialogue can be more systematic and highbrow than in the artistic side of the fence, let alone among consumers. Even if people discussing in such forums can be often described as “geeks” or “socially challenged”, for the Cult, they are invaluable champions who push on their part the very structure of the medium forward, and beyond.

7.4.2 Consumer Discussions

The last but definitely not the least instance of online discussions is the ones that occur among the hardcore real-time imagery consumers, the gamers. One of the most well known, and influential in effect, discussion forums within the video game industry must be the previously referred to NeoGAF forums, which is notorious of its quite vocal hardcore base of gamers represented from all over the globe. These kinds of dedicated forums really bring the best and the worst of the Cult together often in a rather colorful fashion, and discussions like which video game looks “better” on which hardware platform can take the best of anyone participating in such conversations. Indeed, as we touched in Chapter 2.1 briefly upon the instance of hardcore viewership that manifested as an argument over a certain video game’s resolution, the logic of such debate, like of any discussions presented here, remains obscure without acknowledging for instance the underlying idea of definition and its relation to real-time image.

http://www.opengl.org/discussion_boards/ubbthreads.php?ubb=showflat&Number=282497#Post282497
An interesting and perhaps characteristic detail in discussions like the ones at NeoGAF is the extensive use of animated GIF –images alongside the text when discussing a visual fascination of a certain video game. Said GIFs are usually created and employed in order to encapsulate the visually most impressive moments of the given game, and the entire GIF sequence can last only a few seconds, which then repeats in a loop ad infinitum. In my mind, this culture of using short GIFs to express and mediate aesthetic engagement illustrates brilliantly in a great precision what kind of real-time imagery makes hardcore audiences’ hearts beat faster, and it indeed often reduces to certain simulations, level of definition, and the fact that the original footage is supposedly presented in real-time.

We started our journey talking about phenomenon called fanboyism and how prevalent it is in the real-time imagery culture, such as gaming, it is only appropriate to close the circle by ending this chapter with the part of online discussions that hosts and breeds a major...
proportion of the fanboyism out in the wild: the comment sections
of video game blogs and online videos. Comment sections by and
large have a bad reputation and are often considered as the bottom
of the barrel of online discussions – for a reason: They are usually
peer-moderated, or not moderated at all, which does not actually en-
courage to intellectual statements and sound reasoning. However, for
a researcher such discussions provide an illuminating conduit to the
most lowbrow, knee-jerk reactions the hardcore audience can have
over real-time imagery.

For instance, visual comparisons conducted by Gametrailers.com gen-
erate often heated arguments that span hundreds of pages, like the
one that put head to head Polyphony Digital’s Gran Turismo 5 and
Turn 10’s Forza 3 in the field of visual fidelity:\[
\text{wtf?! Why gt5’s graphics are so bad?! It’s just too easy to decide that Forza looks}
\text{a LOT better!!! I thought, GT5 has the best graphics in video games at the mo-
\text{ment... =(- Gekkachuck}
\]

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\text{...}
\]

\[
\text{You know what that video fails to mention, that Forza Motorspot 3 runs barely at}
\text{720P while Gran Turismo 5 runs at 1080P and 60 frames per second, how many}
\text{other games can claim that while pushing the graphics limits and realism?}
\text{– ShinAkumajou}
\]

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\text{...}
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\text{GT5’s shadowing can be a bit rough sometimes but the nonsense about Forza’s}
\text{shadows looking better is just ridiculous. Look at the first cockpit fragment. GT5}
\text{has realtime lightning and shadowing where Forza hasn’t any at all. Also GT5 has}
\text{much nicer lightning and shadowing outside on the track (Global Illumination,}
\]

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32\text{ http://www.gametrailers.com/video/forza-3-gran-turismo/708122}
\]
Even though above excerpts are selected to illustrate the point I am making, I believe it is safe to note that technical details are constantly being used to further one’s argument, and things like the state of real-timeness (frame rate), lighting simulations (shadows, reflections) and level of definition (screen resolution) are what basically determine the “goodness” of given imagery. There are of course other additional social factors in play, but in the end, I would argue that the ideological core reduces to the concepts of real-time, simulation and definition.

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As we can see, the Cult of Real-time Image manifests in many shapes and forms, sophisticated and less so. Some of the modes of the Cult materialize as mere software artifacts like tech demos, while others something based on social interaction and dynamics like discussion forums or combinations of the two like the demoscene. What connects them all is the certain set of ideals, an ideology, that not only fuel the Cult in question, but also push on their part the entire real-time image industry forward. Being part of the Cult can entail breath-taking moments in front of a tech demo, defending fiercely one’s hardware platform of choice in online discussion, staying up all night at a demo party, discussing pages upon pages about the resolution’s importance for a visual landscape or analyzing every bit out of some blurry leaked video of a yet to be released video game.

My personal engagement in the Cult includes obviously playing with video games from all eras on all obtainable hardware platforms, and browsing industry news and enthusiasts’ discussion forums daily, but more importantly keeping up a personal blog about philosophical and practical issues relating to the real-time medium. And of course, writing this thesis in hand which is by far the largest singular contribution on my part to
the Cult of Real-time Image.
But, in the end of the day, the Cult really is what we, the devotees, the
hardcore, make it out to be, and I, for one, would like to see it as a cel-
ebration for the real-time medium’s uniqueness and its subversive quali-
ties that still seem to escape the wider audience, at least for now.
CHAPTER VIII

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RECAP AND CONCLUSIONS
In the previous pages, I have now, hopefully, managed to cover the most substantial angles and aspects in necessary detail that contribute to the ideological foundation of something I call Cult of Real-time Image, and how The Cult manifests itself in various forms. The Cult, which consists mostly of gamers, may seem more esoteric that it actually is, due to the technological jargon and convoluted concepts that defines the medium. However, I believe that the ideas that define and in a way justify the existence of real-time image are universal and worthwhile to everyone to take a closer look, whether one is a gamer or not.

First, we established the notion of ideology governing a perception and overall aesthetic judgment, in that the beliefs we hold affect how the world appears to us. A fitting example of such from the realm of real-time imagery was the case of Killzone 2 demonstration that was conducted with false premises, which misled the aesthetic experience of the audience causing unprecedented backlash from the gaming community. If the Killzone 2 –trailer would have been presented, for instance, as a regular animation, and not as a real-time presentation, no harm would have been done since the presentation in itself was quite entertaining, on par with other sci-fi –imagery. The idea of something being in real-time is so fundamental that it simply makes all the difference in the world for a hardcore gamer, so next we proceeded to contemplate what the concept of real-time is and what it means to representation.

We started our analysis of real-time by reflecting our relationship to the perceived reality, which is practically immanent: If we throw a rock at the window, we see the consequences of that action instantly. After that, we
noticed that the same relationship does not apply to the traditional forms of representation, like literature, cinema, or in most cases, live theatre. Indeed, we experience only what is recorded prior by an author and we do not have a genuine agency in that process. However, we noticed that performance arts are not suffering from such constraints, and are indeed capable of transforming in instant according to a potential input from audience. The reason for that stems from the incorporeal nature of such art pieces, meaning that the core of the piece really consists of choreographed poses and movements within the medium, like a dancer. Then we drew a parallel to a computer that produces imagery also in immaterial fashion through software, in that there is no actual physical matter being transferred in such an image making process. This incorporeal, almost frictionless image making can be for that very reason operate at such rate that imagery starts to become something known as real-time, thus allowing an user input in the process, if so chosen.

Then we proceeded to dissect the notion of simulation that is at the heart of the real-time medium, by adapting Gonzalo Frasca’s stance on video games as a medium. It became clear that simulation does not only replicate the appearance of the referent system, like for instance a photograph, a painting or a sculpture do, but also models its behavior, “how it functions”, to an extent. Also we concluded that simulation looses basically its meaning if the behavior that is being modeled has no real world counterpart, and thus notions like supernatural or transcendent does not really fit under the concept of simulation. Simulation’s ability to reproduce some of the features of reality, thus allowing safe experimentation without ethical or practical consequences within it, makes simulation not only a crucial scientific instrument and a training device for various purposes, but also an apparatus for play and games – a toy basically.

After establishing the concept of simulation in general, we moved on to analyze simulation as a mean to produce representations, and for that we
adapted this time Lev Manovich’s thesis on how computer generated imagery essentially breaks down to three fundamental problems: simulation of space, light and motion. Then we went through how the simulation of each component has been evolved over time from the perspective of a consumer, culminating with something dubbed as simulation of style. So real-time imagery is at its heart about simulation of various real world phenomena in the highest possible definition, and one cannot understand the Cult without at least basic understanding of these central ideas.

The concept of definition was indeed the last of the three pillars, so to speak, to go through, which we did hopefully in necessary detail. The basic premise of definition seems to be the more, the better and as we noticed the notion really penetrates almost every layer of the real-time medium. The reason for that stemmed from the finite capability of a given hardware to handle real-time imagery, so there is always that balance of performance (measured in frames per second) and overall image quality present. The need for hardcore people to have more defined real-time images year after year pushes the hardware industry consequently to come up with products to satisfy that demand. Obviously, that need – as in capitalism at large – never gets completely satisfied, which keeps people buying new hardware and the whole industry in motion.

Finally we got into the various forms the Cult takes as cultural conventions and software artifacts outside the obvious realm of video games. In that spirit we examined how the ideology under scrutiny instantiates through selected examples that were the demoscene, techdemos, benchmarking and certain online discussions. This was conducted in order to draw an outline, not the complete picture, of something I see (and consider to be part of) as a relatively consistent whole: the Cult.
In conclusion, I believe I have now managed to address the most crucial concepts in order to understand real-time image as a medium, but more importantly the hardcore viewership and its connection to the real-time medium. In essence, real-time image seems to be more close to a toy than cinema by its core nature, as it popularly is perceived which tend to lead to unfair assessments when comparing the two. Hopefully this thesis helps to clarify the fact that such endeavors are as futile as they can be misleading.

And to answer the question of can one make a case of the Cult of Real-time Image, I believe when looking at some of the most revealing and telling cases in Chapter 7, at some points, a cult mentality –with and without negative connotations – becomes almost tangible. For instance, the example of NVIDIA –hosted press event in Chapter 7.2.1 cannot really be grasped in my mind without recognizing some level of cult aspect of the phenomenon. When analyzing examples of the Cult through the ideas of real-time, simulation and definition, they made as much sense as possible, without going to deeper psychological issues that were naturally out of the reach of this thesis.

Naturally, as the thesis moved forward, a number of fascinating philosophical questions and details rose during that process, such as the fundamental immaterial nature of real-time art (dance, freestyling, algorithms), simulation’s dualistic nature (modeling of appearance and behavior), or the concept of fetishism altogether that could have used perhaps more attention than they did. Furthermore, some may consider the descriptive approach lacking almost any criticism towards the hypothetical Cult and the real-time medium at large as problematic and I agree for the most part, but, at the same time, I believe that it is a common issue when striving to analyze something from the inside of a frame oneself is located in – and happily so.
8.1 Future Research

Consequently, I would like to see much of the ideas presented here in this thesis, or the whole concept of the Cult of Real-time Image for that matter, as groundwork or as a seed for something yet more profound and as a philosophical project yet to be undertaken. Why concept of real-time fascinates us, the Cult members? What is it in our human nature that seeks the kind of visual simulations found in for instance video games? Why do some people need to push an envelope whenever they see one, like they do in the demoscene? What is the ultimate metaphysical purpose of real-time image? Is there one?

Regarding the future of this research by and large, one line of an enquiry would be thrilling to carry out in the area that captured my imagination the most, which was the design vs. algorithm dichotomy presented in Chapter 5. Given the abysmal failure of the project of artificial intelligence, I find it extremely fascinating how the concept of algorithmic image producing relates to the one conducted by genuinely intelligent, artistic agent. For instance, to what extent an algorithm can substitute and pose as design in, for instance, a real-time art context and what are the limits of an algorithmic process by and large?

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Even though this thesis comes now to an end, my journey in understanding and appreciating real-time image will go on, in one form or another. It has been a heck of a ride so far being a part of something I call Cult of Real-time Image, and hopefully it will continue to be so for many years to come.

Keep it real (time).
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