

# The Evolution of Virtual and Augmented Reality and its Various Practical Applications

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## ABSTRACT

Virtual Reality (VR) and Augmented Reality (AR) are two rapidly evolving fields of technology that use digital elements to enhance an user-experienced 3D environment. In order to predict the future applications of Virtual and Augmented Reality, its history and evolution must be examined. This paper was created after reviewing research papers and collecting data to create a detailed analysis based on our research. We have identified the origin of VR and how it has since then been developed to be used in various fields of study. Additionally, we discuss the stemming of AR from VR and its development with its rapid growth. We also examine the potential for AR and VR growth in the next 10 years. Overall, we are able to conclude that Virtual Reality and Augmented Reality are fields with much opportunity to expand.

## **Introduction**

Virtual and augmented reality, two rapidly developing fields, have helped provide progression in sectors such as transportation, geography, education, sports, manufacturing, just to name a few. However, there remain major distinctions between virtual and augmented reality. AR enhances a real-world scene, while VR provides an immersive virtual experience.

Virtual reality is completely immersive, meaning that the user-experienced software developed only exists virtually. This includes the display of a manufactured environment that takes the place of users' actual surroundings, with enough persuasive detail for them to be able to interact with it.

Augmented reality presents an enhancement of the real world. Augment, originating from the term “augere”, means to add. Augmented reality produces augmentations to the real world, with computer-generated images. In other words, this is a technologically delivered representation of the real physical environment that uses digital visual components, music, or other sensory stimulation. While just 25% of AR is immersive, VR is 75% immersive (Cipresso, 2018). Electrical engineer Douglas Engelbart established SRI International's Augmentation Research Center (ARC) in the 1960s to create and test novel methods and tools for communication and information processing. In today's world, while virtual reality has predominantly been used in gaming thus far and augmented reality is frequently used in fields such as social media, VR and AR have great potential economically.

Virtual reality is a concept generally defined as a simulation or interactive environment or experience. This idea has existed broadly over time, generally being introduced to mankind with panoramic paintings, such as those from the Baroque era stored in the Walters Art Museum, which intend to cover a viewer's full scope of vision. As developments to vision research occurred, the idea that each eye processes two dimensional objects individually led to the creation of the stereoscope by Charles Wheatstone (VRS, 2017). The initial version of a virtual reality device utilizing a computed system is Morton Hegil's Sensorama. Eventually the HMD, head mounted display, became the most well-known form of virtual reality. Thereon, in addition to gaming and entertainment, VR was used in situations ranging from pilot training to navigational systems. Augmented reality

stemmed from virtual reality and was ultimately interchangeable with VR. Originally differentiated by Ivan Sutherland's device "The Sword of Damocles" (VRS, 2017), AR has evolved to become a part of society ranging from social media to flight tests.

## First Form of Virtual Reality

Dating back to 1962, this completely immersive technology started with "head tracking", meaning that individuals moved only their heads around to experience a new reality. Mort Heilig created the Sensorama with an arcade style cabinet, vibrating seat, and sense producer. One of the very first VR sets included riding a motorcycle through Brooklyn. This provided the idea to initiate a VR system to encourage health and welfare amongst individuals. Ivan Sutherland became known as the godfather of VR displays, after creating a gadget that had a crude user interface and a realistic virtual world made up of simple wireframe rooms for visuals. This system was unlike most, as it was connected to a computer, not a camera. A cube floating in the air in front of the user served as the first display application. A head-position sensor, clipping divider, vector generator, matrix multiplier, headset, and a general-purpose computer were among the six subsystems that made up the system as a whole, making it the first practical virtual reality machine as we know it today. This was a significant invention that set the stage for numerous VR technologies, like simple VR headsets to arise.



**Figure 1.** Sensorama Machine in 1962.

Other systems include Paul Sermon's version of the 1992 installation Telematic Dreaming (Else, 2018) that transforms a bed into a platform for high-resolution photos of a partner who may be thousands of miles distant yet still appear intensely alive. The other's light-intense projection causes a surprising suggestion that transforms touching the projected body into a private act. Although it is evident that the other cannot actually be touched, like all virtual reality settings, Sermon attempted to broaden the user's senses (Sermon, 2000).

Systems such as the Sensorama and the Telematic Dreaming device interacted with users in various methods including sensations of smell and touch. Shifting from this physical interaction, the head mounted display intended to create a stereoscopic view visible through lenses (VRS, 2017).



**Figure 2.** Telematic Dreaming Device in 1992

## Various Forms of Virtual Reality

In today's world, VR is used for a multitude of applications such as military training, sports, mental health, education, etc. VR has been used as training simulations before taking the responsibility and dangers of being on a battlefield. This ensures the safety of the user and gives first-hand experience using mock machines for combat. VRET (Virtual Reality Exposure Therapy) has been used to treat PTSD following long years of battles and commuting (Taylor, 1997). This aimed to decrease the intensity of the responses one's body had to memories provoking fright. However, the costs to access these devices were not affordable by every soldier or patient. The software and hardware must've been managed by therapists to tailor it to the requirements of each situation.

Virtual reality has largely aided in training in sports, such as cross country skiing. This is a sport that involves mountaineering rapidly, while sliding on the slopes and snowfields. The innovations in the experiment done by Weyning Chen included putting forth relevant algorithms for ski simulators and designing mechanical structures for the VR systems (Chen, 2022). However, weaknesses in this experiment include factors such as technological difficulties for users, leading to declined user enjoyment. 87% of students claimed that this technology was challenging to use, and only 53% of teachers reported that it gave them pleasure and enjoyment (Chen, 2022). The numbers must be lower for those who claimed this was challenging to use. Ideally, it should be less than 30% of individuals, to ensure that the technology is user-friendly and yields good reviews for future investments. At least 75% of teachers should agree that this technology is exciting, to make it worthy of time.

"Oxford VR for Mental Health Project", the University of Oxford's mental health project has explored the aspects of mental health and brought attention to issues unspoken of in the field. This aided individuals in battling paranoia and claustrophobia, as VR simulations placed them in crowded areas assuring them they'd be safe. Severe paranoia affects 1-2% of people, and it is frequently a key component of mental health conditions like severe anxiety and depression. Patients have a deep distrust of other people and think that they are being intentionally hurt, which is what caused Professor Daniel Freeman to begin this study (University of Oxford, 2016). The strengths of this experiment includes the cost of investment to its results. There has been an investment of \$12.5 million to aid these patients, those who are largely underrepresented in traditional mental health care.

Similar to the mental health project in which individuals were placed in artificial scenarios, VR has been used in education to enhance the social skills of those with developmental disabilities. Company Floreo has been responsible for creating scenarios to help children practice their social skills. This VR app focuses on helping kids maintain eye contact, navigate through real-life scenarios, and regulate their senses (Ravindran, 2019). This focuses on a multitude of development and real-world educational lessons, hence it is reasonable to be priced at \$49.99 per month.

While VR provides many services and potential applications, the current cost of VR poses accessibility challenges. The price of this product is justified due to its numerous features. A typical VR headset requires components such as multidimensional viewing experiences, advanced high definition screens, gyroscopes, 120 degree field of vision systems and more (Tabassum, 2021). While this may be the case, there are prospects of improvement in pricing for VR systems as higher levels of production lead to reduced costs. Currently the global market revenue for Virtual Reality is about \$28.42 billion. The revenue forecast for Virtual Reality market scope by 2030 is \$87 billion (Grand View Research, 2022). This expansion in market scope allows for a chance for price reductions thereby increasing accessibility, benefiting the future of VR and consumer satisfaction with new innovations overall.

While originally defined by the HMD, the 3D camera has allowed VR to find its way into the fields of real estate through immersive 3D walkthroughs (visual representations) such as those implemented by the real estate app, Zillow. Developing tours of homes through the use of a 360 degree camera, Zillow has applied virtual reality as a method of seamlessly viewing a home before purchase. The user interface of swiping makes it comparable to a dating app as one can view a home's profile and view all its aspects from the comfort of their own home. This service only takes 10-15 minutes for a 3,000 square foot home and serves as an effective and convenient alternative to photography sessions that are comparatively expensive and time taking (Shackland, 2019).

Saudi Arabia's recent project, THE LINE, has technologically planned to take VR to the next level. As Neom, Tabuk revealed this \$500 Billion project, it was claimed that they had used VR to present their plans and layout. THE LINE will have a total capacity of 9 million passengers and be constructed on a 34 square kilometer area. This will result in a smaller infrastructure footprint and hitherto unheard-of efficiencies in city operations. Residents will be able to take advantage of the nearby natural beauty due to the optimum environment all year round. This is just a brief example of how VR can be applicable as a tool in construction and engineering to better not just communities' infrastructures, but the living environment of humans.



**Figure 3.** Visual of THE LINE; plan of interior structures

## First Forms and Development of Augmented Reality

In 1968, the first head-mounted form of an AR display came to life, known as the “Sword of Damocles” created by Ivan Sutherland and his team including Douglas Engelbart. This focused on the enhanced user perception of computer-generated graphics. Myron Kruger constructed the “Videoplace” lab, with the notion of artificial reality, at the University of Connecticut, which was solely devoted to virtual reality (Kreuger, 1993). For an interactive experience, onscreen silhouettes were generated inside these walls using projection and camera technologies. The term “augmented reality” only came to life when Tom Caudell, a Boeing researcher had named it. In the 2000s and today, there have been developments such as open-source software libraries (e.g., AR-Toolkit) to have software developers design and develop augmented reality software programs.

## Augmented Reality Programming

While there are a variety of languages in which AR can be programmed (C#, C++, Java, Javascript, Python, Swift, Kotlin), the best language to use is Python, especially for beginners. Its syntax is somewhat similar to C++, and it is also a high-level interpreted language. There are a multitude of modules open for developers, easing development by providing media access resources, networking, mathematical libraries, etc.

## Rapid Growth of Augmented Reality and Virtual Reality

Virtual and Augmented reality are both application areas that have been developing continually since their inception as a result of their wide ranging utility. From its initial development, virtual reality has undergone much transformation and become more popular amongst the gaming community. Valued at \$11.6 billion in 2019, the global VR gaming market size is anticipated to reach \$92.3 billion by 2027 with a CAGR of 30.2% (Grand View Research, 2020). This area of development is expected to grow now that 91% of business organizations are already leveraging or planning to adopt VR or AR technology (TechRepublic, 2020). In fact, the entertainment industry is also quickly adopting AR and VR in streams of media. The FOX show, *Alter Ego*, for example, uses virtual characters to participate in a real singing competition. Additionally, the k-pop group AESPA’s music video for their song “Iconic” is an example of media incorporating VR and AR.

## Conclusion

Ultimately with the purpose of reflective research, this paper was intended to identify the current and upcoming sectors of AR and VR technology as well as track its evolution through history. Major growth should be expected over the next decade within the VR and AR fields. Given the current ventures in sports training, mental health, real estate, social media and more, we visualize the capacity of this technology being applied further in fields such as engineering as envisioned by the VR model of The Line. The review, overall, bridges the ideas in the overarching analysis of AR and VR technologies.

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