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EARLY VIRTUAL WORLDS Pioneers of Extended Realities Between Creative Efforts and Technical Experimentations

Abstract

Through an approach focused on the industrial history of the medium, this research seeks to reconstruct the genealogy of immersive technologies by conducting an in-depth investigation into the conceptual and technical origins of Extended Realities (XR) in the 1960s and 1970s. Over the last thirty years, efforts have been made to trace the medium's history in order to legitimize its existence, identifying a number of pioneers in immersive realities who helped lay the cultural and technological groundwork for a new immersive market to emerge in the 1980s. The personalities of inventor and filmmaker Morton Heilig, computer scientist Ivan Sutherland, and artist Myron Krueger have been regarded as forerunners of the industrial growth of the media. This article attempts to trace the origins of this process by examining Heilig, Sutherland, and Krueger's contributions with a dual purpose. First, it seeks to recreate the theoretical and conceptual foundations of immersive reality. Second, it looks at the larger cotext in which these pioneering attempts evolved.

Keywords

Media industry; immersive media; extended realities; genealogy of virtuality; social history.

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The industrial history of immersive reality began only in the 1980s when the first companies focused on developing and commercialising hardware and software for Extended Realities (XR) were established. The pioneering company in this field was Virtual Programming Languages Research Inc. (VPL), which was founded by US programmer, artist, and entrepreneur Jaron Lanier. Since then, XR has outgrown its experimental stage and entered the realm of the market.

The origins of VPL are well-known primarily because of Lanier and colleagues' firsthand testimonies¹. In September 1984, the US-based journal *Scientific American* featured a picture of Mandala, a program created by Lanier. Mandala was identified as belonging to "Jaron Z. Lanier and his colleagues at VPL Research Inc in Palo Alto, California"², even though VPL Research Inc. had not yet been established. The company name was used to justify the author's affiliation with a research institution for the publication. However, it served as a motivator for formalising the work that Lanier and a

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¹ J. Lanier, *Dawn of the New Everything: Encounters with Reality and Virtual Reality*, New York: Henry Holt and Co., 2017.

² "The Cover", *Scientific American*, 251, 3 (1984): 6.

small group of colleagues were doing in Silicon Valley, and VPL Research Inc. became a reality at the beginning of 1985. Between then and the first half of the 1990s, several multinational corporations invested in developing and commercialising immersive devices, transforming these technologies into a flourishing hi-tech market.

However, there was a significant experimental period before this. Some pioneers of the 1960s and 1970s have been identified in the public discourse, seeking to construct a genealogy of XR that can culturally legitimise the emergence of ‘new media’. These efforts started in the early 1990s when writers like Howard Rheingold³, Frank Biocca and Mark R. Levy⁴ analysed the status of immersive media, anticipating a trend that would continue to grow in the second half of the 2000s. Three names that stand out and help identify the prominent trends of the pre-industrial VR era are Morton Leonard Heilig, filmmaker and inventor of Sensorama; Ivan Edward Sutherland, computer scientist and creator of *Sword of Damocles*; and Myron Krueger, master of electronic art, who coined the term ‘artificial reality’ to describe his main project, *Videoplace*. Each of these people is recognised as the creator of a technology that embodies a different aspect of XR as it is understood today.

In this article, we examine the role each of these authors has played in shaping the imaginary of virtuality and evaluates the significance of their contributions. While their impact on technological development is often limited, it is nonetheless considered alongside their more substantial influence on the dominant rhetorical frameworks that define our understanding of what virtual reality is. The objective is therefore twofold. On one hand, the aim is to identify, within each of their inventions and discoveries, the foundational elements of the contemporary concept of virtual reality, rediscovering the origins of the medium beyond its purely technical aspects. On the other hand, the goal is to reconstruct the context in which these inventions emerged, tracing the connections between institutions, historical circumstances, and techno-artistic developments.

To accomplish this, we will explore the role of Heilig, Sutherland, and Krueger in anticipating and shaping contemporary rhetoric about virtual reality through the analysis of several qualitative sources. In Heilig’s case, these will be patents, articles in popular newspapers, journalistic reviews, and promotional flyers kept at the HMH Foundation Moving Image Archive⁵. Conference proceedings, books, art catalogues, and interviews left by Ivan Sutherland and Marion Krueger are accessible through several institutions and databases. Other sources consulted include specialised journals, such as the US-based *Communications of the ACM*.

1. IN THE BEGINNING WAS CINEMA: MORTON HEILIG AND THE VISION OF AN IMMERSIVE FUTURE

According to Gutierrez, Virtual Reality (VR) is consistently portrayed in popular discourses through the “rhetoric of futurism”⁶, making it “crucial to understand its collec-

³ H. Rheingold, *Virtual Reality. The Revolutionary Technology of Computer-Generated Artificial Worlds – and How It Promises and Threatens to Transform Business and Society*, New York: Simon & Schuster, 1991.

⁴ F. Biocca, M.R. Levy, eds., *Communication in the Age of Virtual Reality*, Hillsdale: Lawrence Erlbaum Associates, 1995.

⁵ The material is available in the digital archive <https://hnharchive.com/project/morton-heilig-collection-finding-aid/>.

⁶ N. Gutierrez, “The Ballad of Morton Heilig: On VR’s Mythic Past”, *JCMS: Journal of Cinema and Media Studies*, 62, 3 (2023): 86-16 (95). DOI: 10.1353/cj.2023.0027.

tively reconstructed past”⁷. From Rheingold’s early works to the more recent studies of Bolter, Engberg, and MacIntyre⁸, historical and contemporary essays locate the year zero of VR in the experiments of a filmmaker whose creations are quite different from today’s understanding of the medium. Referring to the technical definition proposed by Fuchs, Moreau and Guitton, VR should be defined as

a scientific and technical domain that uses computer science (1) and behavioural interfaces (2) to simulate in a virtual world (3) the behaviour of 3D entities, which interact in real time (4) with each other and with one or more users in pseudo-natural immersion (5) via sensorimotor channels⁹.

Heilig’s creations do not use computer science or behavioural interfaces to create virtual worlds. Rather, they belong to the sphere of analogue technologies. Heilig’s rhetorical assimilation with a virtual world pioneer was connected to the goals of his prototypes, which were foreshadowed by an article titled *The Cinema of the Future* that appeared in the Mexican magazine *Espacios* and was translated into English over thirty years later for the US journal *Presence*. In this article, the author imagines an immersive cinema screen that will generate an “art of consciousness”¹⁰ with sensory capabilities that can include taste, smell, and touch, enabling one to “feel physically and mentally transported into a new world”¹¹. His retroactive mythmaking as a VR prophet was determined by his goal to immerse the viewer in the cinematic image, which is remarkably similar to the modern concept of “pseudo-natural immersion via sensorimotor channels” mentioned by Fuchs et al. This produced several patents and prototypes that, according to Heilig’s vision, would make the ‘Cinema of the Future’ a reality.

In 1960, he patented his Stereoscopic Television Individual Apparatus for Individual Use, informally called the Telesphere Mask. The prototype was a stereoscopic headset with two screens that created the illusion of a 140° peripheral view of the television image. The headset’s cool reception prompted him to move his focus to a more ambitious project, the Sensorama Simulator, whose industrial history and social reception are crucial for understanding the milieu in which immersive media arose. Sensorama, which resembles an arcade video game, was designed to immerse the user in a multimodal cinematic experience. Using “a cinematic technique that for the first time combines three-dimensional motion pictures, peripheral vision, binaural sounds, aromas, and tactile sensations”, the Sensorama was marketed as “an entirely new kind of communication device which creates for its user the illusion of being physically present in a different environment”¹². In the patent, Heilig emphasises the Sensorama’s multifunctionality, describing it as a tool for training workers in the military services,

⁷ Gutierrez, *The Ballad of Morton Heilig*, 95.

⁸ J. Bolter, M. Engberg, B. MacIntyre, *Reality Media. Augmented and Virtual Reality*, Cambridge (MA): The MIT Press, 2023.

⁹ P. Fuchs, P. Guitton, “Introduction to Virtual Reality”, in *Virtual Reality: Concepts and Technologies*, edited by P. Fuchs, G. Moreau, P. Guitton, Milton Park: Taylor & Francis Group, 2013: 8.

¹⁰ M. Heilig, “El Cine del Futuro: The Cinema of the Future”, *Presence*, 1, 3 (1992): 279-294 (287). DOI: 10.1162/pres.1992.1.3.279.

¹¹ Heilig, “El Cine del Futuro”, 284.

¹² Promotional materials, patents and press reviews of Heilig’s inventions can be viewed at the Hugh M. Hefner Foundation Moving Image Archive at the University of Southern California, Los Angeles. The quote refers to the first page of the “Introducing the Sensorama Simulator” promo flyer.

mechanised industries, and educational institutions, claiming that the Sensorama could “simulate a desired experience by developing sensations in a plurality of the senses”¹³.

Despite the patent’s intended industrial applications, the publicity material focuses primarily on less technical fields, including public relations, education, psychotherapy, psychological research, and entertainment. While claiming that Sensorama would be ideal for public relations, advertising, and promotional material, not much detail was given. For educational applications, however, it claims that “because the simulator conveys more information in a given period, it dramatically shortens the length of learning and help make complicated ideas clear”¹⁴, and it could be used by the government or universities as an “automatic teaching machine”. Current interest in the educational field is one of the most compelling and most often explored topics for immersive experience applications. Similarly, Sensorama’s promo flyer claims that it “offers psychologists a unique tool for testing emotional responses, learning processes, sensory perception, etc.”¹⁵. Recent studies emphasise the benefits of applying VR to these same fields. On the one hand, they are useful tools for experiential learning, with the ability to “mimic the brain model as much as possible”¹⁶. On the other hand, they can technically control the type of experience to which the user is subjected, offering “new ways of structure, augment, and/or replace the experience of the body for clinical goals”¹⁷. Thus, Sensorama’s optimal applications align with the most recent advancements in VR.

However, Heilig was mainly focused on the entertainment industry, promoting Sensorama as “an experience of incomparable excitement and pleasure”¹⁸ that everyone could enjoy for just 25 cents. In fact, Sensorama was best suited for public areas like malls and theme parks. To achieve this, Heilig created several test films, each lasting roughly three minutes. These include a dune buggy ride (*Dune Buggy*), a date at the beach (*A Date with Sabina*), a belly dancing performance (*Belly Dancer*), a helicopter flight over California (*Helicopter*), and a motorcycle ride through the streets of Brooklyn (*Motorcycle*). According to Rheingold, Heilig said in a private conversation that the biggest problem with the project had been funding¹⁹. The audiovisual industry appears to have been resistant to Sensorama’s potential, and its production history was marked by both highs and lows. The project began in Mexico, where Heilig was working as a documentary filmmaker. He then sought funding in New York, where he created the first prototype, which he exhibited in a Broadway arcade. Despite successfully arranging mass manufacturing of the hardware, Heilig failed to capture market interest, and the project was abandoned in the early 1970s²⁰.

However, the lack of enthusiasm shown by film investors for Sensorama contrasted with the attention the media appeared to give it. In a lengthy piece published in *The Saturday Evening Post* in 1964, Lewis H. Lapham compared the simulator to the futuristic theatre that Aldous Huxley had imagined in his 1931 novel *Brave New World*. The piece also includes an interview with Heilig, who ended it with a somewhat prophetic question, asking the interviewer, “Do you know what this machine really is?”. Then

¹³ M. Heilig, “Sensorama Simulator”, *United States patent Office*, n. 3,050,870, August 28, 1962.

¹⁴ Heilig, “Introducing the Sensorama Simulator”, promo flyer.

¹⁵ *Ibid.*

¹⁶ G. Riva, “Virtual Reality in Clinical Psychology”, *Comprehensive Clinical Psychology*, 10 (2022): 91-105 (91). DOI: 10.1016/B978-0-12-818697-8.00006-6.

¹⁷ Riva, *Virtual Reality in Clinical Psychology*, 91.

¹⁸ Heilig, “Introducing the Sensorama Simulator”, promo flyer.

¹⁹ Rheingold, *Virtual Reality*.

²⁰ *Ibid.*

he answers himself: “It’s an empathy machine, and if we can develop it right, maybe we can get it to inject feelings of warmth and love”²¹. In 2015, author Chris Milk gave a much-quoted TED Talk titled *How Virtual Reality Can Create the Ultimate Empathy Machine*, which paved the way for the modern rhetoric of VR as an ‘empathy machine’²². Once again, the imagery of Sensorama anticipates the imagery of virtual reality.

Lapham was not the only author who wrote enthusiastically about Sensorama’s possibilities. Leonard Lipton urged readers of *Popular Photography Magazine* to “watch out for a remarkable new process called Sensorama!”²³, while Howard Junker wrote in *Film Comment* that Heilig had, literally, “a hot property”²⁴, while complaining that the belly dancer ended her performance too soon. Other newspapers, such as the *Hollywood Reporter* and the *New York Times*, returned to the issue in 1969, adopting a tone that Gutierrez subsequently linked to the “speculative, and largely uncritical articles that would be written about VR in the 1980s and 1990s”²⁵. However, the Sensorama project was abandoned before it could be fully realized. Heilig patented a third innovation in 1971, the Experience Theatre, which was “a new and improved type of theater designed to completely involve a mass audience into a new and exciting world of experience”²⁶. The Experience Theatre was a group version of the Sensorama, probably similar to the modern 4D cinemas seen mainly in amusement parks. Again, its production was unsuccessful.

The idea of Morton Heilig as the genius who foresaw the future before society was ready to accept it was shaped by the ideal synergies between Sensorama and modern VR. According to Gutierrez, this rhetoric represents a posthumous attempt to normalise and legitimate the current state of VR by mythologizing its past. However, it has already been demonstrated that Heilig’s work in the 1960s brought about a number of discursive components that have greatly influenced how the medium is understood today, both in the press and promotional material. Heilig’s contribution to the history of immersive media is thus not technologically significant, and his inventions did not stimulate automatic creative advancements. However, as Rheingold points out:

It appears that technological revolutions don’t happen simply because progress is inevitable; true technological paradigm-shifts require a visionary of two of Heilig’s caliber, access to one or more enabling technologies that would make the visionaries’ gadgets possible and, most important, a person with some power to champion the new idea among the conservative decision-makers who can finance its development²⁷.

Above all, this process serves as an opportunity to reinforce two distinct discursive levels. On the one hand, contemporary rhetoric on VR, shaped by specific marketing strategies and subsequent reception²⁸, portrays it as a medium constantly projected into the future, because the present is still not ready to integrate it into the standard daily media diet. Similar to Morton Heilig and his Sensorama, VR itself struggles to find a

²¹ L.H. Lapham, “The Feely is Here”. *The Saturday Evening Post*, 18 April, 1964: 28-29 (29).

²² C. Milk, “How virtual reality can create the ultimate empathy machine”, TED, 2015. <https://www.youtube.com/watch?v=iXHillTPxvA>. Accessed April 24, 2025.

²³ L. Lipton, “Now Step into a Movie. Sensorama”, *Popular Photography Magazine*, July 1964: 114.

²⁴ H. Junker, “New Perils Awaiting the Serious Drinker”, *Film Comment*, Summer 1965: 36.

²⁵ Gutierrez, *The Ballad of Morton Heilig*, 95.

²⁶ M. Heilig, “Experience Theatre”, *United States patent Office*, n. 3,469,837, September 30, 1969.

²⁷ Rheingold, *Virtual Reality*, 52.

²⁸ J. Nagy, F. Turner, “The Selling of Virtual Reality: Novelty and Continuity in the Cultural Integration of Technology”. *Communication, Culture & Critique*, 2019.

space. This was true in the 1990s, when Rheingold wrote his book, and in the 2000s, when speculation about the medium's origins resurfaced. On the other hand, this process depicts VR as a misunderstood medium that was not considered worthy of investment when Heilig and other pioneers began work on it. So, VR deserves to be rediscovered now to correct an early ancestral mistake. Sensorama failed from a commercial perspective, but the echo of its experimental aura is still recalled as a motivator for implementing the 'new medium'.

2. ANOTHER FACE OF THE COLD WAR ERA: IVAN SUTHERLAND AND THE SWORD OF DAMOCLES

The 1960s and 1970s saw the influx of computer scientists, technicians, and researchers into the immersive field. Indeed, the first HMD prototype was created in the laboratories of Harvard University based on the work of Ivan Sutherland, a computer scientist and computer graphics pioneer who was already well-known in the international academic community for his remarkable work before becoming the 'father' of Augmented Reality (AR)²⁹. While attending some of the most prestigious American universities and research centres, he developed a digital interface that could react to the user's eye movements. He began his academic life at Harvard University, where he established a research team³⁰ in 1965 to develop the first head-mounted display (HMD) apparently inspired by the Bell Helicopter Company's experiments to facilitate night landings through a system of infrared cameras. The cameras, which were placed under the helicopter, moved in synchrony with the pilot's gaze³¹. Sutherland decided to use the same technique with computers³². The CIA was one of the main sponsors of the research, which – given the prevailing inter-generational friction and societal mistrust of government institutions in the United States during the 1960s – sparked a serious scandal³³.

A significant public exposition of the project occurred at the sixth International Federation for Information Processing (IFIP) conference in 1965, where Sutherland gave a paper titled *The Ultimate Display*, which focused on the concept of a kinaesthetic display: "Machines to sense and interpret eye motion data can and will be built. It remains to be seen if we can use a language made of glances to control a computer. An interesting experiment will be to make the display presentation depend on where we look"³⁴.

Sutherland concludes the speech by asserting that the Ultimate Display

²⁹ Sutherland's experiments followed some inventions comparable to today's HMD concept. Notable is the Headsight system, which was created in 1962 by Charles Cameau and James Bryan, two engineers from the Philco Corporation, and consists of a worn stereo camera for video surveillance.

³⁰ It is particularly important to mention Sutherland's fellow researchers, Danny Cohen, Quintin Foster, and Bob Sproull.

³¹ H. McCracken, "A Talk with Computer Graphics Pioneer Ivan Sutherland", *Time*, April 12, 2013. Accessed March 31, 2024. <https://techland.time.com/2013/04/12/a-talk-with-computer-graphics-pioneer-ivan-sutherland>.

³² SIGGRAPH Conference Editors, "VR at 50: Ivan Sutherland's 1968 Head-Mounted 3D Display System". ACM Siggraph, 14 August, 2018. Accessed 31 March, 2024. <https://blog.siggraph.org/2018/08/vr-at-50-celebrating-ivan-sutherland.html>.

³³ W. Aspray, "Oral History Interview with Ivan Sutherland". *Charles Babbage Institute*, 1 May 1989. Accessed March 31, 2024. <https://conservancy.umn.edu/items/cbca2b79-c748-4c30-a0ba-e2a7c85242fa>.

³⁴ I. Sutherland, "The Ultimate Display", in *Proceedings of IFIP Congress 65*, edited by W.A. Kalenich, London: Macmillan and Co, 1965: 506-508 (507).

would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining; and a bullet displayed in such a room would be fatal. With appropriate programming such a display could literally be the Wonderland into which Alice walked³⁵.

Frederick Brooks, who would become one of the most significant VR researchers in the next ten years, most likely attended the talk³⁶. However, the Ultimate Display had to wait a few years before taking shape. Indeed, HMD's earliest prototype dates back to 1968. Similar to more recent AR systems, the HMD could track gaze movements and overlay computer-generated images, but it had to be hung from the ceiling due to the weight of the hardware. This is why it became known as the Sword of Damocles, in allusion to the heavy support hanging over the user's shoulders. The project was first presented at the 1968 Joint Computer Conference and documented in subsequent conference proceedings that highlighted Harvard University's collaboration with a number of federal government institutions, including the Department of Defense's Advanced Research Projects Agency (ARPA) and the Office of Naval Research³⁷.

Like Heilig, Sutherland also anticipates key elements of the contemporary concept of VR, contributing to the shaping of its current imagery. Much like Sensorama, the HMD's unofficial name – Sword of Damocles – evokes an epic atmosphere. Whereas Heilig was a misunderstood prophet³⁸, just like a visionary lacking the opportunity to develop his own ideas, Sutherland is an enlightened technician deeply embedded in, and rewarded by, the system. His extremely heavy HMD was the result of years of experimentation financed by some of the most prominent organisations in the United States. The outcome of his efforts was observable and effective. The Sword of Damocles is a computer that creates images by responding to the movements of the human eye, whereas Sensorama was a futuristic and underrated fantasy that would have revolutionised filmmaking.

However, other notable researchers continued Sutherland's work, which led to significant technical advances in a few specialised fields, especially the military and aerospace. The press tended to focus on the sensational aspects related to the CIA funding controversy at Harvard University, which was reported in New York's *Daily World* ("Harvard's Link to CIA Exposed"³⁹) and London's *Black Dwarf* ("Spy Networks Uncovered"⁴⁰). Nevertheless, its creation provides the first serious look into immersive realities, foreshadowing subsequent industrial advancements in the medium and influencing, among others, Jaron Lanier himself. This is further demonstrated by the continuation of experiments in the search for a kinaesthetic computer, which led U.S. universities to spearhead research until the industrialization of the sector in the 1980s.

³⁵ Sutherland, *The Ultimate Display*, 508.

³⁶ K. Bye, "Fred Brooks on Ivan Sutherland's 1965 'Ultimate Display' Speech", *Voices of VR*, 2016. Accessed by March 31, 2024. <https://voicesofvr.com/359-fred-brooks-on-sutherlands-1965-ultimate-display-speech>.

³⁷ I. Sutherland, "A Head-Mounted Three Dimensional Display", *Proceedings of the AFIPS '68 Fall Joint Computer Conference*, 1968: 757-764. DOI: 10.1145/1476589.1476686.

³⁸ Gutierrez, *The Ballad of Morton*.

³⁹ E. Bert, "Harvard's Link to CIA Exposed", *Daily World*, New York, April 17, 1969: 1.

⁴⁰ "Cambridge, Sussex. Spy Networks Uncovered", *Black Dwarf*, London, May 16, 1969: 2.

3. ART DOESN'T PAY, BUT SCIENCE DOES: MYRON KRUEGER'S VIDEOPLACE

In examining key developments in the conceptualisation of virtuality in the 1990s, Howard Rheingold brings into focus the role of a third important player: Myron Krueger. Krueger is frequently quoted in leading industry publications, including the specialist Italian magazine *Virtual. Mensile di realtà virtuale e immagini di sintesi* (1993-1998), which published interviews with him and excerpts of his work. His theoretical contributions were particularly influential, especially following the publication of his pioneering work *Artificial Reality* (1982), which anticipated many of the foundational concepts that would later define what came to be known as Virtual Reality. Krueger's work is central for its exploration of the relationship between the user and the virtual environment. His artworks introduced the notion of being part of a virtual reality through a computerized presence, laying the groundwork for his theoretical publications regarding the role of art as a pivotal force in the development of a new media – which he refers to as Artificial Reality.

Krueger began participating in a project curated by Dan Sandin, Jerry Erdman, and Richard Venezky shortly after the premiere of *Sword of Damocles* in 1969. Sandin is a master of electronic art and one of the first authors to work in the field of computer graphics. He is a co-director of the Cave Automatic Virtual Environment (CAVE) and a co-founder of the Electronic Visualisation Laboratory (EVL) at the University of Illinois, which is one of the leading centres of experimentation on the relationship between art and computer science. Sandin, in collaboration with sculptor Erdman and computer scientist Venezky, launched a project called *Glowflow*, which Krueger later referred to as “a computer-controlled light-sound environment”⁴¹. Krueger continued to create more electronic artworks based on human-computer interaction after working with Sandin, and debuted his first artwork, *Metaplay*, at the University of Wisconsin Memorial Union Gallery in 1970. It was a flat-screen experience that created a perfectly synchronised viewer-medium-artist triangulation by allowing gallery visitors to interact with an artist, typically Krueger himself, who was in a different room⁴². The subsequent year, Memorial Union Gallery also hosted Krueger's electronic work *Psychic Space*, which was based on the unique interaction between individual users and the automated environment⁴³. The experience was based on a system of sensors scattered across the floor that triggered specific sound or musical reactions to the user's movements in the room.

Metaplay and *Psychic Space* foreshadow Krueger's most ambitious project, both in terms of expressive intent and technological research. *Videoplace*, which debuted in 1975 at the Milwaukee Art Center and was considered to be a laboratory in progress, underwent significant modifications during the 1980s and 1990s. The first version of the work featured at least two participants interacting with a synthetic body replica that was projected onto a screen. The participants' movements were captured in real-time by a video camera, which sent the data to a computer system, which then mixed it with computer-generated graphics. Even though they were in separate rooms, the two users felt as if they were sharing the same virtual world, with the silhouettes of both their

⁴¹ M.W. Krueger, *Artificial Reality II*, Boston: Addison-Wesley Professional, 1991: 12.

⁴² “Metaplay 1970”, About Myron Krueger, Accessed December 5, 2024. <https://aboutmyronkrueger.weebly.com/metaplay.html>.

⁴³ “Psychic Space 1971”, About Myron Krueger, Accessed December 5, 2024. <https://aboutmyronkrueger.weebly.com/psychic-space.html>.

bodies projected onto the screen. This sophisticated mechanism foreshadows Slater et al.'s research on the 'virtual arm illusion', which consists of three experiments intended to demonstrate how the perception of the physical body can be transferred within virtual environments, regardless of the photorealism of computer-generated elements or artificial space⁴⁴. Similarly, Videoplace shows that "people feel that their images are extensions of their identity. What happens to the images happens to them. What touches the images they feel. They immediately accept the reality of any image that includes their own"⁴⁵.

Krueger thus reflects on embodiment within virtual spaces, long before they had become immersive environments in the way we perceive them today. In later versions of Videoplace, the artist introduces new forms of computer autonomy, such as the ability to change the colour, size, and position in virtual space of the body, and digital elements that react to the user's presence⁴⁶. Because of the Videoplace's limitless potential, Krueger presents it as 'a new medium' – a digital setting that can be used to create a variety of experiences through various forms of interaction. The artist continued to work on the project in his Artificial Reality Lab to develop this ideal new medium. Metaplay, Psychic Space, and Videoplace depict the development of what Krueger refers to as a 'responsive environment', namely an environment "in which a single participant's movements are perceived by a computer that in turn responds through visual and auditory displays"⁴⁷. The key component of the new medium is this responsiveness, which is exemplified by Videoplace but that can be broadly defined as Artificial Reality, or what would eventually be known as Virtual Reality. Krueger claims that Artificial Reality lends itself to becoming an autonomous form of artistic expression, based on the crucial principle of interactivity.

Like Sutherland, Krueger was able to create his art inside the exclusive borders of American research institutions and universities. He started working as an adjunct professor at the University of Wisconsin in 1974, where he exhibited both Metaplay and Psychic Space. He continued to work on Videoplace until 1978 within the Space Science and Engineering Center, which is also affiliated with the University of Wisconsin. He was able to do so with the financial assistance of the National Endowment for the Arts, a federal organisation in the United States that funds the most promising works of art, and two other significant organizations – the Wisconsin Arts Board, which supports the arts and creative endeavours, and the Brittingham Wisconsin Trust Grant, which funds university projects. In 1979, Krueger moved – with Videoplace – to the computer science department of the University of Connecticut, where he remained until 1985. Only after ten years of academic affiliation did Videoplace become an autonomous initiative, but it retained close links with the University of Connecticut, which continued to sponsor ancillary projects⁴⁸.

Because of his institutional role, Krueger was at the epicentre of some of the trends that accompanied the growth of XR in the 1980s and 1990s. Like Sutherland, his academic background and Videoplace's official affiliation are rooted in the computer sci-

⁴⁴ M. Slater, D. Pérez-Marcos, H.H. Ehrsson, M.V. Sanchez-Vives, "Towards a Digital Body: The Virtual Arm Illusion", *Frontiers in Human Neuroscience*, 2, 6, 2008: 1-8. DOI: 10.3389/neuro.09.006.2008.

⁴⁵ M.W. Krueger, "Videoplace: A Report from the Artificial Reality Laboratory", *Leonardo*, 18, 3 (1985): 145-151 (148).

⁴⁶ M.W. Krueger, T. Gionfriddo, K. Hinrichsen, "Videoplace – an Artificial Reality", *Proceedings of the SIGCHI Conference of Human Factors in Computing System*, 1985: 35-40. DOI: 10.1145/1165385.317463.

⁴⁷ Krueger, "Videoplace: A Report from the Artificial Reality Laboratory": 147.

⁴⁸ Krueger, *Artificial Reality II*.

ence environment. Krueger began his career as a programmer, which led to his first collaboration with Sandin on Glowflow. He then pursued a personal creative path, but always in environments primarily focused on scientific research. At the same time, *computer art* emerged in the late 1960s and early 1970s⁴⁹. While Krueger was working on Videoplace, the art journals were rife with debate over the aesthetics of algorithms, the linguistic and technological elements, and the ontological specificities of the new medium. In 1979, Frank Malina published *Visual Art, Mathematics, and Computers*, a collection of articles originally featured in the *Leonardo* journal between 1969 and 1977. At the same time, artists and computer scientists were cooperating through events such as *9 Evenings: Theatre and Engineering*, in which ten artists collaborated closely with approximately 30 engineers to create multimedia performances that were exhibited in 1966 at the Brooklyn Museum in New York⁵⁰, culminating in the founding of Experiments in Art and Technology (EAT). London followed soon after with the 1967 launch of the first exhibition focusing on the relationship between art and computers, titled *Cybernetic Serendipity*⁵¹. It was also shown at the Corcoran Gallery of Art in Washington, DC, and the Exploratorium, a museum of art, technology, and science in San Francisco. Opportunities for exchange increased during the 1970s, both because of the establishment of media centres like Bell Labs and EAT itself, which brought together professionals and creatives, and because of the creation of international events, like the *Ars Electronica* in Linz.

Krueger created and developed Videoplace by bridging these two trends – the first wave of scientific interest in producing hardware capable of developing immersion in the virtual environment, and a vibrant artistic community rethinking computers in creative ways, thereby stimulating new technical innovations. Krueger aligns primarily with the artistic field, despite his liminal position between the two poles. In a 1993 SIGGRAPH paper, the artist criticised the tendency to marginalise the driving efforts of the new medium's development to technical organisations like NASA and to associate the development of VR with purely academic and scientific research. In contrast, Krueger emphasises the role of the arts, connecting its roots back to Heilig's Sensorama and, thus, to cinema. During his closing remarks, he states that

virtual reality is more than just a technology – it is a culture-defining medium like film or television. Its use will be judged by aesthetic as well as technical criteria, whether it is used for artistic expression or practical application [...] the new artistic medium will lead to new markets that dwarf the so-called practical applications⁵².

Immersive technologies developed straddling two forces before the creation of a market in the 1980s. On the one hand, the technical-scientific drive of research centres, mostly in the United States, received substantial government support. On the other hand, artistic exploration stimulated research for its own sake, but often without enjoying the same financial security as the academic institutions. This dichotomy shaped

⁴⁹ M. Mancuso, *Arte, tecnologia e scienza. Le art industries e i nuovi paradigmi di produzione nella new media art contemporanea*, Sesto San Giovanni: Mimesis, 2018.

⁵⁰ D. Garwood, "The Future of an Idea. 9 Evenings – Forty Years Later", *Journal of Performance and Art*, 29, 1 (2007): 36-48.

⁵¹ J. Reichardt, "Cybernetic Serendipity: The Computer and the Arts", *Studio International*, special issue, 1968.

⁵² M. Krueger, "The Artistic Origins of Virtual Reality", *Siggraph 93: Machine Culture*, 1993: 148-149 (149).

the evolution of the medium throughout the 1980s and 1990s when key concepts of virtuality, which emerged during the pre-industrial phase of the medium, were re-examined and redefined.

4. CONCLUSION

Before the immersive media market developed, its industrial origins were rooted in a few early attempts to create technologies that could enable sensory immersion in computer-simulated environments. Reconstructing its historical foundations serves to identify the elements that connect contemporary conceptualisations of VR to the medium's earliest developments in the pre-industrial era, but also to examine the broader historical and technological context in which these advancements occurred. Regarding the first goal, each of the three significant inventions discussed here represents a different part of the modern concept of VR. Heilig's patented Sensorama, which is frequently cited in industry publications and specialised platforms as a pioneering example of immersive cinema⁵³, exemplifies the concept of narrative immersion through simulated realities designed to elicit empathy – an aspect that is explicitly emphasised in both its promotional materials and Heilig's public statements. Although the technology itself does not entirely correspond to the definition of virtual reality as established in the introduction, many of its conceptual roots are crucial to the eventual development of VR as a medium.

On the other hand, Sutherland's Sword of Damocles, which introduced the digital simulation of virtual objects that react to human eye movements, represents a significant turning point in the technological development of VR. The Sword of Damocles, often considered as the first head-mounted display (HMD)⁵⁴, sparked controversy at the time, particularly because government agencies such as the CIA were involved in its research and development. However, its significance stems primarily from its impact on the network of computer scientists who built on Sutherland's innovations to advance the field of VR.

While VR can be understood as a scientific domain concerned with simulating virtual environments, its medial dimension emerges from the technology's communicative and expressive affordances. Krueger anticipates this aspect in his Videoplace, which not only introduces digital environment simulation into artistic practice but also serves as a foundation for his later theoretical contributions regarding the role of art in shaping emergent media, as depicted in *Artificial Reality*.

Regarding the historical conditions that shaped the early development of VR, this study also examines the challenges associated with projects driven primarily by artistic and expressive issues. In *Blueprint for a New Hollywood*, Heilig critiques the reluctance of the U.S. film industry to adopt alternative technologies that might have enhanced its competitiveness⁵⁵. His attempts to incorporate the Sensorama into cinematic and entertainment contexts were partially hampered by an industrial landscape that remained

⁵³ J. Di Bon, "Where Did Virtual Reality Come From? And Where Is It Going?", *Huffpost*, 24 October 2017, https://www.huffingtonpost.co.uk/jeannie-di-bon/where-did-virtual-reality_b_12615646.html.

⁵⁴ P. James, "Watch the 'Godfather of VR' Ivan Sutherland Speak at the 2015 Proto Awards", *Road to VR*, 23 September 2015. <https://www.roadtovr.com/watch-the-godfather-of-vr-ivan-sutherland-speak-at-the-2015-proto-awards/>.

⁵⁵ M. Heilig, *Blueprint for a New Hollywood*, 1971, https://web.opendrive.com/api/v1/download/file.json/Ml8xNTA4ODMzMjdftemp_key=%04%B5%04%3D%12Om%059%1D%B4%03m%11m%B4%1C%E2%CBac%8E%0E%97_&inline=1.

resistant to such breakthroughs, despite the mainstream press's good acceptance of the immersive screen concept. Moreover, the Sensorama itself suffered from substantial technical constraints, further limiting its wider adoption.

Second, early experiments with immersive technologies were founded on a scientific curiosity that grew primarily in the United States, in a context marked by the Cold War – and hence major federal investment – as well as a genuine interest in the possibilities of computer science. This scenario gave birth to the Sword of Damocles. The device's significance stems from how Sutherland's early discoveries were deployed within research environments. Between Heilig's industrial failure and Sutherland's technological success stands Krueger's Videoplace. The artistic community's enthusiasm for computer art's expressive possibilities swept through the 1960s and 1970s, a trend that would ultimately be crucial to the subsequent creative application of VR. In this environment, Krueger created an artistic project that mirrored his time's creative climate while receiving funds from American institutions that recognized its substantial technical advancements, similar to the Sword of Damocles.

Heilig and Krueger are symbolically close to the notion of the artist as 'the antennae of the race', a rhetorical figure employed by McLuhan based on Ezra Pound's proposal to demonstrate the power of the arts to anticipate and stimulate technological and social advancements⁵⁶. Heilig gained nothing in terms of economic or commercial success, as his projects remained outside the support of organizations capable of sustaining them. Working in the exclusive settings of universities, Krueger was able to run his own business effectively and react to an inspiring creative atmosphere. Sutherland, on the other hand, abandoned his interest in head-mounted displays early on, but only after leaving computer scientists with an effective Sword of Damocles. The prototypes created by all three authors are comparable to key elements of modern XR, contributing to a larger discussion on the history of immersive technologies.

⁵⁶ M. McLuhan, *Understanding Media: The Extensions of Man*, New York: McGraw-Hill, 1964.