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The Trojan Horses of Virtual Reality

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Abstract

Virtual Reality technologies are on the rise! Commercial Head-mounted Display Devices made VR applications affordable and available to a wide user range. Still, VR companies are far from being satisfied with the market penetration of their VR devices and related software. VR companies and VR enthusiasts are waiting for VR to become omnipresent!

But what if everything is different? What, if VR has already taken over our world – we just are not aware of this fact?

In this essay, I will discuss the Trojan Horses of Virtual Reality – those technologies and approaches, which started taking over our life years ago, we just do not acknowledge this factum.

In this essay I will argue that Virtual Reality is already part of our daily life and that the still pending takeover of VR technologies will only be the final casing stone on top of the pyramid.

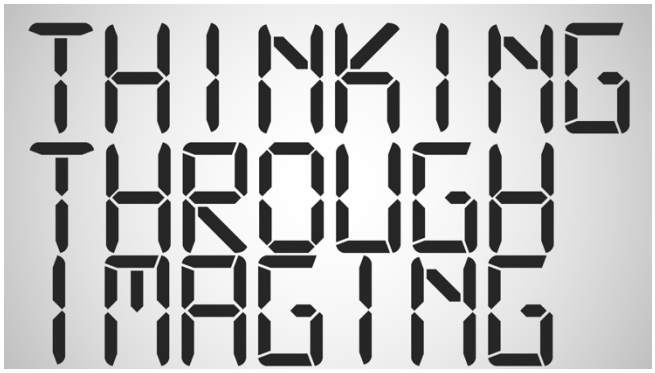
The Foreword for the Foreword

This essay was first presented at the *Symposium on Virtual Realities + Alterities* at the Royal College of Art in London on May 9, 2019. The updated version of this essay was now presented on February 5, 2025 at the *Engineering Reality of Virtual Reality 2025* conference as part of the *Electronic Imaging 2025 symposium* in Burlingame/San Francisco peninsula.

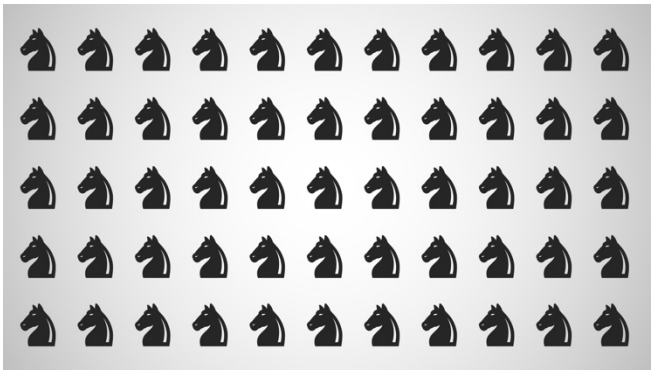
During the last nearly six years, a lot has happened. Obviously, *Virtual Reality (VR)* technologies have drastically advanced their development – and especially web-based and/or cloud-driven technologies have accelerated, with frameworks emerging like Spatial.io [1], Meta Horizon [2], [3], or NVIDIA Omniverse [4], [5].

Thinking through Imaging

This essay can be seen as a Forword for a larger work which is following the new concept "Thinking through Imaging". "Thinking through Technology" is a term coined by Carl Mitcham in his book "Thinking through Technology – The Path between Engineering and Philosophy" [6]. Here, we want to base our reflections more specifically on and around *Imaging*-based technology.



The Foreword



Virtual Reality (VR) is back! Latest since the arrival of the consumer version of the Oculus Rift it is regarded as one of the next big things which are meant to stay [7]! Although we just heard the same a few years ago for 3D TVs – triggered in Europe by the breakthrough of Avatar in movie theatres around 2011 and which were commercially dead since around 2017 [8] – we want to believe that VR is now something lasting and which will change our daily life dramatically.

Discussions lying dead for years are back:

- Will everybody of us use VR on a daily basis in the near future?
- How long do we have to wait until photorealistic rendering has arrived for the consumer?
- When will finally all human senses be supported by VR approaches?
- And when do the Real World and Virtual World merge by using Augmented/Mixed Reality approaches?
- So: when will be VR be "there" – when will it be "here to stay"?

But what, if the Virtual Reality has already "arrived"? What if it IS already part of everyone's daily life?

So, let us start an investigation of our current (status of) reality!

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ONE – Virtual Maps

Let us start with a company which name everybody knows, and which is part of the daily routine in the Western world: Google.

Google – The Search Engine

The company Google's success was triggered by its omnipresent search engine used by millions of users all over the globe (Figure 1) [9], [10]. Google used its financial power to trigger many new innovative approaches – although not all of them were successful (such as Google+).

Google – The Map Provider

A logical extension of the Google search engine was Google maps [11]: we do not only want to query the internet, we also want to query the whole globe, an extension of the real world into the virtual space (Figure 2). It is not only one of the most used navigation services which superseded many mobile car navigation services – it is also one of the most often used information visualization and human-computer interaction applications.

From Virtual Maps to Un-Navigation?

But how do we use this service nowadays?

In the past, many people were able to orient themselves in the real world by just memorizing specific areas, by memorizing a specific place at a crossing where they must turn left. In the old days, people might often have used a printed map to help their orientation.

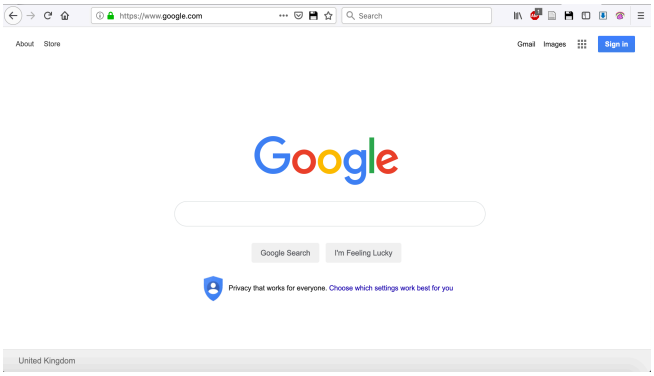


Figure 1. Google – still the most-used search engine around the world [10]. (Google is a trademark of Google LLC.)

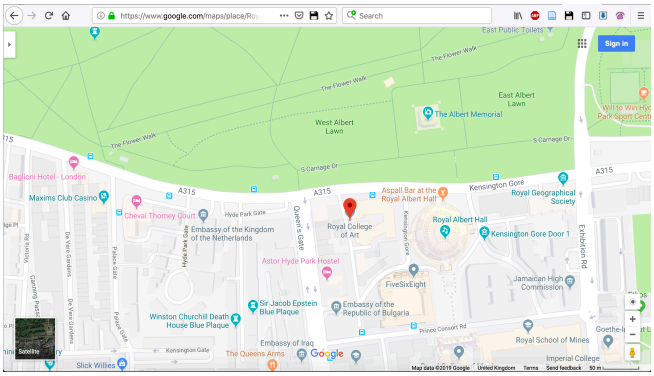
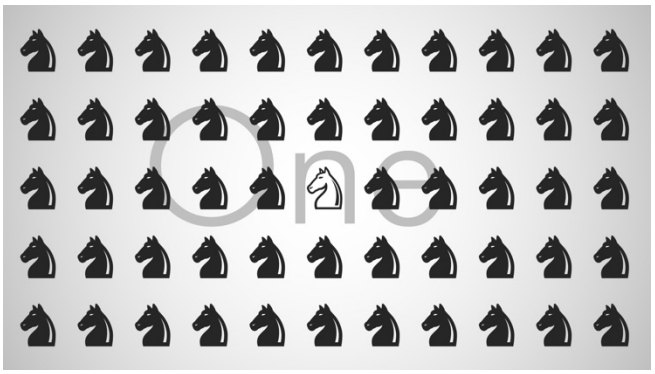


Figure 2. Google Maps™: we do not only want to query the internet, but we also want to query the whole globe, an extension of the real world into the virtual space. (Google Maps is a trademark of Google LLC.)



But the bad message is: many people nowadays have a very bad sense of orientation [12]!

Nowadays, as many people do only pay minimal attention or sometimes no attention at all to the real world, the behavior of the map reader has changed: If not looking to their smartphone running Google maps, users get easily lost – as they do not even attempt to memorize the way back.

So, what does a user do? Looking on his mobile, wondering around a specific place to figure out which direction is the correct one (Figure 3).

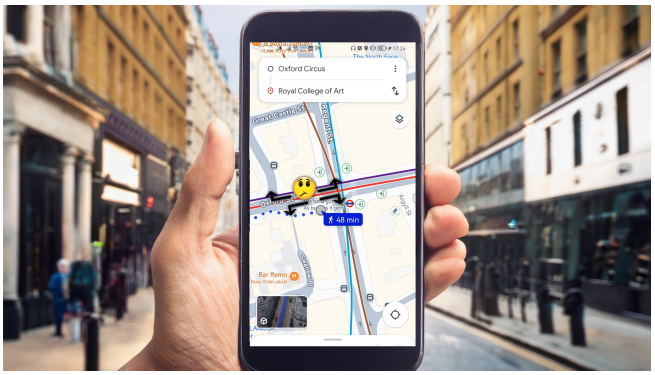


Figure 3. Lost in translation with maps on your mobile phone – which direction is the correct one? Try to find out by moving into one direction and let GPS tracking provide you with the answer. Image created by author with Adobe® Photoshop® AI features. (Google Maps™ is a trademark of Google LLC.)

Another – more traditional but well established – option would be to look for the sun to orient where to go – although often not visible at all. But also, this is usually not done, instead the user just moves forward into an arbitrary direction having the eyes on Google maps, to figure out the correct direction. As a result, some people pay more attention to the virtual world instead of to the real world; they move inside the real world but by focusing onto the virtual world represented by Google maps.

Obviously, here the perception shifts already towards the virtual world on our smartphone – a mental layer is lain over the real world like a semi-transparent curtain.

(Moreover, another interesting observation is that sometimes the information in Google maps concerning opening hours is more up to date than the one on corresponding websites of the companies at a certain location – which means, the credibility of Google maps in terms of reliability might supersede the one of the original company websites. Therefore, in some cases, Google maps is closer to reality than the originally provided info.)

TWO – Being Android

Another big success story of Google is its Operating System for smartphones: Android (Figure 4).

How is an "Android" defined? According to *Collins English Dictionary 2014* [13], "a robot resembling a human being" (Noun, Literary & Literary Critical Terms, in science fiction).

Figure 4. The Android™ logo. Android – but btw. who is the Android here!? (Android is a trademark of Google LLC.)

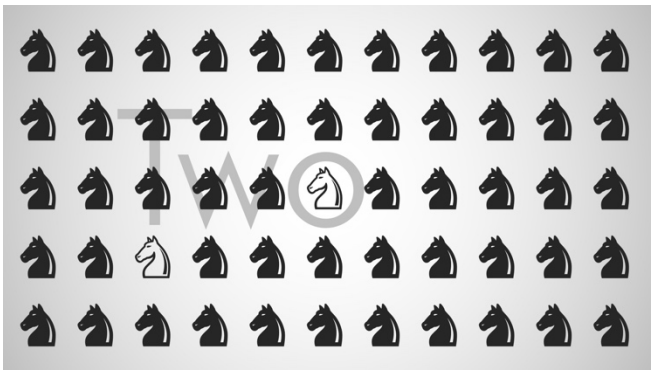
So, let us make some more or less trivial observations: The question we want to evaluate is: what or who is the android?

1. *The Operating System:* the OS is driving the smartphone – it is the "brain" of the smartphone but requires the smartphone as a device/machine to run [14].
2. *The Smartphone:* the smartphone is the hardware device handled by the user, it is a vehicle used by the human operator and while doing so, human attributes are assigned to the smartphone [14].
3. *The User:* the smartphone substitutes the brain of the user; the user is just the vehicle for the smartphone – as the smartphone can go nowhere without the human being/operator. During navigation, Google Maps™ takes over many tasks which usually should be accomplished by the human brain.
4. Back to the beginning, just the other way around: *The Operating System* needs the human to be moved around in the real world, but the human's brain seems to be substituted these days (at least for many tasks) by the OS (Figure 5). We can say: the OS is the "brain" software of the human operator.

If the user just uses Google Maps™ to move around in the real world, just by finding out the movement trajectory by looking at the smartphone, the user basically deactivates his brain in the real world, and for the purpose of moving around, a brain would be not required anymore, as image recognition could be utilized to calculate the movement trajectories, or a mobile vehicle like an autonomous car could be used which brings the person to the intended place. However, the user will lose autonomy, and he will use his ability to memorize. If the technology fails, the user will be lost.

A good example in this context which gives an idea how the far future of mankind might look like: Alien Prometheus from 2012, directed by Ridley Scott shows what happens when impressive technology meets not so impressive/pauperized human intellect [15]: The crew has a highly precise 3D Map of the location they are inspecting – generated by advanced drone and laser scanning technology and handled by an operator on the spaceship (Figure 6).

But they basically are not able to make good use of it: Although the crew on the ground is constantly communicating with the operator who tries to use the high-tech map to give direction and localize the corresponding enemy in the maze, the mission fails – and guess what? Yes, a couple of crew members die in the process!



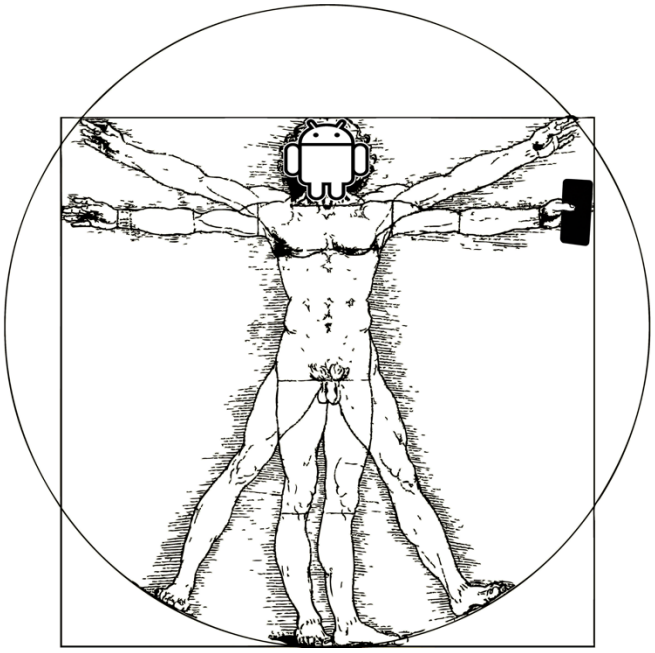


Figure 5. From the Vitruvian man to Homo mobilicus. Image by Leonardo da Vinci ~1490, slightly modified by author. (Android is a trademark of Google LLC.)

Figure 6. An impressive laser scanning-based 3D map as projected in a spaceship, inspired by Alien Prometheus from 2012 (Director: Ridley Scott). If the operator does not know how to operate the map – e.g. by looking into the wrong direction instead of concentrating on the task – the most sophisticated map will not be able to help the threatened crew on the ground trying to stay alive. Image by author, created with Adobe® Photoshop® AI features.

THREE – Virtual Memory Mapping

Before we start now diving into virtual worlds of recent times, let us have a look at those of former times.

Let us go back to 1980s, right to the beginning of commercially successful gaming: Using one of the first affordable personal computers, the Commodore 64 (C 64), the virtual world looked like this: 320x240 pixels which had to be used to represent a virtual world in two dimensions: Figure 7 shows Ultima IV, a game by Richard Garriott a.k.a. Lord British. This is a role-playing game with an extensive storyline behind it – which in theory can be plaid infinitely as it had already open world-similar characteristics [16].

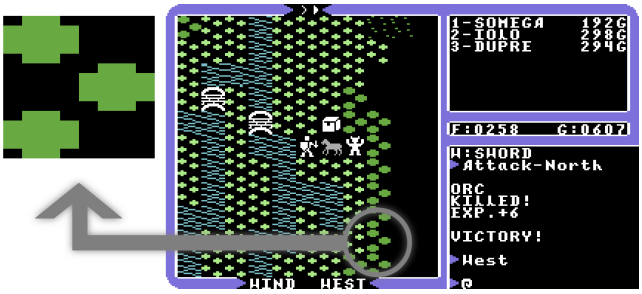


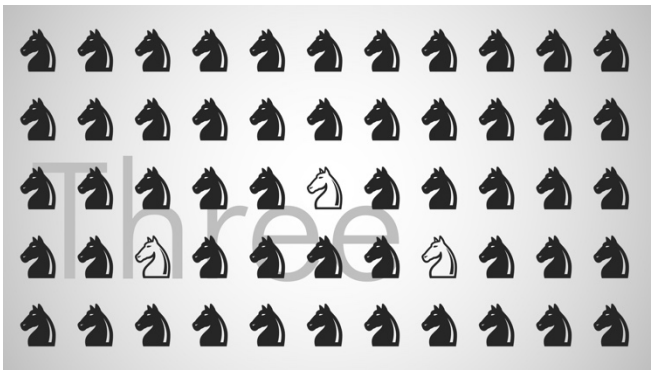
Figure 7. Ultima IV: Quest of the Avatar on the Commodore 64. A virtual world in two dimensions by using 320x240 pixels. Screenshot by author. (Game "Ultima IV" © by Origin Systems, 1985.)

The virtual world – here called Britannia – was something which we would interpret today as a simple virtual map: a forest fragment was presented in 8x12 pixels (Figure 7). But this was sufficient – the simple graphics together with progressive storytelling and the extensive Ultima lore in the background enabled the gamer to be mentally fully immersed in the game. Back in those days as a kid, I plaid this game for a long period of time, wandering in this virtual world, experiencing hundreds of small adventures.

Figure 8. 8x12 Pixels in Ultima IV representing a forest – here a photo of a forest close to the Lake of Constance (Sipplingen). Photo by author.

And now we come to an interesting observation: During my time at Bielefeld University, I often went through the forest of Bielefeld in my spare time, enjoying nature: the Teutoburg Forrest. And especially during the time I was working at the University of Konstanz, I was often wandering around the forests surrounding Lake Constance (Figure 8).

By doing so, even years after playing the game Ultima IV, I still experienced the spirit of adventure when I was wandering through the woods, in memory of the days of my childhood.



The interesting aspect is here: as mentioned before, the virtual world was extremely abstract. BUT because it was completely abstract, concrete places in the real world can be mentally mapped onto the fantasies of our childhood. Similar like the difference between reading a book (or listening to an audio book) and watching the corresponding movie, the fantasy established diffuse images, which can now be mapped to the real world.

Therefore, a virtual layer of memories is lain over the real world, merging the virtual world with the real world.

While games like "Pokémon Go!" combine the real world with the virtual world in an augmented/mixed reality game – an example inspired by a Pokémon found in the Forest Preserve District of Will County [17] is shown in Figure 9 – in our mind this process has started already a long time ago.

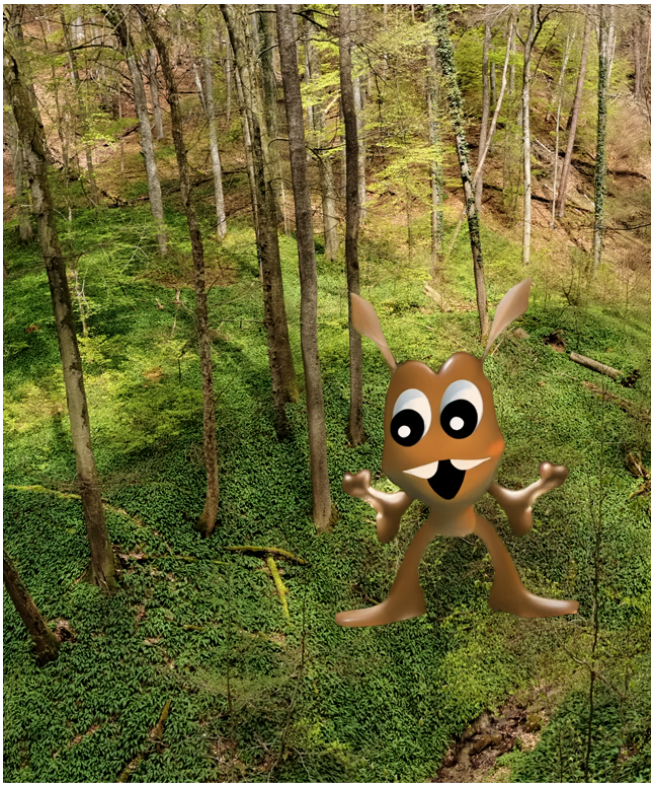


Figure 9. Pokémon Go: An image inspired by a forest photo showing the Pokémon Venonat on the website of the Forest Preserve District of Will County, USA [17]. Background photo by author, image by author, created with Adobe® Photoshop® AI features.

FOUR –
The Virtual Memory Mapping Paradox

Let us assume, we are already there: photorealistic rendering/ real-time raytracing. We are walking through a photorealistic world with optimal *Head-mounted Display (HMD)* resolution, the audio is providing realistic surround sound, and we might be even able to get already haptic feedback plus the remaining senses involved. So, we are experiencing a rich VR environment close to reality or already equal to reality – pushing the boundaries beyond games like the long anticipated Bethesda's Elder Scrolls 6 or the relatively highly-realistic environments UNREAL Engine 5 is already providing today with, e.g., the Electric Dreams Env. [18], [19]. Let's imagine a future where we are already past the Uncanny valley and the interaction with our environment and NPCs *(Non Player Characters)* in it "feels" natural [20], [21].

Let us assume, we play this realistic game over a long period of time, we will be immersed in the story, and it will again be part of our virtual memory's portfolio.

In our memory, a much more precise picture of the virtual world will be recorded – than those compared to the pixelized virtual worlds of computer games in the 1980s (Figure 7).

Figure 10. Virtual Memory Mapping does not work here: The real forest versus a UNREAL Engine 5 environment discussed in Figure 12 as an example for highly realistic landscapes to be used in future open worlds [19].

Therefore, we will not be able anymore to map these experiences to an arbitrary place in the real world (Figure 10). Where the abstract visualization enabled us to map the virtual memory to an arbitrary place in the woods before (Figure 11), this does not work anymore in the real world, as we have a rather precise, highly-detailed and photorealistic picture in our mind where the game play took place.

The dilemma: The higher the grade of realism, the lower the potential for visual generalization, the lower the potential to visually projecting a virtual memory into the real world.

Figure 11. Virtual Memory Mapping works here: The very abstract representation of trees/a section of a forest – based on 8x12 Pixels – can be mapped on to every forest wandering experience, as the representation of the virtual forest can represent a symbol for virtually every forest.

Figure 12. A Forest Run created within a few hours by using UNREAL Engine 5.5.4 and its standard FirstPersonMap in combination with the two assets "European Black Alder" from Quixel [22] and "Light Foliage" from Mythra Tech. [23] downloaded from the Epic Games Fab library. Screenshots by author.

FIVE – Real or Virtual Memory?

Following these observations, we could argue that virtual reality has already arrived! A thin layer which overlies our reality and alters the way we perceive it. The virtual world has already merged with the real world in our minds.

Figure 12 shows a virtual forest run created with UNREAL Engine 5.5.4 [24], [25]. The standard "First Person" game environment was used and the assets "European Black Alder" from Quixel [22] and "Light Foliage" from Mythra Tech. [23] were downloaded from the Epic Games Fab library and within a few hours a small forest patch was setup. The corresponding screenshots can be already very easily mistaken for nature photography (which is also a result of the Lumen Global Illumination and Reflection system introduced with UNREAL Engine 5), whereas the interactive game environment will still need a lot of improvements to surpass the uncanny valley.

In the near future, it will be interesting to observe the impact of the virtual memories and the so-created virtual memoirs to our life. As we all know, beyond a certain age, we will usually invest a growing amount of time in memorizing our past life, and particularly our younger days. In Psychology, this is referred to as the reminiscence bump which is described as the tendency for middle-aged and elderly people to access more personal memories from approximately 10–30 years of age [26]. An important reason is that usually during this time the stable and enduring self-image is formed [26].

In parallel, this is the age range which is mentioned by many surveys to be the most active one in computer gaming (Figure 13), e.g.: After a recent survey of 3,658 respondents in the United Kingdom of all age groups starting from 16, the dominant groups who referred to themselves as active gamers were – within an age group – the age range 16-24 with 85%, and with 71% the age range of 25-24 [27]. In the US, a survey of 5,000 respondents in October 2023 found out that people who identified themselves as video gamers were distributed in the following way across all generations: 10% of the age range 5-10 years, 28% in the age range of 11-26, and 25% in the age range of 27-42, each 18% for the age ranges 43-58 and 59-77, and finally only 1% for the age range 78-90 (as shown in Figure 13) [28].

This clearly shows that the age ranges associated to the reminiscent bump are also those age ranges where the highest percentages of a generation are active video gamers. Although these surveys are focusing on UK and US, it can be expected that similar results are available for many other countries (e.g. Germany [29]).

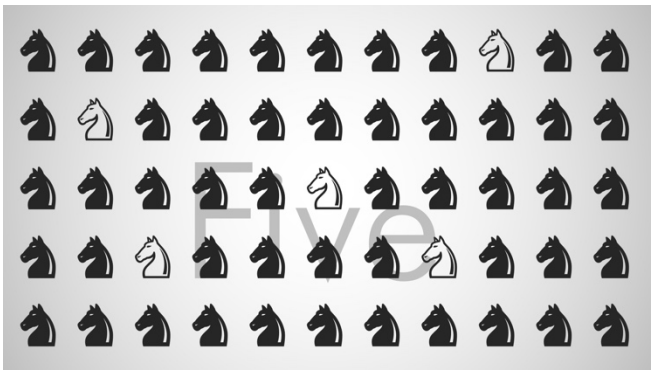
This leads to the question - what will be the future of our (most relevant) memories?

- Will we remember the wrangling with our best schoolfellows at the schoolyard, or the epic fight in our favorite video game?
- Will we remember the first kiss, or will we remember the first virtual romance in a computer game?
- Will we trust in science, or will we believe in the monsters of our computer games?

This is just a very short list which could be easily expanded by hundreds of similar questions.

Moreover, the positivity bias in aging might play an important role here [30]. If we preferred to live in virtual worlds during our childhood instead of interacting with our schoolfellows, our key memories of the future might be associated to virtual worlds.

Obviously, these reflections should be not just devoted to black and white thinking: On one hand a person might have spent a lot of time in virtual worlds during their teenager years.



But on the other hand, they might have spent an equal amount of time discussing with their schoolfellows their virtual experiences, or they even experienced gaming together in front of the same device (Figure 14). In this way, the real and virtual memories will be mixed.

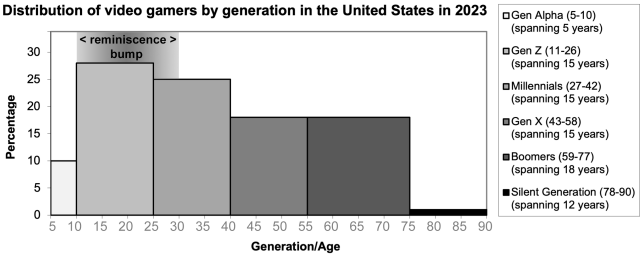


Figure 13. Distribution of video gamers by generation in the United States in 2023 mapped against the reminiscence bump [26], [28]. The period when usually largest proportion of people devote a lot of time towards gaming is the time lying inside the reminiscence bump – which is later the major base for creating our personal memories during the later stages of our life.

Figure 14. Playing alone or together. Real and virtual memories are mixed here and can also be impacted by real world interactions during the gaming experience or afterwards during reflections with friends. Image by author, creation of computer game mock-up discussed in Figure 12, remaining image created with Adobe® Photoshop® AI features.

SIX – Virtual Reality becomes Real

Finally, we could argue: if we can experience the virtual world in perfect quality, why should we leave the virtual reality at all? Why not stay there?

And then we have arrived where a number of movies have done already pioneering work, often inspired by literature. Just to give a few movie examples which are worth revisiting:

- In the *Lawnmover Man (1992)* an intellectually disabled man is transformed into a super-intelligent human being by using advanced technology in combination with psychoactive drugs. He finally mages to digitize himself into the company-internal "mainframe" network with the purpose to take control of the worldwide network – and in this way later of the whole society. A great example on the boundary of digital/physical world and envisioning the future of the Internet [31].
- *Ready Player One (2018)* which came out during the start of the commercial hype of Virtual Reality technologies: a great example of how gamification and full immersion can transform the behavior of gamers and how it might impact our future lives in a not-so-distant future – in the virtual as well as real world. The OASIS is a VR entertainment universe which is highly frequented by gamers in a postapocalyptic world. An Easter egg hidden within the game will enable the finder to take control of OASIS [32].
- And obviously, the first The *Matrix movie (1999)* has to be mentioned here – the place where people can develop super-human powers by outsmarting the *Artificial Intelligence (AI)*-controlled system. Early in the beginning of the movie, the main protagonist gets aware of the fact that most humans are connected to a complex cyberphysical AI system while unconsciously experiencing their daily lives in virtual reality, and meanwhile keeping the AI system alive. This movie is motivating questioning our daily lives and if we can trust in what we perceive as reality [33].

But: are these revolutionary thoughts?

Around 1968, Ivan Sutherland created the first Head-mounted display (HMD), the Sword of Damocles (Figure 15) [34]. This was - being an Augmented Reality device – the base for all existing HMDs, such as the Meta Oculus Quest™ devices which are nowadays very popular in exhibition setups, home and partially also professional use [7].

But around the same time when Sutherland was creating this groundbreaking device, a polish author wrote "The Futurological Congress": Stanisław Lem [35]. The inhabitants of Lem's world live in a virtual reality – or probably more precisely in a number of diverse virtual realities – controlled by psychoactive drugs, usually unconsciously administered via tap water.

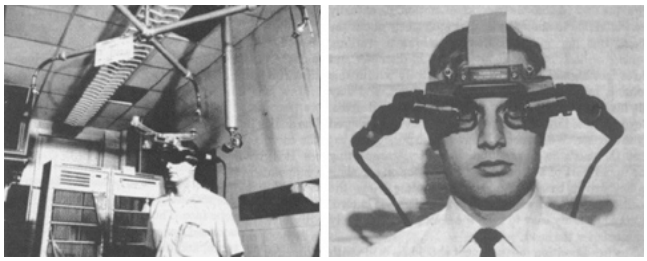
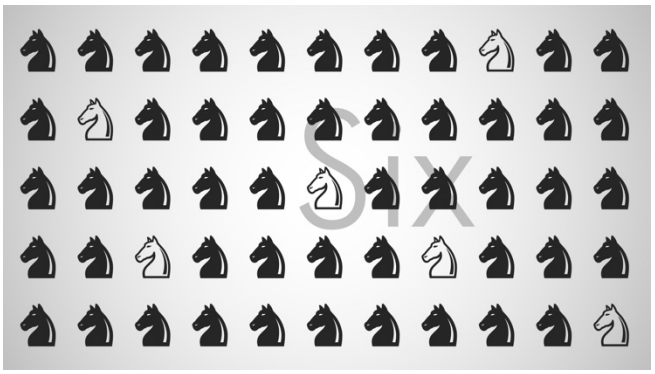


Figure 15. Ivan Sutherland created the first Head-mounted Display in 1968. The concept which nowadays implemented by many companies like Meta, Apple and Microsoft, going back to this original prototype [34].



This rescues them from the perception of reality: in a dystopian future, the world like we know it today is gone: The unaware citizens are living in the sad remainders of a destroyed planet approaching another ice age while only virtual reality enables them to happily ignore their fade. In the end it turns out that also this scenario was a drug-induced hallucination when our hero falls from a skyscraper trying to neutralize one of the system architects – and waking up in the sewer's water close to the Futurological Congress.

Going back to our earlier examples: the abstract representations of 1985s Ultima IV where the 8x12 pixels represented a forest – which can virtually be mapped on any forest you will ever see in your life – to the nearly photorealistic forests of future games which will represent a unique digital place in your future memory: the virtual reality has started taking over our lives!

There is an invisible layer on top of the world we live in (as usually illustrated and utilized in Augmented Reality applications) [36]. Either we can map our virtual memories on an arbitrary place and feel the spirit of adventure wherever we go (Figure 11), or we might try to match our experiences of very well-defined concrete virtual spaces to the place we are currently visiting in real life (Figure 10) – and although this will usually be not successful, there might be occasions where a concrete space in the real world might match the one of the virtual world by accident, or in case a known concrete space from the real world (a landmark, a historic building, a certain environment) was reconstructed in the virtual space [37]. Therefore, we can argue that a continuous pattern matching algorithm is running in our brain which is trying to match virtual with real-world experiences – and vice versa.

In both cases, virtual reality is impacting mentally our real-world experiences, and in this way, we can argue that virtual reality becomes already "real".

Going back to one of the earliest philosophical allegories we can state: the shadows on the wall of Plato's cave have become pixelized (Figure 16) [38]!

Figure 16. The shadows on Plato's cave became pixelized. Section from "Plato's allegory of the cave" by Jan Saenredam, 1604. Public Domain. Shadow pixelized with Adobe® Photoshop® by author.

Postscript

I presented here the first six Trojan Horses of Virtual Reality. As previously mentioned, the first time I presented this talk is now nearly six years ago - in May 2019. For this essay, I drastically expanded the original presentation manuscript and a couple of additional reflections were added and solidified. In particular, "Virtual Memory Mapping" was originally name as "Virtual Memoirs Mapping" which is still a valid term to be explored further, but the observations discussed here do more refer to general reflections on our memories.

Moreover, when presenting this work at the Engineering Reality of Virtual Reality conference in February 2025, I introduced the term "Thinking through Imaging" – which is a more general description of the combination of thinking, reflecting, visualizing, "imagine by imaging" – and will need further exploration on its own in the future.

Of course, during the last six years the immense advancement of *Artificial Intelligence (AI)*-related technologies and approaches have changed the landscape drastically. Alone in the context of this essay, five images have been created by using AI methods (Figure 3, Figure 6, Figure 9, and Figure 14 top/bottom), as well as some background research has been performed by using AI. (The written text has not been enhanced by AI on purpose.)

On the other hand, the visualization capabilities of our computer over the last few years became more impressive, enabling me here to create images of virtual interactive environments which look photorealistic (Figure 10 and Figure 12) and it requires already a close inspection of an expert to differentiate them from an original photo. Although the interactive experience still will need some time to catch up, the hardware is already very close to this target, with professional high-resolution *Extended Reality (XR)* HMDs like the Varjo XR-4 [39] or – on the other end – the advanced prototypes of light-weight AR solutions, such as Snap Spectacles AR glasses or Meta Orion AI glasses [40], [41].

I am confident that Philosophers, Psychologists and other experts from the Arts and Humanities can map a number of theories on the discussed allegories, from Marshall McLuhan's reinterpretation of the medium (1964) to Baudrillard's "Simulacra and Simulation" (1981) introducing the concept of Hyperreality etc. [42], [43]. However, to go here into details lies beyond the scope of this short essay. But I hope that it can inspire and/or provoke to rethink Virtual Reality and XR across different disciplines.

The legendary Trojan Horse from Virgil's Aeneid was a horse without a rider. I discussed here some truths which were well hidden within the horse. But will there be a rider for the Trojan Horses of Virtual Reality? And if so, will the rider be the homo sapiens, or will the rider be an AI assistant?

I identified here my first six Trojan Horses of Virtual Reality (Figure 17). This essay in itself is a Foreword, paving the way for the seventh Trojan Horse of Virtual Reality. And our task will be, to ride this horse. Get ready.

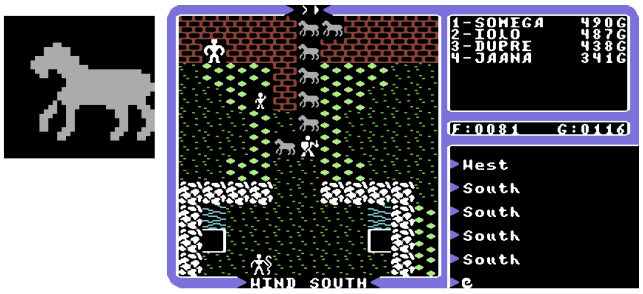
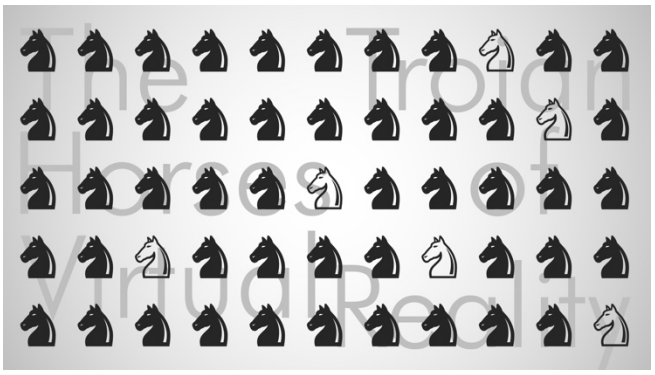


Figure 17. The six Trojan Horses of Virtual Reality … and one. Screenshot by author. (Game "Ultima IV" © by Origin Systems, 1985.)



Abbreviations

- 2D two-dimensional
- 3D three-dimensional
- AI Artificial Intelligence
- AR Augmented Reality
- HMD Head-Mounted Display
- MR Mixed Reality
- VR Virtual Reality
- XR Extended Reality: AR+MR+VR

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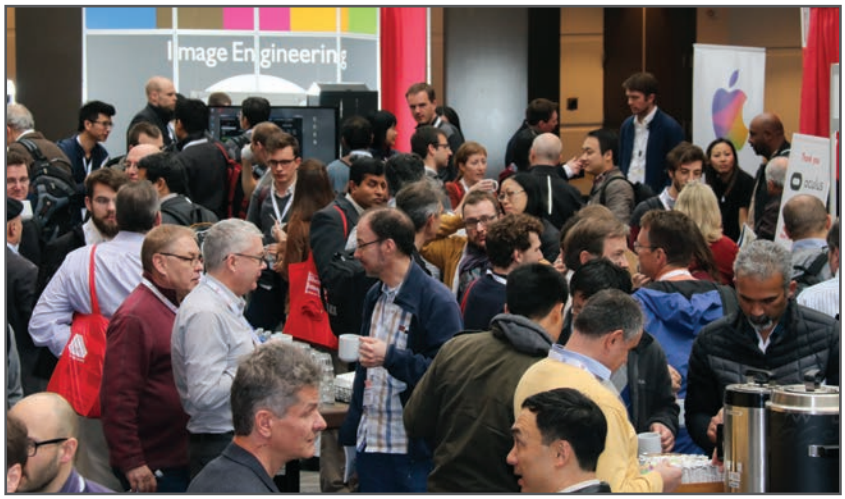

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